PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. II. 1838. No. 55.

AT THE

ANNUAL GENERAL MEETING,

16*th February*, 1838,

The following Report from the Council was read:—

The Council has on this, as on many preceding Anniversaries, to congratulate the Society on the steady augmentation of its numbers a circumstance gratifying, not only because it adds to the efficiency of the body, but because it evinces on the part of the public a growing attachment to Geological Science. During the year 1837 the number of Fellows, with the Honorary and Foreign Members, has risen from 810 to 837, 47 Fellows having been elected during that period, and the deaths and resignations having amounted to 20.

The business to be transacted by the Society having grown with its growth, it has become necessary to review, and in some instances to remodel, the salaried department. It has appeared desirable to the Council that the laborious and difficult duty of arranging and cataloguing the collections should devolve upon an officer whose time should be given to that single object; but the qualifications required in such an officer are so many and so rare, that though numerous candidates have presented themselves, no one has yet been appointed.

The reforms which the Council contemplate in the salaried department will, it is hoped, when complete, add to its efficiency without any material augmentation of expense. In compliance with a Bye-Law of the Society it is the duty of the Council to state that Richard Beauchamp and his wife have been appointed to the situations of porter and housekeeper, instead of Robert Carrier, deceased.

The Council have great pleasure in observing the state of the finances, of which a detailed statement is appended to this Report.

The estimates of the past year have so far exceeded the expenditure as to warrant the expectation that the reduced estimate now given in will be sufficient to meet the expenditure of the present year, notwithstanding the charges which may be occasioned by increased efficiency in the establishment.

The property of the Society estimated at the last Anniversary at 2563*l.* 5*s.* 5*d.* is now estimated at 2898*l.* 5*s.* 10*d.*

In the Auditor's Report for 1833, it was recommended that the Council should, from time to time, make, from the surplus income of the Society, such investments in the Government Funds as would create a capital equal to the amount of sums paid in lieu of annual contributions.

From that period the Council has steadily acted upon the recommendation suggested, and it is gratifying to state, that the Society has now, in funded property, a capital of 1643*l.*, the total amount of compositions received being 3249*l.* 10*s.*

A new part volume of Transactions has been published since the last Report, and from the orderly arrangements now made, there is every reason to hope that this very important department of the Society's concerns will be conducted henceforward with a degree of regularity and despatch which, in the less prosperous state of the Society, it was not found practicable to ensure.

The Council has resolved "that the Wollaston Gold Medal and 21*l.* be assigned to Mr. Richard Owen for his services to Fossil Zoology in general, and especially for that portion of the description of the Fossil Mammalia (collected by Mr. Charles Darwin in the voyage of H. M. S. Beagle) which has already been published."

Report of Museum Committee.

Your Committee, before reporting on the general state of the Museum with reference to the appointment of a new Curator, will first point out what has been principally effected during the past year. A complete suite of all the fossils from the Crag which are in the possession of the Society, has been, for the first time, arranged by Mr. Lonsdale, and they fill ten drawers. All the fossils of the London clay, received from Mr. Stokes and others, have been worked into their proper places, as has been likewise done with those from the chalk. The fossils from the gault and upper green-sand, presented by Dr. Fitton and others, have likewise been arranged. Those of the lower green-sand have been arranged for the first time: the specimens from the green-sand of Devonshire occupy eight drawers. Those from the Portland sand and limestone occupy an equal number. Your Committee in stating what has been done during the last year, wish to observe, that the number of drawers, considerable as it is, gives no just idea of the amount of labour bestowed on the collection. Besides the great care and time required to extract some of the fossils from the rock, in all cases where possible, complete suites of the different species, from their earliest to their most advanced stages of growth, have been formed; the extreme value of which will be at once obvious to every zoologist. On the board on which the specimen is fastened, the locality, name of donor, that of species, and often references to some standard work, are inscribed.

The remainder of the public collection is much in the same state as during former years. Weald clay and Purbeck not arranged. Oolite and lias, specimens labeled but not arranged. The arrangement of the new red sandstone, mountain limestone, and old red sandstone, has been stopped until the publication of Mr. Murchison's work. The formations below the old red sandstone are placed in geographical order, until our knowledge of their relations be more complete. The traps and granites are grouped by themselves. The specimens from Scotland are arranged on the same principle with those from England; but the fossils are comparatively few in number. The arrangement of the Irish collection is geographical. The same principle has been followed in the whole foreign collection, with the exception of a part belonging to the best known formations of France. With respect to the foreign collection, your committee beg to observe, that two of its members having occasion during the last year to consult certain portions of it from distant quarters of the world, namely the Himalaya and the Andes, found the present arrangement the best for their purpose. At p. 461 of the Proceedings a list of the number of drawers, appropriated to specimens from different countries, is given, and therefore it is thought unnecessary here to repeat it.

In the cellars there is a considerable number of boxes containing specimens not yet arranged; and the collection of duplicates is enormous.

After these remarks it may be observed, that the first principle of arrangement in the collection has been geographical; and that, where there existed sufficient data, this has been followed up by a stratigraphical classification. In the latter case, the upper drawers contain the rocks; the next any accompanying minerals, and the lower ones the organic bodies,—beginning with those of the simplest structure, and so proceeding to the higher orders. With respect to catalogues; separate ones have been made by Mr. Lonsdale, of the fossils of some of the English formations. Your committee would suggest the advantage (when time permits) of forming an index of the fossil shells, either according to a natural system, or alphabetically, so that any person might know in which drawer a given species could be found, without having to search the catalogues of the separate formations. And likewise they would suggest, that a brief geographical catalogue of the whole collection should be made, with references to letters pasted on the different cases, so that every member might at once know what specimens were in the collection from any locality. Even the brief list given at p. 461, and before alluded to, with references to the drawers, would, in the opinion of your committee, be extremely useful, and would require very little time.

The mineralogical collection is in the same state as during the previous year. It would, perhaps, be advantageous if attention were called to this collection by a title inscribed over it, instead of over the door of the Library.

With respect to the Library your committee report, that a catalogue has been made by Mr. Humphreys of every book and of the numerous pamphlets in it, with a full title and reference to each. The books themselves have likewise been classed according to the subjects of which they treat, or the system of their publication. Your committee are of opinion, that the catalogue is not only highly useful to the Society, but most creditable to the industry of Mr. Humphreys, who has completed it by himself during the past year. The committee observe that much of Mr. Humphreys's time has been required in supplying books to the members, and in preparing, together with Mr. Bailey, sections for the evening's meetings. The charts were arranged during a previous year, with much care, by Mr. Lonsdale, with references to the printed catalogue. Your committee may remark, that if letters were added to the shelves and cases, a work of very little time, any one consulting the catalogue for the first time would be able immediately to find any chart he wanted. The maps are in a less perfect state of arrangement.

The Committee beg leave to mention as the principal donations to the Museum, since the last Anniversary, the following list:—

Fossils from the Crag; presented by Mr. Brown, F. G. S.

Tooth of a Mastodon from the Crag; presented by Rev. J. Gunn.

Fossils from Grignon, and other tertiary deposits in France; presented by Mr. Stokes.

Specimens of polished Fossil Woods from Antigua; presented by Major Gen. Sir Patrick Ross.

A collection from Cutch; presented by Capt. Grant.

Collection from the Madras Presidency; presented by Mr. Malcolmson.

Specimens from Eastern Australia; presented by Major Mitchell.

Capt. Beaufort has forwarded to the Society several small collections sent to England by officers of the Royal Navy.

Specimens from the countries between Madras and the Neilgherries, and other parts of India; presented by Dr. Benza.

CHARLES LYELL.
CHARLES DARWIN.

Comparative Statement of the Number of the Society at the close of the years 1836 *and* 1837.

	31st Dec. 1836.	31st Dec. 1837.
Fellows having compounded	97	103
——— Contributing	251	253
——— Non-residents	361	382
	709	738
Honorary Members	43	42
Foreign Members	55	54
Personages of Royal Blood	3	3
	810	837

General Statement explanatory of the changes in the Number of Compounders, Residents, and Non-residents, at the close of the years 1836 and 1837.

At the close of 1836			709
Add Fellows elected during 1837			47
			756
Deduct, Deceased,	Residents	3	
	Non-residents	2	
	Compounder	1	
Resigned,	Residents	10	
	Non-residents on becoming Resident	2	
			18
Total number at the close of 1837			738

Deceased Fellows:—

Residents (3): Samuel Daniel Broughton, Esq.; Henry Thomas Colebrook, Esq.; Edward Turner, M.D.
Non-residents (2): Robert Bevan, M.D.; John Hey, Esq.
Compounder (1): James Vine, Esq.
Honorary Member (1): Professor Farish.
Foreign Member(1): M. Gillet de Laumont.

The following Donations to the Museum have been received since the last Anniversary:—

British and Irish Specimens.

Specimens from the Chalk and superficial detritus of Norfolk; presented by C. B. Rose, Esq.
Specimens from Cornwall; presented by James Yates, Esq. F.G.S.
Specimens from Sarn Badrig, Cardigan Bay; presented by Lieut. Sheringham, R.N.
A Collection of British Specimens; presented by Miss Lousada.
Specimens from the Crag of Norfolk; presented by John Brown, Esq. F.G.S.
Pentacrinites Briareus from the Lias, Lyme Regis; presented by Viscount Cole, M.P. F.G.S. and Sir Philip Grey Egerton, Bart. M.P. F.G.S.
Fossils from the Mountain Limestone of Ireland; presented by Viscount Cole, M.P. F.G.S.
Polished Specimens of the Limestone of Kilkenny; a Boulder of the Hertfordshire Pudding Stone; Granite from Newry (on the Road to Belfast); Specimens from the Coal Mines of Burdie-house; Primitive Limestone from Glen Tilt; and Granite and Mica Slate

with Garnets, from between Dunkeld and Blair; presented by William Perceval Hunter, Esq. F.G.S.

Specimens of Coal Plants from Rotherham; presented by — Roberton, Esq.

Tooth of a Mastodon from the Crag of Norfolk; presented by Rev. John Gunn.

Ammonites Lewesiensis from Shakespeare's Cliff, Dover; presented by F. Bonney, Esq.

Vegetable Impressions from the Coal Measures at Rhymney, near Merthyr Tydvil; presented by Thomas Williams, Esq.

Fossils from the Mountain Limestone in the Isle of Man; presented by Captain Bentham, 52nd Regt.

Specimens of Iron Ore from Cornwall; presented by Benjamin Tucker, Esq.

Polished Slab of the Fossil Tree at Cragleith; presented by Messrs. Walker and Burgess.

Stag's Horn, from the Preston and Wyre Railway, Lancashire; presented by Decimus Burton, Esq. F.G.S.

Specimens of the Whitby and Whitehouse Building Stone, and of the Whitby Porcelain Earth in contact with a Whinstone Dyke; presented by the Whitby Stone Company.

Specimens from near the Trap Dyke, in the Penrhyn Slate Quarries; presented by Mr. S. Morris.

Fossils from the Mountain Limestone, Oolitic, and Cretaceous System of England; presented by Miss Bennett, of Norton House.

Vertebra of a Plesiosaurus, from Terry's Pits, Haseley Mill, Oxfordshire, and a Fragment of a Stag's Horn from the same Locality; presented by Rev. T. Birkett, South Taunton, Devonshire.

Specimens from the Slate of Devonshire; presented by Henry Maclauchlan, Esq. F.G.S.

Foreign Specimens.

Specimens from Finland and Norway; presented by Francis Walker, Esq. F.G.S.

Stalagmite from Gibraltar; presented by Louis Hayes Petit, Esq. F.G.S.

Fossils from Grignon, Hauteville, Bordeaux, and Piacenza; presented by Charles Stokes, Esq. F.G.S.

Hippurite from Perigord; presented by Samuel Peace Pratt, Esq. F.G.S.

Polished Specimens of Fossil Wood from Antigua; presented by Major-General Sir Patrick Ross, G.C.M.G. K.C.H. F.G.S.

Osseous Breccia from Cerigo; presented by Dr. Forbes.

Rock Specimens and Fossils from Faxoe; presented by Dr. Forchhammer, For. Mem. G.S.

A Suite of Geological Specimens from New Jersey; presented by Professor D. Rogers, F.G.S.

A Collection of Fossils and Rocks from Cutch; presented by Captain Grant.

Specimens from Sicily, Vesuvius, the neighbourhood of Naples, &c.; presented by John Auldjo, Esq. F.G.S.

Fossils and Specimens of Rocks from the Eastern portion of the Great Basaltic District of India; presented by J. G. Malcolmson, Esq. F.G.S.

Specimens from the country between Madras and the Neilgherries, and other parts of India; presented by Dr. Benza.

Specimens from Cape Horn, the Straits of Magellan, &c.; presented on the part of Charles Collett, Esq. by Capt. Beaufort, R.N. Hon. Mem. G. S.

Specimens from the Pitch Lake at Trinidad; presented by Gilpin Gorst, Esq. F.G.S.

Specimens from the Gold Coast, collected during the voyage of H. M. S. the Chanticleer; presented on the part of Capt. Vidal, R.N. by Captain Beaufort, R.N. Hon. Mem. G. S.

Casts of Basilosaurus, &c.; presented by Dr. Harlan.

Specimens from the shores of the Dead Sea; presented by Henry Beek, Esq.

A collection of Specimens from Australia; presented by Major T. L. Mitchell, F.G.S.

A Specimen of Ficoides; presented by Mrs. Major-General Le Couteir.

A Stone brought up by the lead in eighty fathoms water upon the edge of the bank, about fifty miles east from Cape St. John, Slater Island; presented by Captain Beaufort, R.N. Hon. Mem. G. S.

Specimens from Madras, Beder, &c.; presented by Dr. Cole.

Specimens from Madeira; presented by William Christie, jun. Esq.

Specimen of the Asphaltic Mastic; presented by F. W. Simms, Esq.

Miscellaneous.

Geological Model of the Isle of Wight; presented by Mr. Lowry.

Roman Coin Mould found at Lingwell Gate, near Wakefield, containing remains of Infusoria; presented by J. B. Reade, Esq.

Bust of Dr. William Smith; presented by William Perceval Hunter, Esq. F.G.S.

Model of Clare Island, on the coast of Mayo, Ireland (scale 8 inches to 1 Irish mile); presented by William Bald, Esq. F.G.S.

Two Denarii of Geta and Antoninus Pius; presented by Mr. William Till.

The Library has been increased by the Donation of about 140 Books and Pamphlets.

Charts and Maps.

Admiralty Charts, Sailing Directions and Tide Tables, published during the year 1836; presented by Captain Beaufort, R.N. by direction of the Right Hon. the Lords Commissioners of the Admiralty.

Ordnance Townland Survey of the Counties of Meath, Leitrim, Sligo, and Longford; presented by Colonel Colby, F.G.S., by command of His Excellency the Lord Lieutenant of Ireland.

Sheet 59 of the Ordnance Survey of England; presented by the Master General and Board of Ordnance.

Sections and Plans of the Chester Junction, Chester and Trewe, and the Manchester South Union Railways; presented by Sir Philip Grey Egerton, Bart. M.P. F.G.S.

Fifteenth Section of the Geological Map of Saxony; presented by the Council of Mines of Saxony.

The following List contains the Names of all the Persons and Public Bodies from whom Donations to the Library and Museums have been received during the past year.

Abich, H., M.D.
Academy of Sciences of Paris.
Admiralty, The Lords Commissioners of the.
Allen and Co., Messrs.
American Philosophical Society.
Asiatic Society of Bengal.
Athenæum Club.
Athenæum, Editor of
Auldjo, John, Esq. F.G.S.

Baily, Francis, Esq. F.G.S.
Bald, William, Esq.
Beaufort, Captain, R.N. Hon.M. G.S.
Beek, Henry, Esq.
Benett, Miss
Bentham, Captain, 52nd Reg.
Benza, P. M., M.D.
Beyrich, Ernest, M.D.
Birkett, Rev. Thomas.
Birmingham Philosophical Institution.
Black, James, M.D.
Benny, F. Esq.
Bennias, M. Henri.
Bouillet, M. J. B.
Boulanger, M. C.
Brede, M. F. Julius.
British Association.
Bronn, Dr. H. G.
Brongniart, M. Alex., For. Mem. G.S.
Brown, John, Esq. F.G.S.
Burkart, Joseph, Esq. F.G.S.
Burton, Decimus, Esq. F.G.S.

Cambridge Philosophical Society.
Capocci, Sig. Ernesto.
Cautley, Capt. F.G.S.
Charlesworth, Edw., Esq. F.G.S.
Christie, William, jun. Esq.
Colby, Colonel Thomas, R.E. F.G.S.
Cole, Dr.
Cole, Viscount, M.P. F.G.S.
Collett, Charles, Esq.
Cooper, Daniel, Esq.
Council of Mines of Saxony.
Coxe, Leonard, S. Esq., F.G.S.

Daubeny, Prof. M.D. F.G.S.
De Blainville, M. H. D. For. Mem. G.S.
De Klipstein, M. A.
D'Orbigny, M. Charles.
De Waldheim, M. G. Fischer, For. Mem. G.S.

Egerton, Sir Philip Grey, Bart. M.P. F.G.S.
English, Henry, Esq. F.G.S.

Falconer, M.D.
Forbes, Dr.
Forbes, Prof. James David, F.G.S.

Forchhammer, Prof. G., For. M. G.S.
Foster, T. Esq.
Fox, Robert Were, Esq.
Freyberg, Directors of the Royal Mines at.

Gemmellaro, Prof. C.
Geological Society of France.
Gesner, Abraham, Esq.
Gordon, Alex., Esq.
Gorst, Gilpin, Esq. F.G.S.
Grant, Captain.
Grateloup, M. le Docteur.
Gray, John Edward, F.G.S.
Gunn, Rev. Alfred.

Hall, Capt. Basil, R.N. F.G.S.
Harkness, Capt. Henry.
Harlan, Dr.
Heuland, Henry, Esq. F.G.S.
Hunter, W. Perceval, Esq. F.G.S.
Hutchison, Graham, Esq.

Institute of British Architects.
Institution of Civil Engineers.
Ireland, His Excellency the Lord Lieutenant of.
Islington Literary and Scientific Society.

Jerdan, William, Esq.

Lea, Isaac, Esq.
Le Couteir, Mrs. Major-General.
Leeds Literary and Philosophical Society.
Lhotsky, Dr. John.
Liebig, Professor.
Linnean Society of London.
Loury, Mr. J. W.
Loudon, John Claudius, Esq.
Lousada, Miss.
Lyell, Charles, Esq. F.G.S.

Maclauchlan, Hen., Esq. F.G.S.
Maclure, William, Esq. Hon. Mem. G.S.
Madras Literary Society, Secretary of the.
Malcolmson, John, Esq. F.G.S.
Master-General and Board of Ordnance
Medico-Botanical Society.
Mitchell, Major T. L., F.G.S.
Morris, Mr. Samuel.

Nattali, Mr.
Newhaven Verd Antique Mining Company.

Parish, Sir Woodbine, K.C.H. F.G.S.
Petit, Louis Hayes, Esq. F.G.S.
Phillips, Prof. John, F.G.S.
Pratt, Samuel Peace, Esq. F.G.S.

Reade, J. B. Esq.
Rees, George Owen, Esq. F.G.S.
Repertory of Patent Inventions, Editor of.
Richardson and Co., Messrs.
Roberton, — Esq.
Rodd, Mr. T.
Rogers, Prof. Hen. Darwin, F.G.S.
Rogers, Prof. William B.
Rose, C. B. Esq.
Ross, Major-Gen. Sir Patrick, G.C.M.G. K.C.H. F.G.S.
Royal Academy of Sciences of Lisbon.
Royal Asiatic Society of Great Britain and Ireland.
Royal College of Physicians.
Royal College of Surgeons.
Royal Cornwall Polytechnic Society.
Royal Geographical Society.
Royal Irish Academy.
Royal Society of Edinburgh.
Royal Society of London.
Royle, Prof. M.D. Sec. G.S.
Rozet, M.

Scarborough Philosophical Society.
Seacchi, Sig. A.
Schloss, Herr.
Schmitz, Herr J. W.
Schumacher, Herr H. C.

Sheringham, Lieut. R.N.
Silliman, Benj., M.D. Hon. Mem. G.S.
Sismonda, Sig. Angelo.
Smith, Rev. Dr. John Pye, F.G.S.
Smith, William, LL.D.
Società delle Scienze di Modena.
Société de Physique et d'Hist. Nat. de Genève.
Société des Sciences Naturelles de Neuchâtel.
Society of Arts.
Sowerby, Mr. George.
Stepney, Mr. Samuel.
Stokes, Charles, Esq. F.G.S.
Strickland, Hugh Edwin, Esq. F.G.S.
Studer, Prof. B.
Sudlow, J. J. J., Esq.

Tagart, Rev. Edward, F.G.S.
Taylor, Richard, Esq. F.G.S.
Templeman, J. Esq.
Till, Mr. William.
Tucker, Benjamin, Esq. F.G.S.
Turner, Wilton G., Esq.

United Service Museum.

Vidal, Capt., R.N.
Virlet, M. Theodore.
Voltz, Prof. P. L., For. Mem. G.S.
Von Humboldt, Baron, For. Mem. G.S.
Von Koch Sternfeld, Ritter. J. C.

Walker and Burgess, Messrs.
Walker, Francis, Esq. F.G.S.
Waterton, Charles, Esq.
Weiss, Prof. C. S.
Whewell, Rev. Wm. Pres. G.S.
Whitby Stone Company.
Williams, Thomas, Esq.
Willimott, J. Esq. F.G.S.

Yates, James, Esq. F.G.S.
Yorkshire Philosophical Society.

Zoological Society of London.

The following Persons were elected Fellows during the year 1837.

January 4th.—John Henry Philipps, Esq. of Williamston, Pembrokeshire; the Hon. Col. G. S. Dawson Damer, M.P. of Tilney Street; William Benford Nelson, Esq. of 11, Essex Street, Strand; and Henry Morley, Esq. of the Grove, Camberwell, Surrey.

January 18th.—Benjamin Tucker, Esq. of 21, Mecklenburgh Square; Cæsar Coldough, Esq. of Tintern Abbey, Wexford, and of 9, Princes Street, Hanover Square; George Such, M.D. F.L.S. of New Street, Dorset Square; Travers Twiss, Esq. B.C.L. Fellow of University College, Oxford; Joseph Henry Barchard, Esq. of Putney Heath, Surrey; Gilpin Gorst, Esq. of the Old Trinity House; and William Edward Logan, Esq. of Swansea.

February 1st.—Jonathan Thompson, Esq. of St. Edmond's Hall, Oxford, and Temple Grove, East Sheen, Surrey.

February 22nd.—John Backhouse, Esq. of Hans Place, Sloane Street, Chelsea.

March 8th.—Edward J. Chance, Esq. F.L.S. of Cook's Court, Lincoln's Inn Fields; and Mr. Francis Looney, of Manchester.

March 22nd.—Arthur Capel, Esq. of Charles Street, Berkeley Square; John B. Boileau, Esq. of Upper Brook Street, Grosvenor Square; Henry Still, Esq. employed on the Ordnance Survey; John David Day, Esq. A.B. Brazen Nose College, Oxford; John G. Malcolmson, Esq. Surgeon in the East India Company's Service; and the Right Hon. T. Frankland Lewis, of Hertford Street, May Fair.

April 19th.—Edward Herbert Bunbury, Esq. M.A. Fellow of Trinity College, Cambridge; Henry Boase, M.D. of Burton Crescent; and Thomas Jervis, Esq. Hon. East India Company's Engineers.

May 3rd.—The Rev. Baden Powell, A.M. F.R.S. Savilian Professor of Geometry in the University of Oxford.

May 17th.—Joseph Walker, Esq. of Caldeston House, Liverpool, and President of the Institution of Liverpool.

May 31st.—James Heywood, Esq. of Manchester; Richard Owen, Esq. F.R.S., Hunterian Professor in the Royal College of Surgeons, London; Robert William Mackay, Esq. of Lincoln's Inn; and Charles Humfrey, Esq. A.M. of Downing College, Cambridge.

June 14th.—Raikes Currie, Esq. of Hyde Park Terrace; Rev. Joseph Watkin Barnes, Fellow of Trinity College, Cambridge; Thomas Webster, Esq. of Trinity College, Cambridge, Secretary to the Institute of Civil Engineers; and John Nash Sanders, Esq. of Bristol.

November 1st.—Alexander Crichton, Esq. of Charles Street, Grosvenor Square; Major General Sir Patrick Ross, A.C.M.G. K.C.H. of Richmond, Surrey; John Slade, M.D. of Brock Street, Bath; Philip Hardwick, Esq. of Russell Square; Thomas Eyton, Esq. of Eyton, Shropshire; and the Rev. Robert Wilson, of Ashwellthorpe Hall, near Wymondham.

November 15th.—Henry Edmund Goodhall, Esq. of Guildford Street, Russell Square; William Frederick Mullins, Esq. M.P. of Beaufort House, County of Kerry, and of Great Ryder Street, London.

December 6th.—Levett Landen Boscawen Ibbetson, Esq. of North Kyme, Lincolnshire; Charles Manby, Esq. 9, John Street, Adelphi; Colonel John Briggs, of Cheltenham, Gloucestershire, and of York Gate, Regent's Park.

December 13th.—Lieut. Ouchterlony, of the Madras Engineers; and Rev. Christopher Erle, M.A. Hardwicke Rectory, near Aylesbury, Bucks.

List of PAPERS *read since the last Annual Meeting, February* 17, 1837.

February 22nd.—On the Geology of Cutch; by Capt. Grant, of the Bombay Engineers, and communicated by Charles Lyell, Esq. F.G.S.

March 8th.—On the Geological Structure and Phænomena of Suffolk, and its Physical Relations with Norfolk and Essex; by the Rev. W. B. Clarke, F.G.S.

———— On the Raised Beaches of Staunton Downend and Baggy Point; by the Rev. David Williams, F.G.S.

———— A Communication by Mr. James de Carle Sowerby, On his new genus of Fossil Shells, Tropæum.

March 22nd.—On the Ancient State of the North American Continent; by Thomas Roy, Esq. Civil Engineer, Toronto, Upper Canada, and communicated by Charles Lyell, Esq. F.G.S.

March 8th.—On the Geology of the Neighbourhood of Smyrna; by Hugh Edwin Strickland, Esq. F.G.S.

——————A Letter to Sir Charles Lemon, Bart. F.G.S.; by Robert Were Fox, Esq., On the process by which Mineral Veins have been filled.

—————— Extracts from two Letters, On the Earthquake in Syria, in January 1837, addressed by Mr. Moore, his Majesty's Consul General at Beyrout, to Viscount Palmerston, and communicated by J. Backhouse, Esq., and the Hon. W. T. H. Fox Strangways, Under Secretaries of State.

April 19th.—A Description of the Cranium of the Toxodon Platensis, a gigantic extinct mammiferous species, referrible by its dentition to the Rodentia, but with affinities to the Pachydermata and the Herbivorous Cetacea; by Richard Owen, Esq. F.G.S., Hunterian Professor of Anatomy to the Royal College of Surgeons.

May 3rd.—A Sketch of the Deposits containing Extinct Mammalia in the neighbourhood of the Plata; by Charles Darwin, Esq. F.G.S.

——————Extract of a Letter dated Saharumpore, 18th Nov. 1836, from Capt. Cautley, F.G.S. to Dr. Royle, F.G.S., permitting the announcement of a fact which had long been communicated to the latter, of the finding of the remains of a quadrumanous animal in the Sewaliks or Sub-Himalayan Range of Mountains.

——————On some recent elevations on the Coast of Banffshire, and on a deposit of clay formerly considered to be lias; by Joseph Prestwich, Jun. Esq. F.G.S.

—————— An Account of a Tertiary Deposit near Lixouri, in the Island of Cephalonia; by William John Hamilton, Esq. F.G.S., and Hugh Edwin Strickland, Esq. F.G.S.

May 17th.—A Description of the Geological Character of the Coast of Normandy; by Samuel Peace Pratt, Esq. F.G.S.

——————Extracts from a Letter addressed by Sir John F. W. Herschel, F.G.S. to Charles Lyell, Esq. F.G.S., and dated Feldhausen, Cape of Good Hope, 20th of February, 1836, On secular variations of the isothermal surfaces of the earth's crust.

—————— Extract from a Letter from Sir John F. W. Herschel to Roderick Impey Murchison, Esq. V.P.G.S. in explanation of the letter addressed to Mr. Lyell, dated Feldhausen, 15th of November, 1836.

—————— An Account of a Well at Beaumont Green, in the County of Hertford, fifteen miles from London, and about a mile to the west of the road to Ware; by James Mitchell, LL.D.F.G.S.

May 31st.—On certain areas of elevation and subsidence in the Pacific and Indian Oceans, as deduced from the study of Coral Formations; by Charles Darwin, Esq. F.G.S.

—————— A Letter to Charles Lyell, Esq. F.G.S., On some changes of level which have taken place, during the historical period, in Denmark; by G. Forchhammer, Phil. Doct., Copenhagen, For. Mem. G.S.

June 14th.—On the Physical Structure of Devonshire, and on the Subdivisions and Geological Relations of its old, stratified deposits; by the Rev. Adam Sedgwick, F.G.S., Woodwardian Professor in the University of Cambridge, and Roderick Impey Murchison, Esq. V.P.G.S.

——————— On the Upper Formations of the New Red System in Gloucestershire, Worcestershire, and Warwickshire, showing that the red (saliferous) marls, with an included band of Sandstone, represent the "Keuper" or "Marnes Irisées," and that the underlying Sandstone of Ombersley, Bromsgrove, and Warwick, is part of the "Bunter Sandstein," or "Grès Bigarré," of foreign Geologists; by Roderick Impey Murchison, Esq. V.P.G.S., and Hugh Edwin Strickland, Esq. F.G.S.

——————— A Letter addressed to Charles Lyell, Esq. by Dr. McCleland, on the Natural History of Upper Assam, where the Tea Plant grows wild.

——————— On the Remains of a Fossil Monkey, from the Tertiary Strata of the Sewalik Hills in the North of Hindoostan; by Capt. Proby T. Cautley, Bengal Artillery, F.G.S. and Hugh Falconer, M.D., Bengal Medical Service.

November 1st.—A Letter on Fossil Fishes in the Lancashire Coal Field; by W. C. Williamson, Esq., Curator of the Manchester Natural History Society.

——————— On the Geology of the Island of Zante; by Hugh Edwin Strickland, Esq. F.G.S.

——————— On the Formation of Mould; by Charles Darwin, Esq. F.G.S.

November 15th.—A Letter from Walter Calverly Trevelyan, Esq. F.G.S. to Dr. Buckland, V.P.G.S., On Indications of Recent Elevations in the Islands of Guernsey and Jersey, and on the coast of Jutland, and on some Tertiary Beds near Porto d'Anzio.

——————— A Letter from Sir Robert Smirke, forwarding another from Mr. Edge, On Peat and Fossil Timber found beneath a mass of Granite at St. Peter's, Guernsey.

November 29th.—On the Fossils of the Eastern Portion of the Great Basaltic District of India, by J. G. Malcolmson, Esq. F.G.S., of the Madras Medical Establishment.

December 13th.—On the Geology of the south-east of Devonshire; by Alfred Cloyne Austen, Esq. F.G.S.

January 3rd, 1838.—On the Geological Relations of North Devon; by Thomas Weaver, Esq. F.G.S.

January 17th.—Geological Notes to accompany Major Todd's Sketch of part of Mazunderān; by Dr. Bell.

——————— Notes on the Geology of the Line of the proposed Birmingham and Gloucester Railway; by Mr. Frederick Burr.

——————— On the Coast Section from White Cliff Lodge, one mile south of Ramsgate, to the Cliff's End, near the "Station Brig" in Pegwell Bay, Kent; by Mr. John Morris.

January 31st.—Extract from a Letter addressed by Sir John F. W. Herschel, K.C.H. F.G.S., to Mr. Lyell, On Internal Temperature.

——————— On the Mines of Huantaxaya, in Peru; by Mr. Bollaert.

——————— On Submerged Peat Bogs and Forests near Poole; by the Rev. W. B. Clarke, F.G.S.

VALUATION *of the Society's Property; 31st December* 1837.

PROPERTY.

	£.	s.	d.	£.	s.	d.
Balances in hand, including 49*l.* 19*s.* Wollaston Fund				170	11	0
Arrears due to the Society:						
Admission Fees	74	0	0			
Annual Contributions	390	1	6			
Proceedings	0	14	0			
				464	15	6
Estimated value of unsold Transactions	824	10	6			
——— Proceedings	20	0	0			
				844	10	6
500*l.* Stock, 3 per cent. Consols	450	0	0			
1311*l.* 19*s.* 5*d.* Stock, 3 per cent. Red.	1193	0	0			
				1643	0	0
				£3122	17	0

DEBTS.

	£.	s.	d.	£.	s.	d.
Bills outstanding:						
Taxes	9	3	8			
Scientific Expenditure	1	18	6			
Transactions	3	10	0			
				14	12	2
Cash belonging to the "Wollaston Fund"				49	19	0
Arrears not likely to be received				160	0	0
				224	11	2
Balance in favour of the Society				2898	5	10
				£3122	17	0

[*N.B. The value of the Collections, Library and Furniture is not here included: nor is the "Donation Fund," instituted by the late Dr. Wollaston, amounting at present to* 1084*l.* 1*s.* 1*d. in the Reduced* 3 *per cent. Annuities; the dividends thereof being appropriated to the purposes of the Founder.*]

JOHN TAYLOR, TREASURER.

Feb. 2, 1838.

Sums actually Received and Expended,

RECEIPTS.

	£.	s.	d.	£.	s.	d.
Balances in hand January 1, 1837:						
Banker (including 38*l*. 8*s*. 8*d*. Wollaston Fund)	436	0	7			
Accountant	40	0	0			
				476	0	7
Arrears:						
Admission Fees	119	14	0			
Annual Contributions	187	8	6			
				307	2	6
Ordinary Income:						
Annual Contributions	667	5	6			
Admission Fees: £. s. d.						
Residents 144 18 0						
Non-Residents 157 10 0						
	302	8	0			
				969	13	6
Compositions:						
Six at 31*l*. 10*s*.	189	0	0			
One at 28*l*. 7*s*.	28	7	0			
				217	7	0
Subscription to Alteration Fund				5	0	0
Transactions	403	1	0			
Proceedings	13	13	0			
				416	14	0
Wollaston Donation Fund, Interest on 1084*l*. 1*s*. 1*d*. 3 per cent. Reduced				32	10	4
Dividends, 500*l*. 3 per cent. Consols	15	0	0			
Ditto, 1103*l*. 8*s*. 4*d*. 3 per cent. Red. 6 months	16	11	0			
Ditto, 1311*l*. 19*s*. 5*d*. ditto	19	13	7			
				51	4	7
				£2475	12	6

We have compared the Books and Vouchers presented to us with these Statements, and find them correct.

Signed, W. J. HAMILTON, WOODBINE PARISH, } AUDITORS

February 2, 1838.

during the year ending December 31, 1837.

PAYMENTS.

	£.	s.	d.	£.	s.	d.
Bills outstanding:						
Salaries and Wages, Collector's Poundage	28	15	0			
Scientific Expenditure	0	3	0			
Stationery	0	10	6			
Parochial Rates	2	5	0			
Assessed Taxes	2	8	0			
				34	1	6
General Expenditure:	£.	s.	d.			
Repairs of House	31	2	0			
House Expenses	184	16	1			
Taxes, Parochial	7	5	0			
——, King's	22	11	2			
Household Furniture	41	17	4			
———— Linen	7	4	0			
Plate	8	1	0			
				302	16	7
Insurance				6	0	0
Salaries and Wages:	£.	s.	d.			
Curator and Assistant	200	0	0			
Clerk	75	0	0			
Porter, Housekeeper, and Servant, including Gratuity to Mrs. Carrier	134	15	0			
Collector's Poundage	37	10	0			
				447	5	0
Scientific Expenditure				89	4	5
Stationery and Miscellaneous Printing				50	10	1
Investment in the Funds				689	0	0
Tea for Meetings				52	13	0
Cost of Publications:	£.	s.	d.			
Transactions	511	9	8			
Proceedings	98	18	3			
				610	7	11
Award of Wollaston Fund:						
Medals to Capt. Cautley and Dr. Falconer				21	0	0
Power of Attorney to receive Dividends				2	3	0
Balances in hand Jan. 1, 1838:	£.	s.	d.			
Banker (including 49*l.* 19*s.* Wollaston Fund)	130	11	0			
Accountant	40	0	0			
				170	11	0
				£2475	12	6

ESTIMATES *for the ensuing year* 1838.

INCOME EXPECTED.

	£.	s.	d.	£.	s.	d.
Arrears due to the Society, Dec. 31st, 1837. (See valuation sheet)				464	15	6
Ordinary Income of 1838 estimated:						
Annual contributions (175 Fellows)				550	0	0
Admission Fees:						
Residents (23)	144	18	0			
Non-residents (15)	157	10	0			
				302	8	0
Sale of Transactions	300	0	0			
——— Proceedings	10	0	0			
				310	0	0
Dividends on "Wollaston Donation Fund"				32	10	4
Dividends 500*l.* 3 per cent. Consols				15	0	0
Ditto 1311*l.* 19*s.* 5*d.* 3 per cent. Red.				39	7	2
				£1714	1	0
Balance against the Society				5	1	6
				£1719	2	6

In the above estimated Receipts no Compositions are included.

EXPENSES ESTIMATED.

	£.	s.	d.	£.	s.	d.
Debts outstanding Dec. 31st, 1837. (See valuation sheet)				14	12	2
General Expenditure:						
Repairs of House	20	0	0			
Taxes	50	0	0			
Insurance	9	0	0			
House Expenses	180	0	0			
Household Furniture	100	0	0			
				359	0	0
Salaries and Wages:						
Assistant Secretary	125	0	0			
Curator	125	0	0			
Clerk	75	0	0			
Porter and Housekeeper	70	0	0			
Servant	28	0	0			
Collector's Poundage	35	0	0			
				458	0	0
Scientific Expenditure				75	0	0
Stationery and Miscellaneous Printing				50	0	0
Tea for Meetings				50	0	0
Cost of Publications:						
Transactions	450	0	0			
Proceedings	70	0	0			
				520	0	0
Arrears not likely to be received				160	0	0
Employment of the "Wollaston Donation Fund"				32	10	4
				£1719	2	6

The Reports having been read, it was resolved:

That they be received and entered on the Minutes of the Meeting, and that such parts of them as the Council may think fit, be printed and distributed among the Fellows.

The President then presented the Wollaston Medal to Mr. Richard Owen, and, on doing so, said,

Mr. Owen,

I have peculiar pleasure in presenting to you this Medal, awarded to you by this Society for your services to Fossil Zoology in general, and, in particular, for the description of the Fossil Mammalia collected by Mr. Darwin. I trust it will be a satisfaction to you to read this our testimony of the success with which you have cultivated that great science of comparative zoology, to which you have devoted your powers. I trust it will add to your satisfaction to consider that the subject which we more peculiarly wish to mark on this occasion, in the study of Fossil Zoology, is one to which the resources of your science were applied, while the subject was yet new, by that great man, John Hunter, whose Museum and whose reputation are so worthily assigned to your care. I trust also that this Medal thus awarded to you at the outset, if I may so say, of an enlarged series of investigations, will convey to you the assurance that, in your progress in such researches, you carry with you our strong interest in your endeavours, and our high esteem of your powers and your objects; and will convince you that in all your successes, you may reckon upon our most cordial sympathy in the pleasure which your discoveries give.

Mr. Owen acknowledged his sense of the distinction conferred upon him in the following terms:—

I wish, Sir, that I had words adequately to express my deep sense of the honour I have now received; but I feel assured that you will grant to me the sincerity of my brief acknowledgments. The study of the animal organization has always abundantly repaid me by the pleasure which naturally flows from the contemplation of the marvellous skill with which, in the complete frame of existing species, structures are modified and designed in relation to particular ends; and from the perception of a subordination of the various instruments to one general plan. But since I have pursued anatomical investigations in connection with fossil remains, I have been rewarded by new and extrinsic pleasures. I trace to this source my connexion with the Geological Society, and the possession of some most valued friendships; and now, Sir, my obligations to the Society, and to Palæontology are increased ten-fold by the unexpected honour I have this day received at your hands. I receive this testimony of your good opinion as a strong stimulus to future endeavours. I cannot permit myself to regard it as a reward for the inadequate contributions which I have hitherto been able to make to the history of lost species; and I pledge myself to lose no available time or opportunity which may be applied to further that branch of geological science which has the extinct animals of this planet for its immediate object.

It was afterwards resolved;—

1. That the thanks of the Society be given to the Rev. William Buckland, D.D. and George Bellas Greenough, Esq., retiring from the office of Vice-President.

2. That the thanks of the Society be given to Robert Hutton, Esq. M.P., and Professor J. F. Royle, M.D., retiring from the office of Secretary.

3. That the thanks of the Society be given to Francis Baily, Esq.; William John Broderip, Esq.; William Clift, Esq.; Henry Hallam, Esq.; and Henry Warburton, Esq. M.P., retiring from the Council.

After the balloting glasses had been duly closed, and the lists examined by the scrutineers, the following gentlemen were declared to have been elected the Officers and Council for the ensuing year.

OFFICERS.

PRESIDENT.

Rev. William Whewell, M.A. F.R.S.

VICE-PRESIDENTS.

William Henry Fitton, M.D. F.R.S. & L.S.
Charles Lyell, Jun. Esq, F.R.S. & L.S.
Roderick Impey Murchison, Esq. F.R.S. & L.S.
Rev. Adam Sedgwick, F.R.S. & L.S., Woodwardian Professor in the University of Cambridge.

SECRETARIES.

Charles Darwin, Esq.
William John Hamilton, Esq.

FOREIGN SECRETARY.

H. T. De la Beche, Esq. F.R.S. & L.S.

TREASURER.

John Taylor, Esq. F.R.S. & L.S.

COUNCIL.

Henry Boase, M.D. F.R.S.
Rev. William Buckland, D.D. F.R.S. L.S. Professor of Geology and Mineralogy in the University of Oxford.
Viscount Cole, M.P. D.C.L. F.R.S.
Charles Giles Budle Daubeny, M.D. F.R.S. L.S. Regius Professor of Botany, and Aldrich's Professor of Chemistry in the University of Oxford.
Sir P. Grey Egerton, Bart. M.P. F.R.S.
G. B. Greenough, Esq. F.R.S. & L.S.
Leonard Horner, Esq. F.R.S. L. & E.
Robert Hutton, Esq. M.P. M.R.I.A.
Sir Charles Lemon, Bart. M.P F.R.S.
Marquis of Northampton, F.R.S.
Richard Owen, Esq. F.R.S.
Sir Woodbine Parish, K.C.H. F.R.S.
John Forbes Royle, M.D. F.R.S. & L.S., Professor of Materia Medica and Therapeutics in King's College, London.
T. Weaver, Esq. F.R.S. M.R.I.A.

Address to the Geological Society, delivered at the Anniversary, on the 16*th of February,* 1838, *by the* Rev. William Whewell, M.A. F.R.S. *President of the Society.*

Gentlemen,

You have heard in the Reports just read, statements which show that the Society is in a state of healthy progress both in respect to its numbers and its funds. The total number of Fellows of the Society, exclusive of Honorary and Foreign Members, at the close of the year 1836, was 709. At the close of the last year it was 738, the increase being 29, after deducting 18 Members deceased or resigned.

A Part of the Transactions has recently been published, which is worthy of its predecessors in the interest of its matter, and which is not inferior to them in its appearance and illustrations. I believe it will be found that improvements have been introduced, especially in the colouring of the maps.

Our collections have also gone on increasing, and have, as in previous years, derived great additional value from the labour and knowledge bestowed upon them by our excellent Curator. But your Council has found itself compelled to attend to the great, and I may say intolerable amount of labour which has fallen upon Mr. Lonsdale, and certain alterations in the Society's arrangements, directed to the object of remedying this evil, are now in progress or in contemplation. When they are completed I shall have the satisfaction of announcing them to the Society.

The Council have awarded the Wollaston Medal, as you have already been informed, to Mr. Richard Owen, for his general services to Fossil Zoology, and especially for his labours employed upon the fossil mammalia collected by Mr. Darwin in the voyage of Captain Fitz Roy. I need not remind you, Gentlemen, how close are the ties which connect the study of living and of fossil animals; how much light the progress of comparative anatomy throws upon the interpretation of geological characters; and what important steps in our knowledge of the past condition of the earth are restorations of the animal forms which peopled its surface in former times, but have long vanished away. Since the immortal Cuvier breathed into our science a new principle of life, the value of such researches has ever been duly appreciated; and the award of the Wollaston Medal last year is an evidence how gladly your Council take that method of congratulating the successful cultivators of such studies. I am sure that all who are acquainted with Mr. Owen's labours will rejoice that we have in this manner marked our sense of his success. His earlier researches, those for instance on the Nautilus, have been of exceeding use and interest to geologists. And the first part of his description of the fossil mammalia, collected by Mr. Darwin in South America, contains matters of the most striking novelty, interest, and importance. We have there the restoration, performed with a consummate skill, such as fitly marks the worthy successor of Hunter and the disciple of Cuvier, of two animals, not only of new genera, but occupying places in the series of animal forms, which are peculiarly instructive. For the one, the Toxodon, connects the Rodentia with the Pachydermata by manifest links, and with the Cetacea by more remote resemblances; and thus contributes to the completion of the zoological scale just in the parts where it is weakest and most imperfect: while the other animal, the Macrauchenia, the determination of which is considered by anatomists as an admirable example of the solution of such a problem, appears to be exactly intermediate between the horse and the camel. But this creature is also interesting in another way, since it closely resembles, although on a gigantic scale, an animal still existing in that country and peculiar to it, the Llama. Thus, in this as in some other instances, the types of animal forms which distinguish a certain region on the earth's surface are clearly reflected to our eyes as we gaze into the past ages of the earth's history, while yet they are magnified so as to assume what almost appear supernatural dimensions. The Llama, the Capybara, and the Armadillo of South America are seen in colossal forms in the Macrauchenia, the Toxodon, and the Megatherium. I will not omit this occasion of stating that the profound and enlarged speculations on the diffusion, preservation, and extinction of races of animals to which Mr. Darwin has been led by the remains which he has brought home, give great additional value to the treasures which he has collected, and make it proper to offer our congratulations to him, along with Mr. Owen, on the splendid results to which his expedition has led and is likely to lead. Mr. Owen and Mr. Darwin are engaged in the restoration of other animals from the South American remains in their possession, and I am able to announce that two or three other new genera have already been detected. I am sure I am conveying your feeling, Gentlemen, as well as my own, when I express a cordial hope that these two naturalists, so fitted by their endowments and character to advance the progress of science, may long go on achieving new triumphs; and may have the satisfaction—higher even than that which they derive from the honours we so willingly bestow—of finding the great principles which it is given to them to wield, becoming every year more powerful instruments of discovery; and of seeing, as they pursue their researches, light thrown upon the darkest and widest of the vast problems which they have proposed to themselves.

I will now say a few words concerning a few of the most conspicuous of the names which have been obliterated by death from our list during the year.

Among the members of our body, whom we have lost, there is one whom we cannot but mention with more than common emotion, endeared as he was to many of us by private friendship, and admired by all for his talents, his knowledge, and his services. Dr. Edward Turner, Professor of Chemistry in the London University, filled the office of our Secretary for five years, and subsequently was two years Vice-President, which situation he held at the time of his death in February 1837. Several of you may remember, Gentlemen, that our last anniversary meeting was in some measure clouded by the recollection of this then recent calamity; and that many of the Fellows of the Society, on that occasion, expressed their intention of testifying their respect and regard for the departed by attending his funeral. Of Dr. Turner's private virtues, and of the charm of his society, I must not here speak. I will not allow myself to dwell upon the admirable clearness and precision of his thoughts as expressed in conversation,—upon the delightful openness and candour of his character,—upon the kind and gentle cheerfulness of his demeanour, the genuine fruit of a deep habitual religious feeling. But I may take this occasion to say, that in him chemistry suffered a loss, not only great,—for that all would at once say,—but much greater and more difficult to repair than may at first sight appear. Dr. Turner entertained a conviction (I am stating the result of many interesting conversations which I have held with him) that the time was come when the chemist could not hope to follow out the fortunes of his science, and to read in her discoveries their full meaning, without being acquainted with the language, and master of the resources of mathematics. Acting upon this enlightened view, he did not hesitate to encounter the great labour and exertion of a course of study in the higher mathematics; and he succeeded entirely in making himself a good mathematician. And he was one of the very few who, in our country, labour at a branch of chemistry which is of the highest importance to us as geologists; but which,—we may suppose from its laborious and intricate nature,—appears to repel our most active chemists; I mean that portion of chemistry which is connected with mineralogy.

Yet this department is, in truth, more inviting than it may at first appear. No doubt in it clear mathematical conceptions are necessary, and perhaps some little training in mathematics; but there is good promise that the labour which this line of investigation demands will be rewarded. I am fully persuaded that there is no portion of the frontier line of our knowledge of which we can so certainly say, "Here we are on the brink of great discoveries." Had Dr. Turner been spared to us some years longer, I know no one who was more likely to have had a principal share in such discoveries. Two papers of his, in the Philosophical Transactions,* show that he was able to deal with the atomic theory in a mode which combines the resources of the skilful analytical chemist with the rigour of the mathematical reasoner; a combination which the right prosecution of that theory requires, but which has not always been found in its cultivators.

Dr. Turner lectured on chemistry at the London University from its first foundation in 1828; he was there surrounded by students, whose affection he gained by his kindness, as well as their admiration by the clearness of his teaching. He also gave a course of lectures on geology, in conjunction with Dr. Grant and Mr. Lindley, such of those gentlemen taking a division of the subject with which he was most familiar. Dr. Turner was snatched from science at the early age of thirty-nine, having been born in the island of Jamaica in 1796. He studied anatomy at Edinburgh, and chemistry at Göt-

* On the Composition of Chloride of Barium, 1829; Researches on Atomic Weights, 1833.

tingen, under the able chemist Friedrich Von Stromeyer, to whom he dedicated his Elements of Chemistry; a work which has had, as it well deserves, a very wide circulation among students.

In William Farish, B.D., Jacksonian Professor of Natural and Experimental Philosophy in the University of Cambridge, the Society has lost an honorary member, elected as such soon after its original foundation, namely in November 1808, and one of a number of our countrymen who were at that period placed upon the honorary list. Professor Farish never employed himself peculiarly in geological pursuits as we now understand the term; but it is to be recollected, that within a few years of the date of his election, which I have mentioned, the investigation of the earth's structure made a rapid progress, and, in consequence, assumed a more fixed and technical form. Professor Farish's scientific studies were mainly directed to the arts, manufactures, and machinery of the empire; on these subjects he delivered courses of lectures full of interest and instruction; and he was thus led to describe our mines, and the mode of working them.

But no reference to particular portions of Professor Farish's labours can convey a just notion of the impulse which he gave to the progress of scientific knowledge within his own sphere of influence, by the habit of seizing, with an active and vivid apprehension, upon prominent parts of modern science, and conveying them, in a manner singularly clear and simple, to his audience. For a long course of years his lectures were more efficacious than any other circumstance in stimulating the minds of men in his university to philosophical thought on physical subjects; and to this day these lectures are never mentioned by those who attended them at that period, without admiration and pleasure. His merit was well recognised by the university in which he spent his life. He received the highest mathematical honours of that body on taking his degree of B.A. in 1778, was elected Professor of Chemistry in 1794, and Jacksonian Professor in 1813; and at the institution of the Cambridge Philosophical Society in Nov. 1819, he was its first president.

I cannot refrain from adding, that although I have here to speak of him principally as a man of science, such pursuits were in his case little more than episodes, in a life the main action of which was directed to the ends of religion and benevolence. In his duties, as a minister of Christianity, he was most zealous and indefatigable; and every attempt to relieve the misery, the ignorance, the unjust restraints of any portion of mankind, found in him a strenuous advocate and ready agent. His childlike simplicity, genuine kindness of heart, and untiring religious earnestness were such as well suited his kindred with Bernard Gilpin, "the Apostle of the North," from whom, through his mother, he derived his descent. He was born at Carlisle in 1759, and died at the age of 78.

Henry Thomas Colebrooke, member of the Supreme Council of Calcutta, was one of those extraordinary men whom our Indian empire has produced; and who show the animating effects of the great scene in which they are there placed, by the variety of subjects to which they extend their attention, and by the vigour with which they combine speculative and practical employment. Mr. Colebrooke went to India as a writer in 1782, and about 1792 began to attend peculiarly to Sanscrit literature. A little later we find him beginning to enrich the Asiatic Researches with a series of memoirs on the religion, the literature, and, above all, the science of the Hindoos. In this department his labours on the Zodiac of the Indians*, and on their notions of the Precession of the Equinoxes and the motions of the Planets†, are highly deserving of notice; as were at a later period the account of the Indian Algebra, given in his translations of the Lilawati and Vijaganita. But Mr. Colebrooke was also ready to contribute a share in sciences with which we are more nearly concerned, He took a lively interest in the correction of errors respecting the physical geography of India, and was one of the first to declare (in 1815) his opinion that the Himalaya mountains were higher than the Andes, an opinion soon afterwards fully confirmed. He also was one of the first to enter upon a subject, to which we may now look with the greatest hope. The first part of vol. i. of our New Series of Transactions (published in 1822) contains two papers by him, one upon the geology of the valley of the Sutledge, which had been explored by Lieut. Gerard; the other upon the north-east of Bengal, where Mr. D. Scott had noticed various rocks, and, among the rest, a deposit which contained fossils, resembling, as he conceived, those of the London clay. I shall have occasion, in the course of this address, to refer to a recent repetition of this observation of an identity

* Asiat. Res., vol. ix. † Ibid., vol. xii.

between the fossils of the east of India and those of the London and Paris basin. I may observe that these, and other contributions to Indian geology by other writers, contained in the volume of which I spoke, and a preceding one, induced the Secretaries of that time to insert a map, on which the localities of these observations were indicated; and to express in the volume a hope, that these were merely an earnest of the information which might be expected from the activity of British subjects in that quarter.

Among our foreign members deceased within the year, I regret much to have to mention one, to whom is due, in no small degree, a revolution in the mode of treating the subject of geology, which has taken place in our own times, and the formation of a new branch of geology. This revolution consists in the endeavour, now so familiar to us, to identify geological with recent changes, instead of classifying the great past changes in the surface of the earth which its structure discloses to us, as separate from the newer and slighter modifications of which history and tradition gives us evidence; and the study of the discernible causes of change to which we are thus led, I shall have occasion to speak of under the name of Geological Dynamics. You are well aware that Mr. Lyell is the person who has, with a bold and vigorous hand, moulded the whole scheme of geology upon this idea; but the power which he had of doing this was derived in no small degree from Von Hoff's admirable survey of the evidence of those changes which can be proved by tradition. The extent and universality of the facts thus brought into notice, might well forcibly strike a philosopher already seeking to apply such a principle to geology; and Mr. Lyell has always been forward to acknowledge his obligations to M. Von Hoff. Indeed the idea of such an identification of geological with historical changes was by no means new; it had been both expressed and acted on by Deluc; and must have been present to the minds of those persons who framed the question which gave rise to Von Hoff's book. This question was proposed in 1818 by the Royal Academy of Science of Göttingen. "Considering," they said, "that we have, in the crust of the earth, evidence of great revolutions, which have happened at different times, in different portions, and of which the period and duration are unknown, we are led to ask whether certain more partial alterations may not lie within the domain of tradition, and give us the means of knowing at what period they took place, and what time the formation of certain portions of the earth's crust required; whereby some light may be thrown on those changes which lie beyond the limits of history."

M. Von Hoff's work,—"The history of those natural changes in the earth's surface which are proved by tradition"—appeared (the first part) in 1822, and had the Academy's prize assigned it. This part of the work contained an account of the changes due to the agency of water; and by the wide range of reading and study which it included, and the philosophical manner in which its copious materials were arranged, well justified the distinction which it received. The view presented in it of the great changes which have gone on from the beginning of historical times,—the yielding or advancing of coasts, the disappearing of islands, the union of seas,—appear to give a new face to the globe. But the portion of the judgement of the Academy which the author most valued was, that in which they said that he had used the sources of his information *conscientiously*, In 1824 appeared the second part, containing the history of volcanos and earthquakes; and, although the previous labours of Humboldt and Von Buch had done much to connect and generalise facts of this kind, Von Hoff's labours were an important step: "At least," he himself says, "he was not aware that any one before him had endeavoured to combine so large a mass of facts with the general ideas of the natural philosopher, so as to form a whole." Among other large views, we may see much which, as to kind of change supposed, agrees with the opinions of Mr. Darwin, of which I shall have to speak; for instance, Von Hoff conceives that the island of Otaheite is undergoing a gradual elevation out of the sea.* Finally, the third volume of this work appeared after an interval of ten years, in 1834; in which he considers other causes of change; as rising and sinking of the land; alterations of rivers and seas; the operations of snow and ice; and also the geological results to which the whole survey had led him. In this volume he expresses his pleasure at the appearance of Mr. Lyell's work, which had taken place in the intervening period, and by which he had found much new light thrown upon his own speculations.

In the interval of time between the publication of the second and third volumes, M. Von Hoff published "Geological Observations on Carlsbad," (1825) and "Measures of Heights in and near Thuringia"

* Part II. Pref. p. xiv.

(1833). In this last work he not only gave a great number of his own barometrical measurements, but discussed all extant measures of the heights of points in Thuringia, to the amount of above 1100. He also employed himself in meteorological observations.

Karl Ernest Adolph Von Hoff, Knight of the order of the White Falcon, and invested with several offices of honour and dignity at the Ducal Court of Gotha, died at Gotha the 24th of May last. He was 66 years of age, having been born in the same city Nov. 1, 1771.

Besides the history I have mentioned, which must always continue to be a classical work on the subject of which it treats, he was at the time of his death employed in compiling a continuation of his Notices of Earthquakes and Volcanic Eruptions; and also a new work, which was considered to be an important one, and was to be entitled "Germany according to its Natural Conditions and Political Relations."

In attempting a rapid survey of the contributions to geological knowledge which have come under our notice during the past year, I may perhaps be allowed to advert to a distinction of the subject into Descriptive Geology and Geological Dynamics; the former science having for its object the description of the strata and other features of the earth's surface as they now exist; and the latter science being employed in examining and reducing to law the causes which may have produced such phænomena. We appear to be directed to such a separation of our subject by the present condition of our geological studies, in which we and our predecessors have accumulated a vast store of facts of observation, and have laboured with intense curiosity, but hitherto with very imperfect success, to extract from these facts a clear and connected knowledge of the history of the earth's changes. Nearly the same was the condition of astronomy at the time of Kepler, when the accumulated observations of twenty centuries resisted all the attempts of that ingenious man and his contemporaries to construct a science of physical astronomy. But though checked by such failures, they were not far from success; and when for the next succeeding century philosophers had employed themselves in creating a distinct science of Dynamics, the science of physical astronomy, full and complete, made its appearance, as if it were a matter of course; and thus showed the wisdom of separately cultivating the study of causes, and the classification of facts.

DESCRIPTIVE GEOLOGY.

If we begin with geological facts, our attention is first drawn to that district on the earth's surface within which the facts have been subjected to a satisfactory comparison and classification, which may be considered, in a general way, as including England, France, Italy, Germany, and Scandinavia. The language which the rocks of these various countries speak has been, in a great measure, reduced to the same geological alphabet. The questions of the determination of any member in one country, or the identification of similar members in two countries, are, for the most part, problems admitting of a definite and exact solution. In countries out of this district, on the other hand, we have not only to explore but to classify. We have to divine their geological alphabet;—to decipher as well as to read. We have not only to discover of what British rocks the observed ones are the equivalents, but we have to ascertain whether there be an equivalence; and where this relation vanishes, we have to discover what new resemblances and differences of members are most worthy our notice. The great difference in the nature of the geologist's task in these two cases seems to me to make it desirable to employ the familiar division of *Home* and *Foreign* Geology in a wider sense than has hitherto been common, including in the former all that region of Europe which has had its order of strata well identified with our own; this distinction then I shall employ.

1. *Home* (*North European*) *Geology*.—If we attempt, in this part of our subject, to follow an order of strata, we must begin with the oldest stratified rocks, though they are undoubtedly the most obscure; for the same reason which compels the historian of states to begin with the dim twilight of their savage or heroic times; namely, because at the other extremity of the series there is no boundary; since the events of past ages and their records form an unbroken series, leading us to the unfinished occurrences and works of to-day. Going then as far back as the historian of the earth can discern any light, and, for reasons which may hereafter be spoken of, shaping our course by the stratified rocks alone, we should first have to ask what addition has been made during the past year to our acquaintance

with those formations which have generally been called *transition.* And here, gentlemen, many of you well know, that if I had had to address you at a period a little later, I might have hoped to be able to point out, among the labours of our members, some which may be considered as events of primary importance in this part of our knowledge;—steps which may be described as a new foundation rather than a mere extension of this portion of European geology;—a separation and arrangement of transition rocks, which is likely to become the type and classical model of that part of the geological series, as Smith's arrangement of the oolites became the type of that portion of the strata. I speak of Professor Sedgwick's views on the Cambrian rocks, which occupy the north-west of Wales, and Mr. Murchison's on the Silurian formations which cover the remainder of the principality and the adjacent parts of England. Mr. Murchison's work, which cannot but be one of first-rate value and interest, will, I trust, be in our hands in a few weeks; and I should grieve to think that Professor Sedgwick will be not only so unjust to his own reputation, but so regardless of the convenience and expectations of geologists, as to withhold from the world much longer the views which his sagacious and philosophical mind has extracted from the accumulated labour of so many toilsome years, on a subject abandoned to him mainly from its difficulty and complexity.

Turning then to the researches which have been laid before us upon the earlier stratified rocks, I am first led to notice the important memoir of the two gentlemen I have just mentioned, upon the structure of North Devonshire. According to the views of these gentlemen, founded upon an extended examination of the county, this portion of England forms a great trough, having an east and west position, in which a series of culmiferous beds rest at their northern and southern extremities upon older rocks. The plants found in the culmiferous beds are said to be all identical with species which are abundant in the coal-fields of the central counties of England, and of the South Welsh coal basin: and it was at first conceived that these plants differed essentially from the scanty and imperfect remains of vegetables which are found in the older rocks. More recently, however, the same fossil plants which occur in the culm measures are said to have been detected in the subjacent strata. Before this fact was known, the identity of the fossils and the resemblance of mineralogical character seemed irresistibly to prove the culm-bearing beds of Devon to be the same formation with the culm or coal-bearing measures of Pembrokeshire on the opposite side of the Bristol Channel. How far this apparent anomaly admits of explanation, and in what manner it is to be allowed to modify the conclusion previously drawn, we may perhaps most properly consider as questions hereafter to be decided. The rocks which support the culmiferous formation on the north are conceived by Messrs. Sedgwick and Murchison to be a series, of which the last ascending term is probably of the date of the lowest portion of the Silurian system. On the south the culmiferous strata rest partly upon the granite, and partly upon the oldest slate rocks of Devon and Cornwall.

The same general view of the nature of the transverse section of Devon, and of the age of the culm, has been presented, perhaps I ought to say adopted, by the authors of two other papers upon the same region which have been brought before us,—Mr. Austen and Mr. Weaver;—and also, at least so far as the section is concerned, by the Rev. D. Williams in a communication made to the British Association in September last. Nor am I aware that it has been dissented from by any one who has examined the county in question since this view was made generally known. Resting on the concurrence of so many able observers, I should conceive, therefore, that we may look upon this view as *established*, so far as the time which has elapsed allows us to use the term. No truths should be termed incontestable till a considerable period has been left for the antagonists to show themselves and to try their force.

Although this view has thus so good a claim to acceptance, you are aware, gentlemen, that it is entirely different, both as to the form of the section and the age of the members, from that which was entertained up to the time when these gentlemen turned their attention to the subject. Their opinion respecting Devonshire being adopted, along with the views of the same eminent geologists respecting Cumberland and North and South Wales, one-third of our geological map of England will require to be touched with a fresh pencil.

Nor is this wonderful. It is rather a matter of extraordinary surprise, that when the rest of the geological map of England is again drawn, there are scarcely any but microscopic alterations which require to be made. No higher evidence can be conceived of the vast knowledge and great sagacity of its author.

Such modifications we must ever expect to have to make of a first approximation; and I should think it a misfortune to our researches if we should attempt to elude this necessity by giving up the key of all our geological knowledge of our country,—the doctrine that there is a fixed order of strata, characterized mainly by their organic fossils. If we have not advanced so far as to prove this, what have we proved? If our terms do not imply this, what is their meaning? Is it not true, in our science as in all others, that a technical phraseology is real wealth, because it puts in our hands a vast treasure of foregone generalizations? And if we evade the difficulties which may occur in the application of this phraseology to new cases, by declaring that our terms are of little importance, is not this to deprive our language of all meaning and all worth? Do we not thus refuse to recognise as valuable the tokens which we ourselves circulate, and plainly declare ourselves bankrupts in knowledge? When certain strata of Devon have thus been identified with the coal measures of other regions, can we still term them grauwacke? Either this term implies members having a definite place in our series of strata, or it does not. If it do, it is certain that these strata have not that place. If it do not, it conveys no geological knowledge at all. But if it be used to imply a rejection of such series, it involves a denial of all geological knowledge hitherto asserted concerning the older rocks of this county.

The transition downwards from the culmiferous beds of Devon to the older strata on which they rest, is, according to almost all who have studied the subject, wrapt in great obscurity. In this obscurity, if it be true that the fossil plants of the culm measures are found also in the subjacent rocks, there is nothing which need make us mistrust the clear and positive part of our knowledge. And even if this be so, it will not be the less necessary to separate the culmiferous from the subjacent Silurian and Cambrian systems, by a different name in our lists, and by a different colour in our geological maps, if they are to represent the present state of our information.

The interest of this question has induced me to dwell upon it longer than I had intended, and I must on that account be very brief in my notice of many other communications. I may observe that the very nature of several of these indicates very remarkably the European character which our geology has assumed, since they have for their object the identification of some members of the recognised series of England, and of France, or Germany. Thus Mr. Murchison and Mr. Strickland have attempted to show, by the evidence of organic fossils, now for the first time adduced on this point, that the red saliferous marls of Gloucester, Worcester, and Warwick shires, with an included bed of sandstone, represent the keuper or *marnes irisées* of Germany; and that the underlying sandstone of Ombersly, Bromsgrove, and Warwick is part of the bunter sandstein or grès bigarré of foreign geologists. They are thus led to conclude that though the muschelkalk, which intervenes between these formations in Germany, is absent in the new red system of England, and of a large part of France, its other members may be identified over the whole of the north of Europe.

Proceeding from the new red to the oolite system, we have a memoir from Mr. Pratt containing an examination of the geological character of the coast of Normandy, which necessarily implies a comparison of this series of rocks with those of England. The identification is found to be complete, as had already been believed; but Mr. Pratt has made some alteration in the received doctrines on this subject; for instance, the Caen stone, which is usually considered to represent the great oolite, he finds to resemble in its fossils the inferior oolite.

Ascending still, we have to notice Mr. Clarke's elaborate geological survey of Suffolk, which, of course, refers entirely to the chalk and overlying beds. With regard to the crag of this district, I may remark that M. Desnoyers, in a communication made to the Geological Society of France, has endeavoured to identify this formation with the *Faluns* of the Touraine. M. Deshayes had referred the latter to the *Miocene*, and the crag to the *Pliocene* formations of Mr. Lyell. The point is one of great interest, since it involves the question of the value and right mode of application of the test of the relative number of recent species, on which Mr. Lyell's classification, or at least his nomenclature, is founded. I conceive that in a matter of arrangement any arbitrary numerical character must lead to violations of nature's classifications; and can only be considered as an artificial method, to be used provisionally till some more genuine principle of order is discovered.

Mr. Clarke, in his survey, has noted as one division of the diluvium of his district, a clay of a yellowish or bluish hue, containing rolled pieces of chalk. This deposit is of great extent and thickness in East Anglia and the neighbouring parts; and is worth notice, since this deposit is one main cause of the geological confusion and obscurity in which that region is involved. In the neighbourhood of Cambridge this diluvial deposit is called the *brown clay*; and I can state, from my own experience, that the recognition of it as a separate bed at once rendered the stratification clear, where it had long been unintelligible.

Before quitting our stratified rocks, I may notice the communications respecting some of their fossils which we have received, particularly that of Mr. Williamson on the fossil fishes of the Lancashire coal field, and the establishment of the new genus Tropæum, separated from the Hamites of the green sand by Mr. Sowerby.

In attempting to pursue a stratigraphical order, we are compelled to reserve for a separate head the notice of unstratified rocks, since their age and history are only known by the mode in which they interrupt and disturb the rest of the series. We have not had many communications respecting European rocks of this character; but we cannot but be struck by the subversion of ancient ideas which result from the investigations of Messrs. Murchison and Sedgwick. They have shown that the granite of Dartmoor, and consequently that of Cornwall, formerly considered as one of the earliest monuments of the primeval ages of the earth's history, is posterior to the deposit of the culm measures.

Advancing to newer phænomena, we find the evidences of change still unexhausted. We cannot but reflect how familiar those views of the elevation and depression of portions of the earth's surface are become, which were at first considered so strange and startling. This is remarkably shown by the number of communications concerning raised beaches which we have recently received. When we visit places where these occur, and look at the winding shore, where the sea line is faithfully followed or distantly imitated by terraces, sands and pebbles a little above it, we wonder that we should so long have been blind to this kind of evidence. Such raised beaches have been described during the past year, by Mr. Prestwich, as occurring in the Murray Frith; by Mr. Austin, in the valley of the Axe, the Exe, and the Otter. Dr. Forchammer has given us the evidence of recent elevation in the island of Bornholm; Mr. Trevelyan has given us similar evidence for the coast of Jütland, and the islands of Guernsey and Jersey.

Mr. Morris's paper, describing a series of dislocations in the chalk cliffs to the south of Ramsgate, marked by shifts in a bed of tabular flint, may perhaps be considered as also affording evidence of violent elevation. But since a small derangement of the conditions of support of any stratum might occasion dislocations of the scale of those here described, it would probably be hazardous to consider them as otherwise than local accidents.

Among descriptions of the most recent geological phænomena, I must notice Mr. Clarke's paper on certain peat marshes and submarine forests, which occur near Poole in Devonshire; and in his investigation of the causes which have produced the results now visible, we may see by how easy a gradation descriptive geology passes into the other portion of the subject, the study of the processes by which change is produced.

Finally, in concluding this survey of our descriptive home geology, I notice, with great pleasure, Mr. Burr's communication of his notes on the geology of the line of the proposed Birmingham and Gloucester Railway. In a country like this, in which the order and boundaries of the strata are, for the most part, well ascertained, an additional accuracy of measurement, of great value to us, may be supplied by the operations of civil engineers employed on canals, roads, and the like works. With this persuasion, and acting with the advice of the Council, I wrote letters to a great number of engineers, begging them to communicate to us the levels and sections which they might obtain in the course of their professional employments; and I am happy to see so excellent an example as Mr. Burr's paper supplies, of the advantage which may be derived from materials of this class.

2. *Foreign (South European and Trans-European) Geology.*—In proceeding beyond the Alps, and still more as we advance beyond the shores of Europe, we can no longer, so far at least as geologists have hitherto discovered, trace that remarkable correspondence of the strata of different countries which we can study so successfully in our *home circuit*. With the mountain masses

of those more distant regions we are, it would seem, hardly authorised as yet in making any more detailed distinctions than the general one of secondary and tertiary strata; the latter including the strata in which we trace an approach to the existing species of animals, and the former implying a general comparison with our chalk, oolites, and lower strata. Perhaps we may further distinguish in most countries which have been visited, a great mass of transition slates; but the establishment of such divisions must be the business of geological observers.

We have had several valuable additions to this portion of our knowledge, including, as we must do, Greece and its islands in this foreign district. That the Apennine limestone is the predominant mass of the Morea, had been made known by the researches of MM. Boblaye and Virlet. Mr. Strickland and Mr. Hamilton have told us that the same rock forms a large mass of the island of Zante and other islands in that sea, and of the neighbourhood of Smyrna. They find also tertiary beds, as on the south side of the bay of Smyrna; on the east side of the island of Zante; and at Lixouri in Cephalonia, where the tertiary beds are remarkable for the number and beauty of their fossils, some of which have been identified with species existing in the Mediterranean. Dr. Bell, who travelled from Teheran to the shores of the Caspian, has given us an account of the rocks which he observed in Mazanderan. From the statements made by him, we are led to believe, that a more continued and detailed observation of the country would give the true geological order of the deposits in this region; which might then, perhaps, serve as a connecting link between western Asia and India.

It is among the favourable omens for the geology of India, of which we now see many, that a temperate spirit of generalization has recently been applied to the examination of her soil; a spirit which contents itself with such a general reference of the foreign to the home strata as we have described, till by its own labours it has earned the right of asserting some closer correspondence. If to deny the value of our geological terms within the home district, where they mark an order which has been repeatedly verified, would be a suicidal scepticism in geologists, there would be a rashness and levity no less fatal in applying them to distant regions where no order has yet been ascertained.

Captain Grant in his account of Cutch, and Mr. Malcolmson in his description of a large portion of the Indian peninsula, have not ventured to call the strata which they have examined by the names which describe European formations. We may trust that, hereafter, the admirable activity and resource which our countrymen display in that wonderful appendage of our empire, will enable them to communicate to us a genuine Indian arrangement of secondary strata. In the mean time, Mr. Malcolmson has most laudably employed himself in determining the age of the wide-spread igneous rocks of the peninsula of India, with reference to the contiguous strata. And Dr. McCleland, who was associated with Mr. Griffith in the scientific deputation sent under Dr. Wallich into Upper Asam, has, among other geological observations, noted a raised bed, at 1500 feet above the sea level, in which none of the species are identical with those of the Bay of Bengal on the one hand, or the secondary strata on the north of the Himalaya on the other; but in which a resemblance was at once recognised with the species of the Paris basin.

This resemblance between the extinct animal population of regions so remote from each other, is in itself remarkable enough. It is still more curious to observe, that the same coincidence of the ancient animals of France and India has recently been detected in another case; and what makes the circumstance still more remarkable is, that the animal was not only new in both countries as a fossil genus, but involved a transgression of the supposed boundaries of fossil forms. Not only had no human bones been found in genuine strata, but as it had been generally held, no traces of those creatures which most nearly imitate the human form. This rule now no longer holds good; for during the past year the bones of monkeys have been discovered both at Sansan, in France, in the Sewalik Hills in the north of Hindostan, and more recently under the city of Calcutta.

That this is a highly interesting and important discovery, no one who attends to the signification of geological speculations can doubt. I do not know if there are any persons who lament, or any who exult, that this discovery tends to obliterate the boundary between the present condition of the earth, tenanted by man, and the former stages through which it has passed. For my own part I can see no such tendency. I have no belief that geology will ever be able to point to the commencement of the present order of things, as a problem which she can solve, if she is allowed to make the attempt. The gradation in form between man and other animals, a gradation which we all recognise, and which, therefore, need not startle us because it is presented under a new aspect, is but a slight and, as appears to me, unimportant feature, in looking at the great subject of man's origin. Even if we had no Divine record to guide us, it would be most unphilosophical to attempt to trace back the history of man without taking into account the most remarkable facts in his nature: the facts of civilization, art, government, writing, speech—his traditions—his internal wants—his intellectual, moral, and religious constitution. If we will look backwards, we must look at all these things as evidences of the origin and end of man's being. When we do thus comprehend in our view the whole of the case, it is impossible for us, as I have elsewhere said, to arrive at an origin homogeneous with the present state of things; and on such a subject the geologist may be well content to close his own volume, and open one which has man's moral and religious nature for its subject.

In order to complete the notice of the contributions to foreign geology, I must mention Mr. Roy's account of Upper Canada: in which country he conceives that he has detected terraces which exhibit the beaches of the lakes when the level of their surface was more elevated than they are at present. I must refer also to Mr. Bollaert's paper on alluvial accumulations containing large masses of silver ore in Peru. And, finally, I have to direct your attention to the very curious information respecting the geology of South America, which we have received from Mr. Darwin. In a communication made to us, he gave a very striking view of the structure of a large portion of that continent; and, as I have already had occasion to observe, he has brought to this country the remains of various fossil animals of entirely new kinds, of exceeding interest to the zoologist as well as the geologist. I need only remind you of the gigantic mammifer which has been reconstructed in idea by Mr. Owen, upon the evidence of a fossil skull, and has been named by him the *Toxodon Platensis*. This animal, although a *Rodent*, according to its dental characters, in other respects manifests an affinity to the *Pachyderms*; and also to the *Dinotherium*, and to the *cetaceous* order. Many other fossil animals have been discovered in South

America; and all, from their magnitude, fitted to excite our wonder, when we compare the diminutive size of the present races of animals which inhabit that country. The animal remains found by Mr. Darwin comprise, besides the Toxodon, which extraordinary animal was as large as a hippopotamus,—(2, 3, 4, 5, 6.) the Megatherium, and four or five other large Edentata;—(7.) an immense Mastodon; —(8.) the Horse;—(9.) an animal larger than a horse, and of very singular character, of which a fragment of the head has been found; —(10, 11, 12.) parts of Rodents, one of considerable size;—(13.) a Llama, or *Guanaco*, fully as large as the Camel.

But I should very ill convey my impression of the great value of the researches of Mr. Darwin, by any enumeration of special points of geology or palæontology on which they have thrown light. Looking at the general mass of his results, the account of which he has been kind enough to place in my hands, I cannot help considering his voyage round the world as one of the most important events for geology which has occurred for many years. We may think ourselves fortunate that Capt. Fitz Roy, who conducted the expedition, was led, by his enlightened zeal for science, to take out a naturalist with him. And we have further reason to rejoice that this lot fell to a gentleman like Mr. Darwin, who possessed the genuine spirit and zeal, as well as knowledge of a naturalist; who had pursued the studies which fitted him for this employment, under the friendly guidance of Dr. Grant at Edinburgh, and Professor Henslow and Professor Sedgwick at Cambridge; and whose powers of reason and application had been braced and disciplined by the other studies of the University of which the latter two gentlemen are such distinguished ornaments. But some of the principal of these results may be most conveniently mentioned, when we pass from mere descriptive geology, to that other division of the subject which I have termed Geological Dynamics. And this I now proceed to do.

GEOLOGICAL DYNAMICS.

This term is intended to express generally the science, so far as we can frame a science, of the causes of change by which geological phænomena have been produced. Without here speaking of any classification of such changes, I may observe that the gradual elevation and depression, through long ages, of large portions of the earth's crust, is a proximate cause by which such phænomena have been explained: and this class of events, its evidence, extent, and consequence, is brought before our view by Mr. Darwin's investigations, with a clearness and force which has, I think I may say, filled all of us with admiration. I may refer especially to his views respecting the history of coral isles. Those vast tracts of the Pacific which contain, along with small portions of scattered land, innumerable long reefs and small circles of coral, had hitherto been full of problems, of which no satisfactory solution could be found. For how could we explain the strange forms of these reefs; their long and winding lines; their parallelism to the shores? and by what means did the animals, which can only work near the surface, build up a fabric which has its foundations in the deepest abysses of ocean? To these questions Mr. Darwin replies, that all these circumstances, the linear or annular form, their reference to the boundary of the land, the clusters of little islands occupying so small a portion of the sea, and, above all, the existence of the solid coral at the bottom of deep seas, point out to us that the bottom of the sea has descended slowly and gradually, carrying with it both land and corals; while the animals of the latter are constantly employed in building to the surface, and thus mark the shores of submerged lands, of which the summits may or may not remain extant above the waters. I need not here further state Mr. Darwin's views, or explain how corals, which when the level is permanent fringe the shore to the depth of twenty fathoms, as the land gradually sinks, become successively encircling reefs at a distance from the shore; or barrier reefs at a still greater distance and depth; or when the circuit is small, lagoon islands:—how, again, the same corals, when the land rises, are carried into elevated situations, where they remain as evidences of the elevation. We have had placed before us the map, in which Mr. Darwin has, upon evidence of this kind, divided the surface of the Southern Pacific and Indian oceans into vast bands of alternate elevation and depression; and we have seen the remarkable confirmation of his views in the observation that active volcanos occur only in the areas of elevation. Guided by the principles which he learned from my distinguished predecessor in this chair, Mr. Darwin has presented this subject under an aspect which cannot but have the most powerful influence on the speculations concerning the history of our globe, to which you, gentlemen, may hereafter be led. I might say the same of the large and philosophical views which you will find illustrated in his work, on the laws of change of climate, of diffusion, duration and extinction of species, and other great problems of our science which this voyage has suggested. I know that I only express your feeling when I say, that we look with impatience to the period when this portion of the results of Captain Fitz Roy's voyage shall be published, as the scientific world in general looks eagerly for the whole record of that important expedition.

And I cannot omit this occasion of mentioning with great gratification, the liberal assistance which the Government of this country have lent to the publication of the discoveries in natural history which Mr. Darwin's voyage has produced. The new animals which he has to make known to the world will thus come before the public described by the most eminent naturalists, and represented in a manner worthy of the subject and of the nation. I am sure that I may express the gratitude of the scientific world, as well as my own, for this enlightened and judicious measure.

I may here notice Mr. Darwin's opinion, so ably exposed in a paper read before us, that the change by which a variety of materials thrown on the earth's surface become vegetable mould, is produced by the digestive process of the common earth worm.

I will here also advert to Mr. Fox's paper on the process by which mineral veins have been filled up. This he conceives might be produced by the circulation or ascension of currents of heated water from the deeper parts of the original fissures. The discovery of the causes of the formation and filling of metallic veins, one of the earliest subjects of geological speculation, will remain probably as a problem for its later stages, when our insight into the laws of slow chemical changes is far clearer than it is at the present day.

If, from these proximate causes of change of which I have spoken, we proceed to those ulterior causes by which such events as these are produced;—to the subterraneous machinery by which islands and continents appear and vanish in the great drama of the world's physical history;—we have before us questions still more obscure, but questions which we must ask and answer in order to entitle ourselves to look with any hope towards geological theory. Of late years an opinion has taken root among us, that the dynamics of geology must invoke the aid of mathematical reasoning and calculation, as the dynamics of astronomy did, at the turning point of its splendid career. Nor can we hesitate to accept this opinion, and to look forwards to the mathematical cultivation of physical geology, as one of the destined stages of our progress towards truth. But we must remember, that in order to pursue this path with advantage, we have, in every instance, two steps to make, each of which demands great sagacity, and may require much time and labour. These two steps are, to *propose* the proper problem, and to *solve* it. Last year an important example of this kind was brought under your notice by my predecessor. The supposition that there are, beneath the crust of the terrestrial globe, liquid or semiliquid masses which exert a pressure upwards, leads to the inquiry what phænomena of fissure, disruption, and dislocation, this subterraneous strain would produce. The answer to this inquiry must be given by mathematical reasoning from mechanical principles; and Mr. Hopkins, who proposed, and to a considerable extent solved this problem, has put forth a set of results, with which, so far as they are definite and decisive, it will be highly important to compare the existing phænomena of disturbed geological districts. The same assumption, of an incandescent mass existing deep below the earth's surface, has led two other distinguished members of our body to another train of speculations; which, however, though highly interesting, I should be disposed to consider as only the enunciation of a problem, requiring no small amount of mathematical skill for its solution. I speak of the speculations of Professor Babbage and Sir John Herschel, concerning the subterraneous oscillations of the isothermal surfaces of great temperature. They remark that such oscillations will arise, when thick and extensive deposits take place on any parts of the surface of the earth, (as for instance at the bottoms of seas,) because such deposits increase the thickness of the coating over a given subterraneous point; and thus removing the cooling effect of the surface, bring a high temperature to a place where it did not exist before. The deposited strata might thus be invaded by violent heat advancing from below; and there might result both changes of position arising from extension and contraction, and a metamorphic structure in the rocks themselves. It is highly instructing to have this chain of conceivable effects pointed out to us; but we may venture to observe that in order to render the suggestion of permanent use, it will be necessary, to express, in some probable numbers, the laws of the result as affected by the conductivity of the earth's mass, the rate and thickness of the deposit, and other circumstances. For instance, we know that a deposit of one thousand feet thick would be quite insufficient to occasion a metamorphic operation in its lower strata. Would then a deposit of ten thousand or of twenty thousand feet call into play such a process? To answer questions like these, of which a vast number must at once occur to our minds, we have many experimental data to collect, many intricate calculations to follow out. And it would be easy to point out problems of a still more abstruse kind, in which we no less require aid from the mathematician, before we can proceed in our generalizations. May we not hope to see some fortunate man of genius unveil to us the mechanics of crystalline forces? And when that is done, can we doubt that we shall have a ray of new light thrown upon those extraordinary phænomena of slaty cleavage in mountain masses which have lately been brought under our notice? Or, recollecting the experiments of Sir James Hall, (a striking step in geological dynamics,) may we not hope then to learn how those crystalline forces are stimulated by heat; and thus follow the metamorphic process into its innermost recesses? These and a thousand such questions lie before us;—tangled and arduous inquiries no doubt, but connected by their common bearing upon one great subject;—'a mighty maze, but not without a plan.' And through this maze we must force our way in order to advance towards any sound geological theory. The task is one of labour and difficulty; but I well know, gentlemen, that you will not shrink from it on that account. Those who aspire to the felicity of knowing the causes of things, must not only trample under foot the fears of a timid unphilosophical spirit, which the poet deems so necessary a preparation, but they must look with a steady eye upon difficulty as well as violence. They must regard the terrors of the volcano and the earthquake, the secret paths by which hot and cold and moist and dry ran into their places, the wildest rush of the fluid mass, the latent powers which give solidity to the rock,—as operations of which they have to trace the laws and measure the quantities with mathematical exactness. And though there can be no doubt that the greater part of us shall be more use-fully employed in endeavouring to add to the stores of descriptive geology, than in these abstruse and difficult investigations, yet we must always receive, with great pleasure, any communications containing real advances in the mathematical dynamics of geology, from those whose studies and whose powers enable them to lay an effectual grasp upon these complex and refractory problems.

I have but a single word to add in conclusion. This Society has always been an object of my admiration and respect, not only from the importance and range of its scientific objects, the wide and exact knowledge which it accumulates, the philosophical spirit which it calls into play, the boundless prospect of advance which it offers; but also for the manner in which its meetings and the intercourse of its members have ever been conducted; the manly vigour of discussion, tempered always by mutual respect and by good manners; the deep interest of all in the prosperity of the Society, to which, whenever the hour of need comes, private differences of opinion and resentments have given way. To be placed for a time at the head of a body which I look upon with such sentiments, I must ever consider as one of the greatest distinctions which can reward any one who gives his attention to science. I trust, by your assistance and kind sympathy, gentlemen, I shall be able to preserve the spirit and temper which I so much admire;—to hand that torch to my successor burning as brightly as it has hitherto done. And there is one consideration which will make me look with an especial satisfaction upon such a result. I have not myself the great honour of being one of the members of the Society who are connected with it by an early interest in its fortunes, and by long participation in its labours. I may consider myself as only belonging to its second generation. Now if there be a critical and a perilous time in the progress of a voluntary association like ours, it is when its administration passes out of the hands of its founders into those of their successors. It is like that important and trying epoch when the youth quits the paternal roof. I will say however, gentlemen, for myself and for my fellow-officers, some of whom are in the same condition, that our best cares shall not be wanting that the Society may suffer as little as possible by this change. And among our grounds for hope and trust, the main one is this: that though the offices of the Society may be in younger hands, the parental cares of its founders are not withdrawn. We have to discharge our office with the aid and counsel of those excellent persons to whom the prosperity of the Society up to the present time has been owing. Surrounded by such men, knowing their generous and ready sympathy for the attempts and exertions of their followers and disciples, I feel a cheerful confidence in the future destinies of the Geological Society; and a persuasion that it will not only preserve but extend its influence as a bond of scientific and social union among its members.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

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Feb. 21.—William Blount, Esq., of Cumberland Place, and José Estavão Cliffe, Esq., of Cuijaba, Brazils, were elected Fellows of this Society.

A paper "On part of Asia Minor," by William John Hamilton, Esq., Sec. G.S., was read.

In this paper, the author gives an account of the geological structure of the country from the foot of Hassán Dagh, a few miles S.S.E. of Akserai (lat. 38° 20′ N., long. about 34° E.), to the great salt lake of Toozla or Kodj-hissar, and thence eastwards to Cæsarea and Mount Argæus.

The formations, noticed by Mr. Hamilton, are trachytic conglomerates, considered by him one of the oldest formations of the country; a system of highly inclined beds of red sandstone, conglomerates and marls, which rest upon the trachytic conglomerate, and are apparently connected with the saliferous deposits of the country, though the author did not observe any beds of salt in the sandstone*; a limestone belonging to the vast, calcareous, lacustrine formation of the central part of Asia Minor; a great system of volcanic tufts, trachytes and basalts, apparently of comparative modern origin; and a grey granite which is newer than the sandstone, as it penetrates and disturbs that formation near Kodj-hissar; but pebbles of a grey granite identical in composition also occur in the conglomerate.

Hassán Dagh, upwards of 8000 feet above the sea, consists entirely of trachyte, and trachytic and porphyritic conglomerates, and rises from the eastern termination of a great calcareous plain. Several volcanic cones, composed of trachytic conglomerates and scoriæ, occur near the base on the S.S.W. and N.W. sides. All the latter, with the exception of one, are in the present valley, and below the tufaceous beds which cap the hills on its north side, and were, therefore, produced subsequently to the excavation of the valley. From one of them a considerable stream of black, vesicular lava proceeds, and encircles some of the smaller cones.

* The extensive beds of rock salt on the borders of Pontus and Galatia, occur in troughs or small basins resting upon the perpendicular edges of a red and brown sandstone conglomerate.

From the foot of Hassán Dagh to the great salt lake of Kodj-Hissar, the road traverses a plain, bounded on the south by low hills of the lacustrine limestone; and on the north by hills having narrow peaks and steep escarpments, of red and yellow sandstone, sometimes associated with calcareous conglomerates, sand and marl, and capped towards the east and north-east by beds of tuff and a white pumiceous rock, which passes into trachyte. Still further east, is a hill in which the sandstone rests upon a trachytic conglomerate.

The phenomena presented in this district, the author conceives, indicate the following operations:—

1. The irruption of the trachyte, from which the trachytic conglomerate was formed.
2. The deposition of the sandstones, conglomerates and marls.
3. The ejection of the igneous matter constituting the overlying beds of volcanic tuff and pumiceous rock.
4. The excavation of the valley.
5. The formation of the volcanic cones at the foot of Hassán Dagh.

The water of the salt lake of Kodj-hissar is so highly charged with saline matter, that no fish can live in it; and if the wings of a bird touch it, they become instantly stiff and useless with incrustation. Mr. Hamilton could not ascertain the exact dimensions of the lake, but he was informed, that it is about thirty hours or leagues in circumference. The bottom is a soft mud, incapable of supporting the slightest weight; but at the part examined by the author, a thick, solid crust of salt, which bore the weight of a horse, rested upon the soft mud, and was covered by about six inches of water, which he was informed would be dried up in another month.

The sandstone formation extends beyond the village of Kodj-hissar, towards the N.N.W., dipping in the same direction. It is penetrated near the town by a mass of finely-grained, grey granite, which also sends veins into the sandstone, and produces an anticlinal inclination, the dip towards the south being 80°. In the sandstone conglomerate, of the neighbourhood, Mr. Hamilton, however, noticed pebbles of a grey granite similar in composition to that of the protruded mass. About a mile N.W. of Kodj-hissar are detached portions of the horizontal white limestone, either resting unconformably against the sandstone, or filling up irregularities in its surface. In some places it caps the hills, which flank the valley a little to the north of the village.

The only fossils noticed in the sandstone, were impressions resembling fucoids, and similar to those found in the Alpine limestone near Trieste.

The author then describes the structure of the country between Kodj-hissar and Cæsarea, a distance of about 108 miles. It consists of the same sandstone system containing gypsum, and occasionally overlaid by horizontal beds of the lacustrine limestone and volcanic tuff; but the latter constitutes likewise large districts, the fundamental rock of which is not visible. Granite forms a range of hills thirty miles in extent, about midway between Kodj-hissar and Sari-karaman, and is traversed in one place by a N.N.E. and S.S.W. dyke of claystone porphyry: granite occurs also between the latter town and Tatlar. Trap and trachyte were noticed at several places, likewise serpentine and greenstone near Sari-karaman; and basaltic rocks form table lands overlying the volcanic tuff near Tatlar and Baktash; and close to Nembscheher beds of basalt alternate with the volcanic tuff. To the east and north-east of Tatlar the author remarked several volcanic hills, from which streams of basalt or lava appear to have flowed. To the south-east of the village he also saw a stream of a more recent date than that which caps the neighbouring hills; for it not only flows at a lower level, but below the steep escarpments of the older basalt. In the ravine near Tatlar, and in the vallies of Utch-hissar and Urjub, the tuff has been worn into cones from 150 to 300 feet high. They are principally detached from the sides of the vallies, but are connected at the base; and are in some places so numerous and close together, that they resemble at a distance a grove of lofty cypresses. Where the cones occur on the sides of the vallies, they exhibit every stage of development, from the first indication of a mound near the summit of the slope, to the full-formed cone at the bottom. In the valley of Urjub some of them are capped by a mass of hard rock, which projects like the head of a mushroom. The production of these cones the author ascribes to the action of running or atmospheric waters.

One of the principal objects of Mr. Hamilton's visit to this part of Asia Minor, was to ascend to the summit of Mount Argæus, which had not previously been reached by any traveller.

This mountain rises abruptly from the alluvial plain of Cæsarea, sending out prolongations and spurs into the plain which stretches to the north, between Injesu and Cæsarea; but it is connected at its eastern base with other ranges of mountains. It rises, like Hassán Dagh, to a single peak, and it resembles in outline, the summit of Ararat. The highest part consists of a reddish brecciated and scoriaceous conglomerate, full of fragments of trap and porphyritic trachyte, and may be said to be the point of junction of two enormous, broken craters, one of which opens to the N.E., the other to the N.W., the steep sides of which are covered to the north with eternal snow for 2000 or 3000 feet below the summit. The height of the mountain was ascertained by Mr. Hamilton to be about 13,000 feet, the following being the results of his observations.

By barometer	13,293
By angle of elevation from the Greek Convent	13,242
By angle of elevation from Kara-hissar	12,809

A little below the summit, on the S.E. side, rugged, serrated ridges rise through the snow, some of them consisting of a compact trachytic rock, with a highly conchoidal fracture, resembling that of hornstone; but others are composed of porphyritic trachytes of various colours and textures. Near the foot of the great cone, on the S.E., W., and N. sides, rise numerous smaller ones of pumice and lapilli, from some of which on the N.W. side, streams of basalt or lava may be traced.

In conclusion the author expresses his regrets, that the want of organic remains, prevents him from determining the comparative antiquity of the formations, with respect to those in Europe. In only one instance, the fucoid impressions near Kodj-hissar, did he observe a trace of an organic body in the sandstone; and the only occurrence of fossils in the limestone series which he noticed, was in the neighbourhood of Sevri-hissar W.S.W. of Angora, where he discovered, in the upper beds of the formation, Limnea and Planorbis.

March 7th.—Charles William Hamilton, Esq., M.R.I.A., Sec. G.S. Dublin, Dominick Street, Dublin, was elected a Fellow of the Society.

A notice was first read, on some remarkable dikes of calcareous grit at Ethie, in Ross-shire, by Hugh Edwin Strickland, Esq., F.G.S.

These dikes, which traverse the lias schist, are displayed only at low water. Two of them are parallel to the strata of schist; but another, which sends off branches in various directions, is in no part of its course parallel to those strata. Their thickness varies from one to three feet; but that of some of the lateral branches does not exceed three inches. They exhibit no variation in texture or composition, and show no signs of lamination, but are frequently fractured transversely to their direction. The transition from the dike to the lias shale is immediate; no change being apparent in the latter at the point of junction. The shale, from its greater softness, has been removed between the dikes, leaving them like walls from one to three feet in height.

These dikes, and similar ones in other places, were noticed by Mr. Murchison, in his examination of the coast of Scotland, in 1826.

By what means the dikes were produced, the author does not venture to inquire; his only object being to draw the attention of geologists still further to them.

A paper, on the connexion of certain volcanic phænomena, and on the formation of mountain-chains and volcanos, as the effects of continental elevations, by Charles Darwin, Esq., Sec. G. S., was then read.

The author first gave a detailed account of the volcanic phænomena, which accompanied the earthquake that destroyed Concepcion on the morning of the 20th of February, 1835; and then deduced from volcanic phænomena, certain inferences with respect to the formation of mountain-chains, and continental elevations.

In describing the phænomena of the earthquake of 1835, Mr. Darwin quotes the published accounts by Captain Fitzroy* and Mr.

* Journal of the Royal Geographical Society, vol. vi., p. 319, 1836.

Caldcleugh*; likewise communications received by him from Mr. Douglas, a resident on the island of Chiloe.

A few days after the earthquake, several volcanos within the Cordilleras, to the north of Concepcion, though previously quiescent, were in great activity. It is doubtful, however, if the volcano of Antujo, in nearly the latitude of Concepcion, was affected, while the island of Juan Fernandez, 360 miles to the north-east of the city, was apparently more violently shaken than the opposite shore of the main land. Near Bacalao Head, a submarine volcano burst forth in sixty-nine fathoms water, and continued in action during the day as well as part of the following night. That island was also affected in a remarkable manner, by the earthquake which overthrew Concepcion in 1751.

In Concepcion, the undulations of the surface appeared, to the inhabitants, to proceed from the south-west; and this direction was likewise inferred, from the effects observed in the buildings; for those walls, which had their extremities towards the point of disturbance, remained erect, though much fractured, whilst those (and the streets cross each other at right angles) which extended parallel to the line of the vibration, were hurled to the ground. This was strikingly exemplified in the cathedral, where the great buttresses of solid brick-work were cut off, as if by a chisel, and thrown down; while the wall, for the support of which they had been built, though much shattered, remained standing.

In Chiloe, south of Concepcion, the shocks were very severe, but they entirely ceased in about eight minutes. The motion, as described by Mr. Douglas, was horizontal, and similar to that of a ship going before a high, regular swell; from three to five shocks being felt in a minute; and the direction being from N.E. to S.W. Forest-trees nearly touched the soil in these directions; and a pocket compass placed level on the ground vibrated, during the violent shocks, two points to westward, but only half a point to eastward; and during the minor shocks the needle pointed north. At Calbuco, a village on the mainland opposite the northern extremity of Chiloe, as well as at Valdivia, between Chiloe and Concepcion, the earthquake was much less severely felt; and near Mellipulli, in the Cordilleras (not far from Calbuco), not at all. The volcano of Villareca, near Valdivia, which is said to be more frequently in irruption than almost any other in the chain, was not the least affected; though the volcanos of central Chili are stated by Mr. Caldcleugh to have been seen, some days afterwards, in great activity. Several of the culminating points of the Cordillera in front of the island of Chiloe, exhibited increased energy during the earthquake, and immediately after it. During the shocks, Osorno, which had been in activity for at least forty-eight hours previously, threw up a thick column of dark blue smoke; and directly it had passed away, a large crater was seen forming in the S.S.E. side of the mountain; Minchinmadiva also, which had been in its usual state of moderate activity, commenced a fresh period of

* Phil. Trans., 1836; Part I. p. 21.

violence. At the time of the principal shock, the Corcovado was quiet; but when the summit of the mountain was visible a week afterwards, the snow had disappeared from the north-west crater. On Yntales, to the south of the Corcovado, three black patches, resembling craters, were observed above the snow-line after the earthquake, though they had not been noticed previously to it. During the remainder of the year, the whole of the volcanic chain, from Osorno to Yntales, a range of 150 miles, exhibited, at times, unusual activity. On the night of the 11th of November, Osorno and Corcovado threw up stones to a great height; and on the same day, Talcahuano, the port of Concepcion, 400 miles distant, was shaken by a very severe earthquake; and on the 5th of December the whole summit of Osorno fell in.

After these details of more particular phænomena, Mr. Darwin alluded to the great areas over which earthquakes have been simultaneously felt; but he added, it is impossible even to guess through how wide an extent, in the subterranean regions, actual changes may have taken place. In order to enable the reader, who may be more familiar with European than South American geography, to comprehend the vast surface which was affected by the earthquake of February 1835, he stated, that it had a north and south range, equal in extent to the distance between the North Sea and the Mediterranean: that we must imagine the eastern coast of England to be permanently raised; and a train of volcanos to become active in the southern extremity of Norway; also that a submarine volcano burst forth near the northern extremity of Ireland; and that the long dormant volcanos of the Cantal and Auvergne, each sent up a column of smoke.

The contemplation of volcanic phænomena in South America, has induced the author to infer, that the crust of the globe in Chili rests on a lake of molten stone, undergoing some slow but great change; for if this inference be denied, he says, the only alternative is, that channels from the various points of eruption must unite in some very deeply-seated focus. This conclusion, however, he doubts, on account of the union of the different trains of volcanos on the one line of the Cordillera, and more especially as many hundred square miles of surface in Chili, have been elevated during the same earthquake. Moreover, these elevations have acted within a period geologically recent, throughout the whole, or at least the greater part, of Chili and Peru, and have upraised the land several hundred feet. He is further of opinion, that the shocks coming from a given point of the compass, and the overthrow of the walls, according to their position with respect to this point, prove that the vibrations do not travel from a profound depth, but are due to the rending of the strata not far below the surface of the earth.

In a geological point of view, the author conceives, the three classes of phænomena exhibited during this earthquake of February 1835, viz. a submarine outburst—renewed volcanic activity, simultaneously at distant localities—and a permanent elevation of the land, to be of the greatest importance, as forming parts of one great action, and being the effects of one great cause, modified only by local circumstances. Mr. Darwin further observed, that, as the volcanos near Chiloe commenced, at the moment of the shock, a period of renewed activity, which lasted throughout the following year, the motive power of these volcanos (as well as of the submarine outburst near Juan Fernandez) must be of a similar nature with that, which, at the same instant, permanently raised another part of the coast; and he therefore concluded, that no theory of the cause of volcanos, which is not applicable to continental elevations, can be considered as well-grounded.

Mr. Darwin then offered some remarks on the two tables published by Humboldt, of the great earthquakes which affected, in 1797 and 1811, so large portions of America; and he is of opinion, that a repetition of the coincidences can alone determine how far the increased activity of the subterranean powers, at such remote points, was the effect of some general law, or of accident. He likewise disbelieves that periodical eruptions, as those of Coseguina, in 1709 and 1809, or of earthquakes, as the shocks felt at Lima on the 17th of June 1578, and the 17th of June 1678, are more than accidental agreements. He also gave a table of the volcanic phænomena in South America in 1835; and concluded, that it is probable that the subterranean forces manifest, for a period, their action, beneath a large portion of the South American continent, in the same intermittent manner as they do beneath isolated volcanos. In the latter table, Mr. Darwin pointed out the case of Osorno, Aconcagua, and Coseguina, (the first and last being 2700 miles apart,) which burst into sudden activity early on the morning of June 20th, 1835; but he hesitated to assent to there being any necessary connexion between them. He further remarked, that if such simultaneous outbursts had been observed in Hecla and Ætna, points unconnected by any uniformity of physical structure, it would be doubtful how far they would have been worthy of consideration; but in South America, where the volcanic orifices fall on one line of uniform, physical structure, and where the whole country presents proofs of the action of subterranean forces, he conceives it ceases to be improbable, to any excessive degree, that the action of the volcanos should sometimes be absolutely simultaneous.

The author then briefly described the groups into which the volcanic vents of the Cordilleras have been divided. The most southern extends from Yntales to the volcanos of central Chili, a distance of nearly 800 geographical miles; the second, from Arequipa to Patas, rather more than 600 miles; the third, from Riobamba to Popayan, a distance of about 300 miles; and to the northward, there are in Guatimala, Mexico, and California, three groups of volcanos separated from each other a few hundred miles. That the vents in each of these groups are connected, the author has little doubt; but that the groups are united in one system, there are less satisfactory means of proving.

Mr. Darwin next considered the nature of the earthquakes which occur at irregular intervals on the South American coast. He is perfectly convinced, from the numerous points of analogy which exist between these phænomena and simple eruptions, that they belong to the same class of events; but he makes this distinction, that earthquakes, unaccompanied by eruptions at the chief point of disturbance, are followed by a vast number of minor shocks. These, he believes, indicate a repeated rending of the strata beneath the surface; whereas, in an ordinary eruption, a channel is formed during the first outburst.

Among other phænomena belonging to earthquakes, Mr. Darwin alluded to their affecting elongated areas. Thus the shock in Syria, in 1837, was felt on a line 500 miles in length by 90 in breadth; and those in South America are felt along 800 and 1000 miles of coast, but are on no occasion transmitted across the Cordillera to a nearly equal distance; and, as a consequence, the inland towns are much less affected than those near the coast. He does not conceive, however, that the disturbances proceed from one point, but many ranged in a band, otherwise the linear extension of earthquakes would be unintelligible. For instance, in 1835, the island of Chiloe, the neighbourhood of Concepcion and Juan Fernandez were all violently affected at the same time.

The last consideration which Mr. Darwin entered upon indicating the cause of earthquakes, is, that in South America they have been generally accompanied by elevation of the land; though it is not a necessary concomitant, at least to a perceptible amount. But he especially observed, that, as at Concepcion, during the few days succeeding the great shock, several hundred earthquakes, of no inconsiderable violence, were experienced, whilst the level of the ground in that part of the coast certainly was not raised by them (but after the interval of a few weeks, it stood lower,), there is a clear indication of some cause of disturbance, independent of the uplifting of the land in mass.

In summing up the evidence of phænomena accompanying earthquakes, the author is of opinion that the following conclusions may be drawn:—

1st. That the primary shock of an earthquake is caused by a violent rending of the strata, which, on the coast of Chili and Peru, seems generally to occur at the bottom of the neighbouring sea.

2ndly. That this is followed by many minor fractures, which, though extending upwards, do not, except in submarine volcanos, actually reach the surface.

3dly. That the area thus fissured extends parallel, or approximately so, to the neighbouring coast mountains.

Lastly. That the earthquake relieves the subterranean force, precisely in the same manner as an eruption through an ordinary volcano.

The author afterwards discussed the nature and phænomena of mountain chains; and stated his belief, that the injection, when in a fluid state, of the great mass of crystalline matter, of which the axis is generally composed, would relieve the subterranean pressure in the same manner as an ejection of lava or scoria; and that the dislocation of the strata would produce horizontal vibrations through the surrounding country. In drawing this parallel, he also stated his belief, that the earthquake of Concepcion marked one step in the elevation of a mountain chain; and he adduced, in support of this opinion, the fact observed by Capt. Fitzroy, that the island of Santa Maria, situated 35 miles to the south-west of that city, was elevated to three times the height of the upraised coast near Concepcion; or at the southern extremity of the island, eight feet; in the middle, nine feet; and at the northern extremity, upwards of ten feet; and that at Tubal, to the south-east of Santa Maria, the land was raised six feet*; this unequal change of level indicating, in his opinion, an axis of elevation in the bottom of the sea, off the northern end of Santa Maria.

Mr. Darwin then alluded to Mr. Hopkins's Researches in Physical Geology, where it is demonstrated, that if an elongated area were elevated uniformly, it would crack or yield parallel to its longer axis; and that if the force acted unequally, transverse cracks or fissures would be produced, and that the masses, thus unequally disturbed, would represent the irregular outline of a mountain-chain. He further added, that if the force should act unequally beneath the area simultaneously affected, various fissures would be formed in different parts, having different directions, and thus give rise, at the same moment, to as many local earthquakes. The author believes, that this view will more readily explain intermediate districts being little disturbed (as Valdivia in 1835, and in cases alluded to by Humboldt,) than the supposed inertness of intermediary rock in conveying the vibrations from a deeply-seated focus.

If the preceding theory of the cause of earthquakes be true, Mr. Darwin said, we might expect to find, that the many parallel ridges of which the Cordillera is composed, were of successive ages. In Central Chili, the only portion examined by him, this is the case, even with regard to the two main ridges; and some of the exterior lines of mountains appear, likewise, to be of subsequent dates to the central ones. The contemplation of these phænomena led him, while in South America, to infer, that mountain-chains are only subsidiary, and attendant operations on continental elevations.

The conclusion, that mountain-chains are formed by a long succession of small movements, the author conceived may be arrived at by theoretical reasoning. The first effect of disturbing agents, Mr. Hopkins has shown, is to arch the crust of the earth, and to traverse it by a system of parallel but vertical fissures; and that subsequent elevations and subsidences of the disjointed masses would produce anticlinal and synclinal lines. In the Cordillera, the strata in the central parts, are inclined at an angle commonly exceeding 45°, and are very often absolutely vertical, the axis being composed of granitic masses, which, from the number of dikes branching from them, must have been fluid when propelled against the lower beds. How then,

* Journal of the Royal Geographical Society, vol. vi. p. 327.

he asked, could the strata have been placed in a highly inclined and often vertical position, by the action of the fluid rock beneath, without the very bowels of the earth gushing out? If, on the other hand, it be supposed that mountain-chains were formed by a succession of shocks similar to those which elevated Concepcion, and after long intervals, time would be allowed for the injected rock to become solid, as well as the upper part of the great central mass. Thus, by a succession of movements, the strata might be placed in any position; and the crystalline nucleus gradually thickening, would prevent the surface of the surrounding country, being inundated with molten matter.

In crossing the Andes, Mr. Darwin was surprised at finding, not one great anticlinal line, but eight, or more; and that the rocks composing the axes were seldom visible, except in denuded patches in the vallies. This circumstance, he conceives, must be due to the thickness of the up-heaved strata being equal, or nearly so, to the average distance of the anticlinal from the synclinal lines. For in that case, the masses of strata, when placed vertically, would occupy, or rest on, as great an horizontal extent, as they did before they were disturbed.

In the central ridges of the Cordillera, there are masses of compact, unstratified rocks, half again as lofty as Ætna; and these, he believes, for the reasons before stated, were formed by the gradual cooling of the subjacent fluid mass; afterwards slowly elevated to the present position, by the injection of molten matter at nearly as slow a rate, as we must suppose the innumerable layers of volcanic products, of which the Sicilian mountain is formed, have been ejected.

In conclusion, Mr. Darwin repeated the argument, that mountain-chains and volcanos are due to the same cause, and may be considered as mere subsidiary phænomena, attendant on continental elevations;—that continental elevations, and the action of volcanos, are phænomena now in progress, caused by some slow but great change in the interior of the earth; and, therefore, that it might be anticipated, that the formation of mountain-chains is likewise in progress; and at a rate which may be judged of, by either actions, but most clearly by the growth of volcanos.

March 21st.—Richard Henry King, M.D., of Reigate; John Warden Robberds, Esq., of Norwich; Edmund Lloyd, Esq., of Bloomsbury-square; and Lieut. Tremenheere, of the Bengal Engineers; were elected Fellows of this Society.

A paper was first read, on the Dislocation of the Tail, at a certain point, observable in the skeletons of many Ichthyosauri, by Richard Owen, Esq., F.G.S., Hunterian Professor to the Royal College of Surgeons, London.

Mr. Owen commences his observations by referring to the skeleton of the existing cetacea, and pointing out how slight is the indication afforded by the caudal vertebræ of the large terminal fin, which forms, in that class, so important an organ of locomotion; and the improbability that its presence would have been suspected, had the cetacea been known only by their fossil remains, in consequence of the fin having consisted entirely of decomposable and unossified material.

He states, that the flattened shape of the terminal vertebræ, which gives the only indication of the horizontal fin—and which character is not present in all the cetacea—is not recognisable in the skeletons of the Ichthyosauri and Plesiosauri; but he proceeds to describe a condition of the tail in the skeletons of the Ichthyosauri, which, he conceives, affords an indication of a structure in the extinct animal, analogous to the tegumentary fin of the cetacea, and which has not been suspected by the authors of the conjecturally-restored figures of the Ichthyosauri, already published. The condition alluded to, is described as an abrupt bend of the tail about one-third of its whole length distant from the end; and at the thirtieth caudal vertebra in the *Ichthyosaurus communis*; the broken portion continuing, beyond the dislocation, as straight as in the part which precedes it. As there is no appearance of a modification of structure in the dislocated vertebræ, indicative of the tail having possessed more mobility at that point than at any other; and as the dislocation has taken place at the same point in seven specimens examined by the author, he conceives that it must be due to some cause operating in a peculiar manner on the dead carcase of the Ichthyosaurus, in consequence of some peculiarity of external form, while it floated on the surface of the sea.

A broad tegumentary fin, composed of dense but decomposable material, might have been attached to the terminal portion of the tail; and such a fin, either by its weight, or by presenting an extended surface to the beating of the waves, or by attracting predatory animals of strength sufficient to tug at, without tearing it off, would occasion, when decomposition of the connecting ligaments had sufficiently far advanced, a dislocation of the vertebræ immediately proximate of its point of attachment. The two portions of the tail, with the rest of the skeleton, would continue to be held together by the dense exterior integument, until the rupture of the parietes of the abdomen, at some yielding point, had set free the gases generated by putrefaction; and the skeleton, having undergone certain partial dislocations, from the decomposition of the more yielding ligaments, would subside to the bottom, and become imbedded in the sedimentary deposits, exhibiting the fracture of the tail alluded to.

With respect to the relative position of this conjectured, caudal, tegumentary fin of the Ichthyosaurus, Mr. Owen cannot perceive any indication of its horizontality in the forms of the vertebræ, which he supposes to have supported it; and he regards the superaddition of posterior paddles in these air-breathing marine animals, as a compensation for the absence of that form of fin, which is so essential in the cetacea, for the purpose of bringing the head to the surface of the sea to inhale the air. On the other hand, a vertical caudal fin seems especially required by the short-necked and stiff-necked *Ichthyosauri*, in order to produce, with sufficient rapidity, the lateral movements of the head, which were needed by those predatory inhabitants of the ancient deep; while, in the *Plesiosaurus*, such a fin would be unnecessary, in consequence of the length and mobility of the neck; and Mr. Owen concludes, by stating, that in those skeletons of *Plesiosauri* in which the tail is perfect, it is straight, and presents no indication of the partial fracture or bend, which is so common in the tails of *Ichthyosauri*.

Figures of the tails of five specimens of *Ichthyosauri*, now in London, accompanied the Note; the subject of which was also illustrated by a sixth skeleton of an *Ichthyosaurus* on the Table, the property of Sir John Mordaunt, Bart.

A paper was commenced, on the Primary Formations of England, by the Rev. Adam Sedgwick, V.P.G.S.; Woodwardian Professor in the University of Cambridge, &c.

PROCEEDINGS

OF

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April 4.—Thomas William Maltby, Esq., M.A., of Turnham Green, Middlesex; William Taylor, Esq., B.A., late of Queen's College, Cambridge, now of New Ormond Street; Mr. Isaiah Deck, of Cambridge; and Dr. Ainsworth, late Naturalist of Col. Chesney's Expedition; were elected Fellows of this Society.

A paper was read, entitled, "A Description of Viscount Cole's specimen of *Plesiosaurus macrocephalus* (Conybeare)," by Richard Owen, Esq., F.G.S., Hunterian Professor in the College of Surgeons, London.

The author premises his description of the *Plesiosaurus macrocephalus*, by pointing out the characters of a species of Plesiosaurus, which he regards as distinct from the *Plesiosaurus dolichodeirus* of Mr. Conybeare; and which, from the completeness of its skeleton in the British Museum and other collections, he selects for a more immediate comparison with the *Plesiosaurus macrocephalus*.

He proposes to call the species thus selected, as a term of comparison, *Plesiosaurus Hawkinsii*, in honour of the gentleman to whose remarkable skill and indefatigable labour, the beautiful and perfect skeletons of it are exclusively due. The chief points in which the *Plesiosaurus Hawkinsii* differs from the *Pl. dolichodeirus* are,—that the neck is a little longer than the trunk, instead of being fully equal to the body and tail united;—that it contains twenty-nine cervical vertebræ, bearing hatched-shaped ribs, instead of thirty-five; and that the length of the head is equal to one-tenth part of the total length of the skeleton, instead of one-thirteenth part as in the *Dolichodeirus*. The *Pl. Hawkinsii* differs also in the relative shortness and form of the ulna and fibula, and in some other minor points.

Having defined the species selected to illustrate the specific peculiarities of the *Pl. macrocephalus*, Mr. Owen next offers some new views respecting the elementary composition of a vertebra in the abstract, suggested principally by a study of the vertebral column in the *Plesiosauri*; for having observed that the vertebral ribs, or the elements termed by Geoffroy St. Hilaire *paraaux*, or *para-vertebral elements*, are not bent down in the caudal region to form the protecting laminæ of the vascular trunks beneath the tail, but are continued as shorter rib-like processes through a great part of the tail, co-existing with the inferior laminæ (also called *paraaux* by Geoffroy), he proposes to call these latter or inferior elements (which remain united in the *Plesiosauri*) '*hæmapophyses*', in allusion to their physiological relations with the great blood vessels. The superior laminæ he denominates on the same principle '*neurapophyses*', from their being developed to protect the great nervous trunk. The author further observes that the parts or processes of a complicated vertebra are of two distinct kinds; some being developed independently in separate cartilages, while others are mere projections from these independent constituents.

As examples of the first, or autogenous elements, Mr. Owen instances the *centrum*, or body of the vertebræ; the *neurapophyses* and *superior spine*; the *hæmapophyses* and *inferior spine*; and the *ribs*, or costal processes. The transverse and oblique processes are instances of the second, or exogenous parts of a vertebra.

The vertebræ of the *Plesiosaurus* are then described according to the preceding views, and the varying relations of the different vertebral elements in different regions of the spine are pointed out.

The dorsal vertebræ having been determined in previous descriptions of the skeletons of this genus by their usual anatomical character of affording articular surfaces to ribs, much difficulty has been experienced in defining the precise number of the cervical vertebræ, in consequence of the gradual change of the cervical ribs (hitherto considered as transverse processes), from the form of an expanded hatchet to that of an elongated style. The author, however, regarding the lateral appendages of the spinal column throughout its whole extent as modifications of one and the same vertebral element, proposes to distinguish the cervical and dorsal regions of the spine by the position of the articular surface supporting that lateral element, or rib: thus he would call cervical all those anterior vertebræ in which the body affords the whole or any part of the costal articular surface; and the dorsal series would commence at that vertebra where the costal surface had first passed upon the neurapophysis. The author finds in the *Plesiosaurus Hawkinsii* that the costal processes of the two vertebræ which are articulated to the ilium, and which are consequently to be regarded as sacral, begin again to slide down from the neurapophysis upon the centrum; and that in the *Pl. macrocephalus*, where the costal appendages are lost, the bodies of the first two vertebræ which again begin to exhibit a portion of the costal pit, correspond, in their relative situation to the ilia, with the sacral vertebræ in the more perfect skeletons of the *Pl. Hawkinsii.* In the vertebræ which succeed the sacral ones, the ribs rapidly descend from the neurapophyses upon the centrum; but the bodies of the caudal vertebræ so characterized may be distinguished from those of the cervical by the absence of a longitudinal groove which traverses the costal pits in the cervical region; and also by the presence of the articular surfaces for the hæmapophyses. The determination of characters in the body or central element of a vertebra which point out the region of the spine to which it belongs, is the more valuable in the skeletons of the *Enaliosauri*, because in these cold-blooded reptiles ossification is tardy in its progress, and anchylosis of the autogenous elements of a vertebra rarely takes place; and hence the bodies are often found separated and detached from their peripheral appendages.

After concluding his observations on the structure of the vertebræ in the *Plesiosauri* generally, the author next proceeds to point out the specific peculiarities of the cervical, dorsal, sacral, and caudal vertebræ of the *Plesiosaurus macrocephalus*.

The bodies of the cervical vertebræ of this species may be distinguished from those of the *Pl. Hawkinsii* and *Pl. dolichodeirus* by the close proximity of the costal to the neurapophyseal depressions: in this respect, indeed, the anterior cervical vertebræ of the *Pl. Macrocephalus* differ from those of every *Plesiosaurus* which the author has examined. Other minor distinctive characters are also pointed out. The number of cervical vertebræ in the *Pl. Macrocephalus* is twenty-nine, that of *Pl. Hawkinsii* thirty-one; the length of the neck is twice that of the head; in *Pl. Hawkinsii* it is three times the length of the head.

The dorsal vertebræ of the *Pl. macrocephalus* differ from those of the *Pl. Hawkinsii* and *Pl. dolichodeirus* in being more flattened in the antero-posterior direction, and more concave at the sides; true transverse processes are developed from the neurapophyses to support the ribs, as in other *Plesiosauri*.

In the sacral vertebræ the medullary canal presents a slight enlargement as compared with that in the neck.

The terminal caudal vertebræ in the specimen described, are wanting, but in those of a perfect skeleton of the *Pl. Hawkinsii* in the British Museum, the author discovered an interesting modification of the surfaces by which the bodies are joined to one another. They are hollowed out like the vertebræ of the *Ichthyosaurus*, so as to join by double concave surfaces; he conceives this to be, as in the Batrachian reptiles, the original structure of all the vertebræ, and that it is permanent in those which are most remotely situated from the centre and source of vital energy: but Mr. Owen observes, that this arrest of development is obviously designed, to give to the tail of the Plesiosaurus the same combination of elasticity with flexibility, which characterizes that of fishes.

After describing the vertebral and sternal ribs of the abdominal region, the author next compares the bones of the pectoral and pelvic extremities with those of other species of *Plesiosauri*. In the *Macrocephalus* the ulna is relatively longer and broader, and presents a more complete reniform figure than in the *Hawkinsii* or *Dolichodeirus*. These characters are still more marked in the fibula; the femur is longer than the humerus. There are eight ossicles in the carpus, and six ossicles in the tarsus; these latter are so arranged as to allow of greater freedom of inflection forwards, and to give a compound motion to the stroke of the hinder paddle.

The author concludes with a detailed account of the structure of the cranium, which he compares, at each step, with that of the two principal modifications of the Saurian type, as exemplified in the Crocodilian and Lacertine species; and he points out many particulars in which the *Plesiosaurus* deviates from the Loricate, and corresponds with the Lacertine or Squamate group. Amongst these may be noticed, the predominance of the elongated form in the cranial bones, extending from point to point with wide interspaces, and giving to the osseous fabric of the head the appearance of a scaffolding; the posterior bifurcation, mesial crista, and foramen of the parietal bone; the form and relative position of the posterior frontals, and especially the absence of the ridge which, in the Crocodile, extends like a second zygoma longitudinally across the zygomatic cavity. Mr. Owen further dwelt upon the form and position of the zygomatic portion of the temporal bone, the bony interspace of the external nostrils, the structure of the lower jaw, and particularly on the existence of a wide space on each side of the posterior region of the skull, bounded above by the arch formed by the bifurcate processes of the parietal and the tympanic bones, and opening into the temporal fossæ, as evidences of the affinity of the *Plesiosaurus* to the Lacertine Sauria. The correspondence of the cranial organization of the *Plesiosaurus* to those of the Crocodile, was noticed in the strength of the maxillary apparatus, the general form and structure of the upper jaw, and in the nature and alveolar lodgement of the teeth. The peculiarities of structure referable to the special exigencies of the extinct form of Saurian under consideration, were also dwelt upon, and, lastly, those which characterized the species described, and which illustrate its more immediate affinities.

April 25.—Egerton V. Vernon Harcourt, Esq., M.A., of Nuneham, Oxfordshire; George Crane, Esq., Ynyscedwyn Iron Works, near Swansea; Mr. James Tennant, Strand; C. W. Grant, Esq., Capt. Bombay Engineers; and B. F. Outram, M.D., Hanover Square, were elected Fellows of the Society.

A paper was first read, entitled, "Notes on a small patch of Silurian Rocks to the west of Abergele, on the north coast of Denbighshire;" by J. C. Bowman, Esq., and communicated by R. I. Murchison, Esq., V.P.G.S.

The author's attention was first directed to these strata by Mr. John Price, of New College, Bristol. They occur immediately south of the narrow belt of carboniferous limestone, which skirts the coast from the Great Ormes Head, eastward, to the Point of Air and the Estuary of the Dee. The belt of limestone is here not above a mile broad, and the strata dip N. or N.E. At the base of the limestone precipices at Craig y Forwyn, is a seam of impure coal about a foot thick, and a thinner layer of bituminous shale with carbonized impressions of Lepidodendra? and a leaf-like Poacites. The beds constituting the following section are successively displayed between Llandulas and Garthewin, a distance of nearly six miles:—

1. Immediately under the limestone is a conglomerate, the basis consisting of "light loam," and the rounded pebbles of greenish, slightly micaceous sandstone, containing a few bivalves and joints of encrinites. This stratum the author has also seen between Llandeilo Bay and Colwyn on the Holy-

head road, but the pebbles are there sometimes a foot in diameter.

2. Thin bed of the same sandstone.
3. A thick deposit of red marl, containing numerous angular and water-worn pebbles, interspersed thickly with shells apparently belonging to the Ludlow rocks. This marl forms a considerable part of Ffernant Dingle; but it alternates with a compact marl, and is sometimes speckled green or yellow. The beds dip at a high angle to the north. Similar pebbles are found on the top of the limestone precipices, and beyond them on the beach.
4. Compact, hard, arenaceous conglomerate, composed of pebbles more or less rounded, of liver-coloured and green micaceous shelly sandstone, also of pebbles of quartz, and the reddish subjacent limestone.
5. Thin beds of compact reddish limestone containing few organic remains. It passes occasionally into a calcareous sandstone.
6. Near the lower end of the dingle, the limestone rests on a bed of very fine blue clay.
7. Blue clay-slate, finely grained, slightly micaceous, and containing occasionally a layer of small shells. It sometimes presents obscure indications of vertical cleavage. This rock constitutes the whole of the southern portion of the dingle, and in one place is traversed by a fault.

The rill in Ffernant dingle flows into Melin y Person brook. The red marly conglomerate is there succeeded, on the south, by alluvium containing slate pebbles. Above the village of Bettws Abergele the slate rocks occur, but are greatly contorted; and on the height a little further south, and to the east of the road, is a hard finely grained rock inclosing joints of small encrinites. Still further south this rock alternates with beds of breccia, containing encrinital and other organic remains, the imbedded angular fragments consisting of glossy clay-slate. A little south of this quarry, towards Garthewin, the non-fissile blue slate again occurs, and the author found in it abundance of small fragments of encrinites, with univalves and bivalves. These fossils occurred apparently in layers, but were much decomposed. Similar remains were noticed, by Mr. Bowman, in the debris of the lead mines at the Bronhaylog, to the north-east of Garthewin.

The paper was accompanied by a list of fossils prepared by Mr. James de Carle Sowerby, including the following species which have been found by Mr. Murchison in the Ludlow Rocks elsewhere: *Leptæna lata*, *Terebratula nucula*, *T. pulchra*, *T. navicula*, *Conularia quadrisulcata*, *Atrypa affinis*, *Orthis orbicularis*, *Cypricardia cymbæformis*, var., *Nucula ovalis*, *Euomphalus funatus*, *Orthoceras striatum*, *Avicula retroflexa*, and *Pleurotoma corallii*.

A notice "On the Occurrence of Wealden strata at Linksfield, near Elgin; on the Remains of Fishes in the Old Red Sandstone of that neighbourhood; and on raised beaches along the adjacent coast;" by J. Malcolmson, Esq., F.G.S., was then read.

The country around Elgin is composed of sandstones, conglomerates, and concretionary limestones, belonging to the old red sandstone; but at Linksfield, one mile south of Elgin, that formation is overlaid, unconformably, by a series of beds, which Mr. Malcolmson has ascertained, by their organic remains, to represent the Wealden strata of England, though they have been usually considered to be lias.

The following section gives the principal beds in descending order, the average thickness of the whole series being from 20 to 30 feet:

1. Blue clay, containing thin bands of limestone, the lower being shelly.
2. Thin bands of limestone and clay.
3. Blackish shale, not bituminous, 1 to 2 feet.
4. Compact grey limestone, without shells, in layers separated by clay, 4 feet.
5. Laminated green clay, with a network of fibrous carbonate of lime.
6. Red, sandy, calcareous marl, abounding with rolled pebbles of granite, gneiss, &c., also angular fragments of the fine-grained yellow and grey sandstone forming the hills to the west, but the geological position of which is not yet ascertained.

Cornstone of the old red sandstone in unconformable position.

The fossils are principally found in the lower bands of the top bed. They are rarely well preserved, and cannot be separated from the rock. The species are few in number, but abundant in individuals; and one species of *Cyclas* is undistinguishable from the *C. media* of Sussex, found also by Prof. Sedgwick and Mr. Murchison in the Isle of Skye: there is likewise an *Avicula*, which agrees with one found in the Purbeck strata at Swanwich. Mr. Malcolmson procured also fragments of an *Astarte* and a *Venus*, and a microscopic univalve. The clay below this shelly limestone is full of the valves of a new, round species of *Cypris*. The author also obtained teeth and scales of fishes; and the Rev. G. Gordon has found a Saurian bone.

Fossils of the same description have been recently discovered by that gentleman at Lhanbryde, three miles to the east of Linksfield; and in a micaceous white sandstone, he has procured a large *Pinna*, which Mr. James Sowerby has identified with a species found in the Portland sand of England. In April, 1832, Mr. Gordon communicated to the Society a notice of the discovery in a dark clay*, penetrated while draining the Lake of Spynie, of the *Turritella muricata* of the Coral Rag. Mr. Malcolmson, therefore, hopes that many members of the series above the old red sandstone, not yet known to exist south of the Murray Frith, will be discovered by the practical geologists resident in that district.

Mr. Martin, of the Anderson Institution, has recently discovered in a bed of calciferous conglomerate, near Elgin, and supposed by Mr. Gordon to represent the old red sandstone of Clasbennie in

* Proceedings, vol. i. p. 391.

Perthshire, scales, teeth, and bones of fishes; and, by comparing these remains with a magnificent specimen of a fish from Clasbennie, in Mr. Murchison's possession, Mr. Malcolmson has ascertained this supposition to be correct. A doubt, therefore, which formerly existed respecting the age of the conglomerate, is now removed.

The paper concluded with an account of eleven ancient beaches on the coast, rising above each other, and from one of which, 15 feet above high-water mark, and cut through in draining Loch Spynie, Mr. Malcolmson procured twelve species of existing marine testacea.

A paper, "On the Origin of the Limestones of Devonshire," by Robert Alfred Cloyne Austen, Esq., F.G.S., was afterwards read.

The object of the paper is not to account for the origin of calcareous matter, or the means by which marine animals derive it from the surrounding medium, but to show how far the limestones of South Devonshire may have been produced by polypi.

These limestones are stated by the author to occur, in nearly every instance, in the immediate vicinity of volcanic disturbances, and to be partly included in the slates and sandstones, and partly to rest upon them. To the former belong the broad band extending from Staple Hill to Dean Prior, the minor bands in the neighbourhood of Hempstone and Totness, and all those which occur beyond the Dart; also the limestones of Newton and Torbay. They are said to be less pure and more slaty than the overlying limestones, and to be frequently separated by seams of shale. Transverse sections of these bands show, that the strata in some cases become thinner as they descend, and that the partings of shale increase, as near Staverton in the valley of the Dart, and at Staple Hill; but that in other instances, as between Newton and Totness, the strata instead of fining off end abruptly upon the slate, and are covered in the direction of the dip by similar slates. The strata are always inclined, but they invariably form a table-land at the surface. This inclined position the author conceives is not due to dislocation, but to the beds having been deposited at the angle which they now present; and he illustrated his opinion, by a section between three and four miles in length, through the parishes of Pegwell, Denbury, and Abbots Kerswell, a remarkably level country. The bands of limestone dip 40°, but are nowhere more than 150 feet thick, and they all contain the same description of organic remains. If the bands were deposited horizontally, and the most recent nearly at a level with the surface of the ancient ocean, then the lower beds, the author says, would have been placed at a depth of nearly three miles, although the organic remains prove that all the beds were formed under precisely similar conditions.

In the structure of the Devonshire limestones, however, Mr. Austen considers that he has discovered evidences of an origin similar to that of modern coral reefs, and which will explain their inclined position. At Ogwell Park the limestone forms a horizontal capping to the inclined strata; and at Bradley rests conformably against a ridge of slate, the basset edge of each bed rising to the level of the crest of the ridge. This structure, Mr. Austen states, agrees with that of the coral reefs in the Southern Ocean, where the polypi raise their habitations on the flat summits or sides of submarine hills, to a level with the surface of the water. The stratified arrangement of the calcareous masses he considers may be explained by the occasional deposition of sedimentary matter, which might interrupt, for a time, the labours of the polypus; and thus a series of beds would be produced varying in thickness according to the recurrence, at shorter or longer intervals, of interfering agents, each bed rising successively to the surface level of the water. If the deposition of sedimentary matter were great, then the polypi would be destroyed, and the reef would become encased in a mechanical accumulation. In further proof of the limestone of Devonshire having been coral reefs, Mr. Austen adduced the great abundance of zoophytes found on the surface of the lower strata, imbedded in the layers of sand which separate the beds; and, he added, that their absence in other parts, especially in the interior of the bands, is no objection to his view of the origin of the limestone, because, in recent reefs, all traces of organic structure are frequently obliterated.

May 9.—Joseph Skilbeck, Esq., of Highbury Place, London; the Rev. John Hymers, Fellow and Tutor of St. John's College, Cambridge; and the Rev. Walter Davenport Bromley, of Wootton Hall, Staffordshire, were elected Fellows of this Society.

A communication by Dr. Black, F.G.S., was first read, "On a fossil stem of a Tree recently discovered near Bolton-le-Moor."

The rock in which this fossil was found, occurs in the middle of the coal-measures, about 50 yards beneath a six-feet bed of coal, and it rests upon another bed four feet thick. It consists of three strata of argillaceous sandstone dipping from 15° to 18° to the south-west, and amounting in all to about 40 feet in thickness. The upper portion of the fossil stem was discovered about thirty feet beneath the surface of the rock, and the lower end extended to within 5 or 10 feet of the subjacent bed of coal. It was inclined 18° to north-east, or in an opposite direction to the sandstone strata; and, when first laid open, it appears to have been about 30 feet in length, but at the time it was examined by Dr. Black only 12 feet remained *in situ*. The upper end of this portion was 15 inches in diameter, and the lower 9 inches. The whole of the exterior of the stem was singularly striated, and irregularly furrowed, as if by compression; and it was coated with a layer of coal, which evidently occupied the place of the bark. The interior of the stem is stated to be composed of a dark, hard, argillo-ferruginous sandstone, having a specific gravity of 2·9. A Sternbergia, about an inch in diameter, extended along the whole length of the stem, and in some parts appeared to be half imbedded in a groove in it. This connexion of the two plants was Dr. Black's principal object in making the communication to the Society, not having previously observed a similar occurrence, nor having heard that it had been noticed elsewhere by other collectors. He is of opinion that the Sternbergia was not accidentally allocated with the larger stem, but that it was, while living, a parasite, and in this respect resembled the mighty creepers of the existing tropical regions.

A paper was next read, "On the Distribution of Organic Remains in part of the Oolitic Series on the coast of Yorkshire;" by Mr. Williamson, Curator of the Natural History Society of Manchester.

In former communications* Mr. Williamson explained the vertical range of organic remains in the Lias of inferior and great oolites, and in this he showed their distribution in the upper sandstone and shale, the cornbrash, the Kelloway Rock, and the Oxford Clay.

The upper sandstones and shales vary considerably in their characters, but they consist of three principal divisions, the highest and lowest being composed of sandstones sometimes ferruginous, and the middle one of clays and shales. The principal localities for the fossils are on the north side of Scalby Beck, near Scarborough, and Burniston Bay. The most characteristic plants are *Pecopteris Murrayana, Cyclopteris digitata,* and *Otopteris obtusa*; but remains of Cycadeæ and Equiseta also occur. The list of plants is much smaller than that generally given, in consequence of Mr. Williamson having removed to the great oolite, a bed generally considered as belonging to the upper sandstones.

Cornbrash.—This formation seldom exceeds five feet in thickness, and in Cayton Bay consists of the following strata in descending order:

Fissile oolite	6 inches.
Softer rock, sometimes ironshot..	2 feet.
Hard ironshot rock............	2 feet.
Blue clay, from	3 inches to 4 feet.

The fossils contained in the fissile upper bed, are chiefly *Terebratula ovoides, T. obsoleta, Ostrea edulina,* and *O. Marshii.* The greater portion of the organic remains are found towards the middle of the deposit, the following being the most abundant: *Ammonites Herveyi, Ostrea Marshii, Plagiostoma rigidulum, P. interstinctum, Trigonia clavata, T. costata, Cardium citrinoideum, Unio peregrinus, Amphidesma decurtatum, A. securiforme, Mya literata,* and *Clypeus orbicularis.* Twenty other species also occur, but less numerously. In the bed of clay, remains of a small *Astacus* (?) are obtained, also a shell resembling an *Unio,* and an undescribed Belemnite. Thirteen of the species found in the cornbrash are stated to exist also in the great oolite of Yorkshire, and nine in the coralline or Oxford oolite.

Kelloway Rock.—This deposit consists of soft sandstones, sometimes calcareous, but towards the top it is occasionally very ferruginous; and it varies in thickness from 35 to 70 feet. The fossils are numerous and highly characteristic, particularly the Ammonites. The ferruginous bed is full of organic remains, consisting chiefly of

* Proceedings, vol. ii., pp. 82, 429. Geol. Trans., vol. v. Part I., p. 223, *et seq.*

Belemnites abbreviatus, B. tornatilis, Ammonites Calloviencis, A. sublævis, A. Königi, A. Sutherlandeæ, Ostrea Marshii, Gryphea dilatata, β. The most abundant species in the sandstones are, *Ammonites flexicostatus, A. sublævis, A. gemmatus, A. Calloviencis, A. perarmatus, A. ichthyodorsus* (W.), *A. gamma* (W.), *A. rotifer* (W.), *A. oblisus* (W.), *Belemnites abbreviatus, B. tornatilis, Turbo sulcostomus, Terebratula ornithocephala, T. socialis, Gryphæa dilatata, Ostrea Marshii, Avicula Braamburiensis, A. expansa, Lucina lirata, Amphidesma recurvum* : 18 other species of testacea occur, though less abundantly. Five species are stated to be common to the Kelloway rock and the cornbrash, and ten to the Kelloway rock and the coralline oolite. Remains of fishes and of Ichthyosauri and Plesiosauri also occur in the deposit.

Oxford Clay.—This great argillaceous formation is about 130 feet thick, and consists chiefly of fissile shales, but towards the upper part it becomes sandy. Fossils are comparatively rare in it, and are confined to the lower part, the only shell discovered in the upper by Mr. Williamson being *Pinna lanceolata.* The characteristic fossils are *Ammonites Vernoni, A. cristatus, A. athleta, A. occulatus, Belemnites gracilis, Nucula nuda, N. elliptica, Pinna mitis, Astarte lurida, A. carinata, Avicula expansa.* The bed resting on the Kelloway rock is characterised by *Belemnites abbreviatus* and *Gryphæa bullata.*

In future communications, the author purposes to illustrate the distribution of organic remains in the higher oolitic strata of the Yorkshire coast.

A paper was afterwards read, "On the State in which Animal Matter is usually found in Fossils;" by Mr. Alfred Smee, Student of King's College, London, and communicated by Prof. Royle, M.D., F.G.S.

The author first describes briefly, the composition of those parts of recent animals capable of being preserved in a fossil state; and then proceeds to detail his investigations into the composition of fossil organic remains.

For the sake of arrangement, he divides fossils into two great classes, one in which animal matter is present in various states, the other in which it has been removed. The first class he further subdivides into three cases: 1. comprehending those fossils in which animal matter retains its original condition; 2. those in which it has been partially changed; 3. those in which only the carbon of the animal matter remains.

1. The following examples were given of the first case.

Small portions of the tooth of a horse, of an ox, and a stag, from the chalk rubble at Brighton, were submitted to the action of diluted muriatic acid; and after the earthy portions had been removed the animal matter retained the shape of the bone, was white, and of the consistence of cartilage. Fragments of a tooth of a mammoth from Norfolk, and of a rib of a mastodon from Big-bone-lick in Ohio, when similarly treated, gave the same results. A thin slice of the rib exhibited under the microscope the structure of recent bone. Fragments of a stag's rib and horn, of an ox's head, and the tusk of a boar found near the Bank of England, associated with Roman implements, retained their animal matter unaltered. Small portions of a Terebratula and of two species of Productæ, from the Silurian rocks of Malvern, were placed in very diluted muriatic acid, and when the earthy portions had been removed, small flocculi of animal matter, resembling the recent membrane of a shell, floated in the solution. A minute fragment of *Asaphus caudatus* yielded little shreds of animal matter. The experiments on the shells were repeated several times with the same results. Under the microscope these fossils exhibited also the structure of recent shells.

2. The second case in which animal matter has been partially changed, was illustrated by the following experiments. Portions of a stag's jaw from the Brighton chalk rubble, of a fish-bone, and a shark's tooth from the London clay, when dissolved in diluted muriatic acid, gave only a brown powder; and the animal matter of a fragment of the humerus of a mastodon from Big-bone-lick exhibited but little flexibility, and was easily torn, particularly in the longitudinal direction. It was found impossible to make sections of the jaw-bone of the stag or the humerus of the mastodon for microscopic observation. Part of a human parietal bone found upon the site of the cathedral of Old Sarum, and human bones obtained from the church-yard of St. Christophe le Stocks, on part of which the Bank of England stands, were ascertained to have had their animal matter reduced to the same state as that of the stag's jaw. A fossil oyster from the Isle of Wight, when placed under the microscope, showed black spots over its surface, and the structure of the shell was apparently destroyed. A fragment of a Pecten from the lias also exhibited opaque spots. Part of an ammonite when dissolved left a substance resembling Sepia.

3. The third case, where only the carbon of the animal matter remains, was explained by two series of experiments, one of which proved it to be associated with bitumen, and the other that it existed by itself. The scales of *Dapedium politum* and other fishes from Lyme Regis, when acted upon by acid, left carbon undissolved; and when heated under a test-tube gave a considerable quantity of bitumen.

Portions of the bones of the Ichthyosaurus and Plesiosaurus from the lias, yielded a black residuum, which deflagrated with red hot nitre, and the resulting mass gave a precipitate with chloride of calcium. To prove that the carbon was a portion of the bone and not an adventitious ingredient, a section was made, and the greatest quantity of carbon was found in the thickest part; and an analysis showed that the proportion of carbon was about the same as in the animal matter of a similar mass of recent bone. A still further proof was adduced, in no gelatine having been detected after 36 hours boiling of a fragment of the fossil. A section of recent bone displayed, when carbonized by heat and charged with crystals of alum or a composition of whitening, a similar appearance in the arrangement of the carbon as in the fossil bone. No bitumen was given off, when fragments of these bones were acted upon by heat under a test-tube.

With respect to the second great class in which the animal matter has been removed, the following cases were mentioned :—Portion of the external and internal parts of a mammoth tusk from Siberia, did not blacken by heat, and dissolved completely in muriatic acid. The internal part of a tusk from Ohio gave the same results, but the external part was found to contain a considerable proportion of animal matter. In bones from the crag, the animal matter had been abstracted. Human bones which had been long buried were found to be in the same state.

The paper concluded with the following remarks. As the different states, in which animal matter is found in fossils, pass insensibly into each other, and as many of the changes occur in church-yard and other bones, it follows, that no extraordinary circumstances are requisite to produce these alterations; but that they may be effected by the ordinary processes of putrefaction. Even the carbonization of animal matter may be accomplished by similar processes without the aid of heat, as bones become black by being macerated too long. It is also to be observed, that the parts of animals preserved in the fossil state, are those which longest resist putrefaction. It having been likewise shown that the degree of change does not depend upon the age of the bed in which the fossil occurs, it is a curious subject of inquiry for the geologist to ascertain how far the conditions necessary to putrefactive air, a certain temperature and moisture, were present in those strata, in which the change has been great; how far they were absent in those, in which the change has been small.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. II. 1838. No. 58.

May 23.—A memoir entitled, a Synopsis of the English series of stratified rocks inferior to the old red sandstone—with an attempt to determine the successive natural groups and formations. By the Rev. Adam Sedgwick, *Woodwardian Professor in the University of Cambridge,* commenced on the 21st March, was concluded.

Introduction.—The author, after stating what was now offered to the Society to be only a first approximation, involving many questions of difficulty and doubt, pointed out the principles on which he had undertaken the task. There are two elements of classification applicable to stratified rocks of all ages, viz., physical structure and order of superposition; one giving the mineralogical unity of a group of rocks, the other their relative age. In addition to the two former, are classifications founded on the organic remains in the several groups. In the commencement of geology the last method was only subsidiary to the two former. But after observations had been multiplied, laws respecting the distribution of organic types were discovered, which not merely superseded, in many large formations, all classifications founded on mineral structure; but often, through wide regions, gave indications of succession which were unsupported by the direct evidence of sections. As, however, the (so called) laws respecting the distribution of organic types, are mere general results grounded on actual observation, it is obvious that they can never upset conclusions drawn from the clear and unambiguous evidence of sections. The two methods may be used independently, and conspire to the same end; but in their nature cannot come into permanent collision.

The author then points out some examples in which these principles had been violated. (1) The attempt formerly made by some geologists to arrange the Stonesfield slate in a tertiary group, merely from the presence of certain fossils of a class not commonly found in secondary rocks. (2) Some of the doctrines put forth in the papers of M. Deshayes, which if pushed to their utmost extent would make the evidence of sections of no value; whereas without sections fossils could never have led to any general laws of succession. (3) The recent discussions respecting the age of the culm plants of North Devon. The plants were assumed to be of the age of the greywacké, from the mineral structure of the rocks in which they were imbedded; or the rocks were assumed to be of the carboniferous period by the species of the imbedded plants: whereas true geological reasoning required that, anterior to either of the preceding conclusions, the true position of the culm measures should be determined by actual sections.

The author then goes on to point out the difficulty of classifying the vast series of schistose rocks below the old red sandstone —from the great resemblance of their mineral type—from the absence of well-defined beds of organic remains in many large regions—and from their entire disappearance in the last members of the descending series. The Silurian system is almost the only exception to this remark; and even this system is developed in many parts of England without any distinct succession of natural groups. The mineral type is on the whole much more uniform in the great series under notice than in the secondary system of England; but the frequent absence of organic remains, and of any succession of distinct groups, is compensated by the enormous scale of development, as shown in the natural sections: and the author concludes, that it is not by hypothetical views and analogies, or by maintaining one part of geological evidence at the expense of another; but by applying every kind of evidence in its proper place, and above all by actual surveys and detailed sections, that we can ever hope to bring into coordination the complicated phænomena of which he is only attempting to give a brief synopsis.

TWO CLASSES OF OLD STRATIFIED ROCKS, &c.

The author first notices the older stratified series of Scotland, and divides it into two classes.

(1.) The primary class (composed of gneiss, mica slate, quartz rock, &c. &c.,) is largely developed in the Highlands.

(2.) The second class (greywacké, greywacké slate, &c. &c.,) is also largely developed in the Lammermuir hills, and in the whole chain extending in the south of Scotland from St. Abb's Head to the Mull of Galloway. It is shown, partly on mineralogical characters, and partly on the evidence of sections, that the rocks of the former class are inferior to those of the latter. For a zone of slate rocks (the *roches chloriteuses et quartzeuses* of Dr. Boué) is superior to the crystalline slates of the Grampians, and is (at least provisionally) placed on the same parallel with the earthy and mechanical slates of Lammermuir chain. Both the preceding classes are shown to be inferior, and generally unconformable, to the old red sandstone; which in the northern part of Scotland was once grouped with the primary class; but in the geological map of Scotland is now put in its true place.

After giving a series of sections to connect the structure of the Lammermuir chain with the adjacent parts of the north of England, he then proceeds to describe, in general terms, the expansion of the rocks of the second class through various mountainous tracts of South Britain. The frontier chain of Scotland—the slaty series of the Cumbrian mountains—of North and South Wales—and of the whole region between the eastern side of Devon and the western end of Cornwall—as well as the slate rocks of some smaller unconnected tracts, are all referred to one great class, the highest group of which passes into the old red sandstone, while the lowest (where the development is complete) rests on the crystalline system of the first class. Independently of the direct evidence from detailed sections, the several regions are shown to be related; 1st, by a common physical structure; 2ndly, by organic remains; 3dly, by common lines of *strike*; tending to show that several disconnected tracts of wide extent, having partaken of the same accidents, were once probably connected and continuous deposits in a deep sea.

In illustration of these views he shows that the prevailing strike of the beds (as well as the prevailing direction of the anticlinal and synclinal lines) in the Lammermuir system, in the Cumbrian system, and in the system of all the highest chains of North Wales, is nearly N.E. and S.W. and he further shows that the actual impress was given to all these regions before the period of the old red sandstone. In Cornwall the average strike is about W.N.W., but gradually bends round to the E. and W., in which prevailing direction the rocks cross Devonshire. In the southern parts of the slate regions of South Wales the beds also have an east and west strike; and these parallel dislocations of Devonshire and South Wales are posterior to the carboniferous series and probably contemporaneous with one another. Where the two preceding systems of strike meet, the beds are thrown into inextricable confusion; and on the outskirts of Wales, and in the counties where the Silurian system has been most largely developed, the dislocations are too irregular and complicated to be reduced to any law. Lastly, he notices a system of dislocations that have brought up a portion of the older rocks (of the class here described) at Dudley, on both sides of the Warwickshire coal field, and in Charnwood forest. At all these localities the strike is the same, and the lines of greatest movement are nearly parallel—all being about N.N.W. and S.S.E.; and all these movements belong to one epoch, having been completed *after* the deposition of the lower red sandstone, and *before* the period of the upper and gypseous marls. Hence we have three great systems of elevation, each marked by parallel lines of strike, and the three systems of strike indicating three distinct periods of elevation.

The author then points out the importance of such facts to the broad speculations of geology, as well as the limitations under which they are to be applied. The dynamical powers of elevation appear to have been employed in three principal forms. 1st. In gradually raising up ridges through large spaces of the earth's crust. These will explain the correspondence of strike through very extensive regions; and such elevations if continued beyond a certain limit must have produced longitudinal fissures and lines of volcanic vent. 2ndly. In the long-continued protrusion and eruption of igneous rocks along such lines of vent. 3dly. In local and partial eruptions and protrusions, producing valleys of elevation, local derangements, and other phænomena that terminate in ordinary volcanic action. Elevatory forces, when considered in this general way, explain the phænomena of strike—the parallelism of great contemporaneous elevations—as well as the exceptions to the rule of parallelism.

GROUPS OF THE CUMBRIAN SECTION, &c.

The author then commences the separation of the whole series of rocks of the *second class* into natural groups, founded on sections exhibited in the several districts above noticed; and after shortly discussing two sections connecting the Cheviot hills with the formations in the basin of the Tweed, he describes in some detail a transverse section through the whole system of the Cumbrian mountains, which exhibits the following groups in ascending order.

(1.) The group of Skiddaw Forest, &c., the lower part of which rests on the granite, and passes into a system of crystalline strata resembling the rocks of the first class; the upper part abounds in a fine dark glossy clay slate, interrupted here and there by beds of more mechanical structure. The whole is of great thickness, almost without calcareous matter, and without any trace of organic remains, and forms the mineral axis of the Cumbrian mountains.

(2.) A group essentially composed of quartzose and chloritic roofing slates alternating with mechanical beds of coarser structure, and also with innumerable igneous rocks (compact felspar, felspar porphyry, brecciated porphyries, &c. &c.,) which partake of all the accidents of the slates. It is of enormous thickness, and rises into the highest mountains of the country; and though chiefly developed on the south side of the preceding group (No. 1), it also appears extensively on the north side of the lower group, which thus forms a mineral axis —a fact not yet noticed in any of the published geological maps. Though abounding in calcareous matter, it has no organic remains. (*Lower Cambrian system*).

(3.) A great series, expanded through Westmoreland and parts of Lancashire and Yorkshire. It is based on calcareous slates, passing into limestone, and full of organic remains, and in its lower division are fine roofing slates, but less crystalline than those of the preceding group. Its upper division (not however separable by any very distinct zoological or mineralogical characters from the lower) abounds in arenaceous flagstone, coarse quartzose greywacké, coarse slates with imperfect cleavage, and not fit for use, and the series is incomplete, being cut off by the unconformable deposits of old red sandstone and carboniferous limestone. Distinct beds of limestone are almost wanting in this upper division, and organic remains are very rare, but they appear here and there in very thin bands among the coarse siliceous slates. Provisionally, the lower division is placed in the *Upper Cambrian system*, and the upper division in the *Silurian* system; but without being separable into any further clear subdivisions. This great group (No. 3.) does not appear on the north side of the mineral axis of Cumberland, as was represented in the early geological maps.

SECTIONS OF NORTH WALES, &c.

The author next discusses a series of sections illustrating the structure of North Wales. One is drawn from the Menai Straits, in a direction about E.S.E., so as to cross the Berwyn chain and end in the carboniferous series near Oswestry. The others are drawn from the Berwyn chain to different parts of the carboniferous limestone range on the north side of Denbighshire. The greater portion of the first section crosses the older beds (the *Cambrian System*) which strike towards the N.E. The other sections intersect the upper series (*Silurian System*) which strike towards the N.W., passing (in some places unconformably) round the beds of the older system. From a consideration of the whole evidence the rocks are grouped in the ascending order as follows.

(1.) Chlorite slate, quartz rock, and mica slate of Anglesea and Caernarvonshire. These are placed on the parallel of the first class; and nothing is discovered in the section that is perfectly analogous with the Skiddaw slate, or first Cumbrian group, above described.

(2.) The old slate series of Caernarvonshire and Merionethshire, alternating indefinitely with bands of porphyry and felspar rock; many parts absolutely identical in structure with the second Cumbrian group above-described. It is of enormous but unknown thickness, and is bent into great undulations, the anticlinal and synclinal lines of which are parallel to the strike of the chain. Through wide tracts of country it is without fossils; but at Snowdon and Glider Fawr, encrinites, corals, and one or two species of bivalves have been discovered in it. It ends with the calcareous beds which range from Bala to the neighbourhood of Dinas Mowddy. This is called the *Lower Cambrian System.*

(3.) The next group (the *Upper Cambrian System*) commences with the fossiliferous beds of Bala, includes all the higher portion of the Berwyns, and all the slate rocks of South Wales which are below the Silurian System. Its slate beds are less crystalline, and its general structure is more mechanical, than the preceding group, and it contains incomparably more fossils, which (though there are many extensive portions of the group without fossils) are disseminated through the more calcareous beds in great abundance. Many of the fossils are identical in species with those of the lower division of the *Silurian System,* nor have the true distinctive zoological characters of the group been well ascertained.

In many parts of South Wales it is separated from the *Silurian System* by great faults and derangements of the strata, marked by a broad band of rotten non-fossiliferous schist. At the north end of the Berwyn chain it appears to pass by insensible gradations into the lower division of the Upper System (the *Caradoc Sandstone*).

(4.) The last natural group (the *Silurian System*). For all details respecting this system the author refers to the abstracts of Mr. Murchison's papers, and to his forthcoming work. He then describes the sections:

(1.) East of the Berwyns, in which the Caradoc Sandstone is finely developed; containing the *Llandeilo flagstone* and other characteristic calcareous and shelly bands.

(2.) The sections north of the Berwyns, connecting Montgomeryshire with Denbighshire. The ascending series is described as follows:—

(1.) A series of beds several thousand feet in thickness, and apparently forming a passage between the Upper Cambrian and lowest portion of the Silurian System.

(2.) Bands of calcareous slate with numerous organic remains of the "*Caradoc Sandstone.*"

(3.) Series of flagstones, more or less calcareous, with many orthoceratites and two species of cardiola, overlaid by, and associated with, irregular masses of roofing slate with a transverse cleavage.

(4.) Flagstones and rotten slates, many parts in an imperfect state of induration, and the whole surmounted by the Carboniferous Limestone.—Of the preceding section the lower part of No. 3. is identical with the series of Long Mountain in the Silurian sections of Mr. Murchison; but No. 4. is mineralogically unlike any thing he has described, although it has been found to contain some of the fossils of the *Upper Ludlow Rock*. It appears from these details that the Silurian System, although its subdivisions are obscure from the absence of the Wenlock and Ludlow limestones, is more fully developed than in the group (No. 3.) of the great Cumbrian section above described.

The author then briefly notices the slate rocks of Charnwood Forest, which he refers provisionally to the Upper Cambrian System; but from the imperfection of the sections and the absence of organic remains, their exact place is not determined.

SECTION FROM THE NORTH TO THE SOUTH COAST OF DEVONSHIRE.

I. *North Devon section.*—For details the author refers to a paper by Mr. Murchison and himself, but enumerates the successive groups for the purpose of adding some remarks, and of connecting the system of Devon with that of Cornwall*. The ascending order is as follows:

(1.) A series of coarse arenaceous slates, not noticed in the former paper.

(2.) The calcareous slates of the river Lyn.

(3.) The coarse red flagstones, &c., of Exmoor Forest, and of the coast to the east of Combe Martin.

(4.) The calcareous slates and limestone bands of Ilfracombe.

(5.) The contorted slate zone south of Ilfracombe.

(6.) The calcareous slates and irregular masses of limestone between the preceding group and the culm measures.

The whole of the preceding series is placed in the Upper Cambrian System with the exception of the upper portion of No. 6., which is

* See Proceedings, p. 556 et seq.

considered, both from its structure and its fossils, as near the doubtful limit between the Upper Cambrian and Lower Silurian Systems.

II. *Culm measures.*—This series is described (as in a former paper) to occupy a great trough, which ranges across the country in a direction bearing nearly east and west; on its north side overlying the preceding group (No. 6. of the North Devon section), and on its south side rising up to the granite of Dartmoor, or overlying the older slate system of Devonshire and Cornwall*. Its subdivisions are enumerated as in the former paper; and the author adds, that during the summer of 1837 he ascertained that the lower beds of the culm measures rest unconformably on a portion of the slate rocks in the north of Cornwall, near Launceston. On the contrary, in the cliffs near Barnstaple, the lower culm measures seem to graduate almost insensibly into the formation on which it rests. Hence (independently of all other evidence) it is clear that slate rocks in the north of Cornwall are of an older epoch than the upper group of the North Devon section.

The author then considers the classification of the culm series, and states his opinion that the base of it is lower than the base of the ordinary English carboniferous series. The base line (in the former paper) was intentionally left in an ambiguous position; and the difficulty of the subject has been subsequently increased by the supposed discovery of some true carboniferous plants in the highest group (No. 6.) of the North Devon section. In the upper part of the culm measures all the fossil plants have been described as identical in species with plants of the carboniferous series; and hence (unless some conflicting evidence be discovered) the culm measures and common coal measures must continue to be placed on the same parallel.

Lastly, he states that, independently of any question of classification, the former paper by Mr. Murchison and himself first pointed out the following facts in the general structure of the county:—

(1.) That the Wavellite rock and culm limestone (of Barnstaple, &c.) were in position, structure, and fossils distinct from all the other calcareous groups of Devon.

(2.) That the same group was repeated over again with a reversed dip on the north side of Dartmoor, and entirely distinct from the calcareous slates of Cornwall, with which it had no analogy in structure or fossils.

(3.) That the Holcombe Rogus limestone was a part of the culm series.

(4.) That the culmiferous system was superior to all the slate rocks of Devonshire and Cornwall, and was overlaid by no older rock than the new red sandstone. Whereas before, the portion of the culm series near the granite had, from its metamorphic structure, been confounded with the oldest rocks of Devonshire and Cornwall; and the position of whole series among the Devonian groups had been misapprehended.

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* See Proceedings, p. 561.

III. *South Devon section.*—This section, in conformity with the scheme given in the former paper, is as follows, in the ascending order*:—

(1.) A series of slate rocks subdivided into two groups,—the lower containing a few calcareous bands, the upper group more calcareous and ending with the Plymouth limestone. The two are considered as one formation; and the name, *Ashburton bands,* which had been given to the calcareous beds of the lower division, is now withdrawn, as the position of the Ashburton lime rock is considered ambiguous. The name of *Ugborough bands* is not liable to the same objection.

(2.) A great group of coarse red flagstone and slate, identical in its structure with No. 3. of the North Devon section, and containing some corals that do not appear in the mountain limestone, but are found both in the Cambrian and Silurian systems. This group is provisionally identified with No. 3. of the North Devon section.

(3.) A great group of slate rocks without beds of limestone, and very rarely with any traces of organic remains. By the suppression of No. 4., this group is considered as the equivalent of No. 5. of the North Devon section.

(4.) Mica and chlorite slate, anomalous in structure and position, and forming no part of the ascending series.

The preceding identifications are only provisional, and many desiderata are enumerated; but it is considered certain that the South Devon section belongs, on the whole, to a lower series than the North Devon. Neither of them are, however, supposed to descend lower than the Upper Cambrian, or the higher part of the Lower Cambrian, group. To place the South Devon section above the North Devon, would be to violate all the analogies of structure derived from other parts of England; and would not, the author believes, be supported by any specific evidence derived from fossils.

CLASSIFICATION OF THE ROCKS OF CORNWALL.

The author states, that the Plymouth limestone, in its range westwards, gradually thins off, and comes to an edge about the middle of Whitesand bay. The strike of the beds and the trending of the coast prevent this limestone and all the upper groups of the *South Devon section* from appearing again on the south-eastern side of Cornwall.

The inferior portion of the first group (No. 1.) of the South Devon section passes into Cornwall in a broad zone, gradually acquires the strike of the Cornish rocks, and so runs along the S.E. coast; and finally passes from Falmouth bay to Mounts bay; rising on its north side towards the granite, and on its south side dipping under the serpentine of the Lizard district. As in Devonshire, the group contains beds more or less calcareous, and, rarely, thin beds of limestone.

In the same way, though not with the same clear evidence, the calcareous slates rising from beneath the culm-measures near Launceston, double round the granitic promontory of Rough-Tor, and

* See Proceedings, p. 562.

are thence expanded (though with considerable irregularities of strike and modifications of structure) as far as St. Ives' Bay.

The granitic ridge of the county is supposed to represent an interrupted mineral axis, on the N.E. and S.W. sides of which are slaty groups of the same geological period. In all cases near the granite the slaty groups change their structure; but this change of structure cannot be assumed as the ground of a classification dependent on the age of the deposit; as it is shown by a series of sections, that in several places the fossiliferous slates on the coast are of the same date with the indurated metalliferous slates that rise to the granite. Hence the crystalline and metalliferous slates of Cornwall are considered as metamorphic, and in that respect agree with the bottom culm series that touches on the Dartmoor granite.

Of the rocks of Cornwall the newest are the granites; next come the serpentine and other trappean rocks; and the oldest are the slate rocks. These slate rocks (including all the killas of Cornwall of whatever structure) appear to be an actual prolongation of the lowest group of the *South Devon section*, and therefore, agreeably to what is stated above, are provisionally arranged near the upper portion of the *Lower Cambrian System*.

Many of these rocks were formerly considered primitive; but none of them have any pretension to that class. Numerous fossils were found by the author in the cliffs on both sides Loe bay, and on both sides of the Fowey river, and still further west in Gerrans bay. Mr. J. Conybeare found fossils many years since in the Tintagel slates; and the author in 1828 traced the fossiliferous system into the cliffs west of Padstow. During M. De la Beche's survey he had (before the author's last visit to the N.W. coast of Cornwall) found fossils innumerable in that part of the county. The Cornish fossils are generally ill preserved; but among them are some corals that are common both to the Silurian and Cambrian systems. The fossils of New Quay and South Petherwin are an exception to the remark; as many of them are well preserved. They consist of corals; encrinites; numerous specimens of the genera *Terebratula, Orthis*, and *Spirifer*; of four or five species of *Orthoceratites*; *Goniatites*; and lastly, three or four new species of a genus described by Count Munster under the name Clymene, and by Mr. Ansted under the name Endosiphonites. As they occupy a position so much lower, so, as a group, these fossils are distinct from those of the Silurian system.

Conclusion.—The author here takes a retrospect of the preceding description, and states that the classifications are founded on the details of actual sections; and that as far as such detailed sections throw light on the several questions that may arise, there is not much that remains to be done in England. Some of the generalizations are, however, founded on imperfect evidence; and to render them more complete, it is now necessary to appeal to the organic remains in the several groups. In this department little has been yet effected, excepting in the higher part of the Silurian system, where the upper divisions (at least in one part of the island) assume definite mineralogical and zoological types. Whether definite zoological groups can be made out in any lower system still remains to be seen. The rigid determination of the Devon and Cornish fossils, which are very numerous, and a rigid comparison of the Berwyn and Bala fossils with those near the base of the third group of the Cumbrian section, give the fairest promise of an answer to the question, and are pointed out as immediate *desiderata*.

The difficulty of classification by organic remains increases as we descend, and is at length insurmountable; for in the lowest stratified groups, independently of metamorphic structure, all traces of fossils gradually vanish; and the great range of certain species through numerous successive groups, and the very irregular distribution of fossils even in some of the more fossiliferous divisions, add greatly to the difficulties of establishing true definite groups even within the limits of our island. The difficulties are indefinitely increased in comparing the formations of remote continents. But these circumstances are compensated by the magnificent scale of development of the successive groups, and their wide geographical distribution. Taken together they have a great unity of character; and even in remote continents they seem to form a common base, from which we may hope to compute the whole series of secondary and tertiary deposits that surmount them.

The author then briefly touches on questions of structure and cleavage; on the indefinite alternations of trappean beds; on metamorphic structure; on the long duration of the deposits; and on their great disruptions and symmetrical dislocations, indicating a greater violence of disturbing forces than is indicated in the secondary formations of this country. Following the geological scale of deposits from top to bottom, we can trace a series of phænomena indicating the same kind of causation differing at different times in intensity and degree. The mean intensity can therefore only be collected by ascertaining the intensity during every geological period, and can never be obtained by assuming the intensity of any one epoch, past or present, as the arbitrary standard. Again, the successive organic types indicate great physical changes; and following the descending scale they at length vanish; conducting us, however, to the confines of other investigations in exact science which must prove the ultimate basis of physical geology.

Finally, the author gives a tabular arrangement of the several classes and subdivisions agreeably to the system of the preceding communication.

Class I.—*Primary stratified Groups.*

Gneiss, mica slate, &c., &c. Highlands of Scotland and the Hebrides. Crystalline slates of Anglesea and the S.W. coast of Carnarvonshire.

The series generally without organic remains; but should organic remains appear unequivocally in any parts of this class, they may be described as the *Protozoic system.*

Class 1. (*a*). The crystalline slates of central Skiddaw forest, and the upper Skiddaw slate series. The whole is inorganic and intermediate between Class I. and Class II.

Class II., or *Palæozoic series.*

This class includes all the groups of formations between Class I. and the old red sandstone; and is subdivided as follows:—

1. *Lower Cambrian System.*—All the Welsh series under the Bala limestone. The two great groups of green roofing slate and porphyry on the north and south side of the mineral axis of the Cumbrian mountains. A small part of the slates of Cornwall and South Devon.? A part of the slate series of the Isle of Man, &c., &c.
2. *Upper Cambrian System.*—A large part of the Lammermuir chain on the south frontier of Scotland. A part of the third Cumbrian group, commencing with the calcareous slates of Coniston and Windermere. The system of the Berwyns and South Wales. The slates of Charwood forest.? All the North Devon and a part of the South Devon series. The greater part of the Cornish series.
3. *The Silurian System.*—The upper part of the third Cumbrian group, chiefly expended in Westmoreland and Yorkshire. The flagstone series of Denbighshire. The hills on both sides of Llangollen. The region east of the Berwyn chain. The regions described in the papers of Mr. Murchison, from which the types of the system are derived. The lowest part of the culmiferous series.?

Over all the preceding comes the *Old Red Sandstone*—divided into three great natural groups in the country bordering the Silurian types of Mr. Murchison; in the northern counties developed in a less distinct manner, chiefly in the form of great unconformable masses of conglomerate, appearing at irregular intervals between the preceding groups and the carboniferous series.

Little notice is taken in the memoir of the crystalline unstratified rocks associated with the several series. Any questions of classification, bearing on their geological epoch, can only be determined by the effects, produced by them on the stratified series, which mark the period of their first protrusion; but for the present this subject is not touched on by the author.

June 6th.—William Stark, Esq., of Norwich, was elected a Fellow of this Society.

A paper was first read, "On Spirolinites in Chalk and Chalk-flints;" by the Marquis of Northampton, F.G.S.

The fossils described in this memoir were chiefly found in the flints of Sussex; and though above two hundred specimens, more or less perfect, have been discovered by the author in that county, he has very rarely met with the genus elsewhere. They have been also found in the same county by the Rev. G. Smith and Mr. Walter Mantell. They occur more frequently in the grey than the black flints; and are sometimes accompanied by innumerable minute fragments of other organic bodies. The size of the best-preserved specimens, including the prolongation, is about one-third of an inch; and the number of chambers or divisions varies in the same species.

Of the six species described in the paper, one had been previously named, by Mr. Mantell, *Spirolinites Comptoni*, and the other five have been named by the Marquis of Northampton, *S. Murchisoni*, *S. Stokesii*, *S. Lyellii*, *S. Mantellii*, and *S. Bucklandii*; the author, however, stated that it is exceedingly difficult to determine satisfactorily specific differences, especially in such minute fossils, imbedded in flint, and exposed only by accidental fracture.

A communication was next read, entitled, "A Note to accompany Specimens of Quicksilver Ore from the mine San Onofre, near the town of El Doctor, Mexico." By John Taylor, Esq., Treas. G.S.

Though quicksilver had been known for some time to exist in Mexico, yet few attempts had been made to ascertain to what extent, till the increased prices and demand induced the directors of the Real del Monte and Bolaños Mining Companies to have researches made. Ores of that metal have, in consequence, been discovered and traced in districts very remote from each other; but Mr. Taylor confined his remarks to the locality at which the specimens presented to the Society were obtained.

The ores of San Onofre are chiefly cinnabar, partly hepatic, but native quicksilver occurs, and native calomel. They are stated to exist in a regular vein, two or three yards in width, the gangue consisting of carbonate of lime, with sulphate of barytes, and a small portion of silex. It traverses a limestone hill of considerable height, and appears to have been worked in former times.

Extracts were also read from a letter addressed to John Taylor, Esq., Treas. G.S., by Mr. Frederick Edmonds, explanatory of some specimens of obsidian from the mountain of Real del Monte, Mexico, collected by Mr. Frederick Edmonds, and presented to the Society by Mr. Taylor.

About half a mile from the ancient obsidian mines is the Cerro de las Navajas, in which several passages may be observed from an earthy felspathic rock to perfect obsidian. Although no good section is exposed, the obsidian is stated to occur in irregular beds, chiefly vertical, and Mr. Edmonds is of opinion, that it has been derived from the fusion of the felspathic rock under pressure. The collection presented to the Society's museum, contained a specimen of calcareous tuff from the thermal springs of El Grande.

A notice was next read of a specimen of the Oar's Rock, nine miles south of Little Hampton, Sussex, by Roderick Impey Murchison, Esq., V.P.G.S.

The specimen consists of a calcareous grit, bearing no resemblance to the Bognor rock, or other beds above the chalk, but agrees with some of the beds in the green sands below that formation, or to the

Portland beds. Mr. Murchison's principal object in laying this notice before the Society was to point out that the Oar's Rock is between the parallels of disturbance which traverse the Wealden of Sussex on the north, and the Isle of Wight on the south, the intermediate space being also traversed by the protruded chalk-outliers of Portsdown Hill, north of Portsmouth, and High-down Hill near Worthing, described by Mr. Martin*. Mr. Murchison, therefore, inferred that the Oar's Rock may indicate the protrusion of strata at that point. He noticed likewise the earthquakes so frequently felt at Chichester, which is situated intermediate between Portsdown Hill and Highdown Hill.

A paper was then read, "On the discovery of Fossil Fishes in the Bagshot sands at Goldworth Hill, 4 miles north of Guildford;" by the Rev. William Buckland, D.D., F.G.S.

These remains were recently obtained in cutting through the summit of Goldworth Hill, on the line of the London and Southampton Railway, and their preservation is due to Mr. Sibthorpe of Guildford. The only organic bodies previously discovered in the Bagshot sand are the casts of shells found near Chobham Park, and noticed in Mr. Warburton's account of the formation.† The fossils described by Dr. Buckland, were obtained from a bed of greenish sand, the sixth from the top of the section; and they consist of a few imperfect casts of marine shells, and the remains of marine fishes. The most numerous among the latter are the teeth of sharks, and the palates and teeth of rays, similar to those which abound in the London clay. One large tooth of a saw-fish, procured from the same bed, affords the first well-authenticated example of the discovery, in England, of the genus *Pristis*. In addition to these remains, three forms of cartilaginous fishes, and a few vertebræ of bony fishes, resembling those procured in Sheppy, have been found, also three new genera of fishes. For the latter Dr. Buckland proposes the names of *Edaphodon*, *Passalodon*, and *Ameibodon*. In the first genus the structure of the teeth is nearly allied to that of the broad and flat palates so common in the oolitic and carboniferous limestones. There were three of these teeth in the upper jaw, and three in the lower on each side, and they were disposed so as to form a pavement, arming the interior of the mouth with powerful instruments for crushing shells. Their surface is pitted with minute depressions, disposed in nearly the same manner as in the genus *Psammodus*. The body of each tooth also, as in *Psammodus*, is composed of hollow, long, cylindrical columns, placed nearly at right angles to the working surface. The bones to which the teeth are attached, are not granulated as in cartilaginous fishes; but are cancellated after the manner of bony fishes. The mode of insertion of the teeth in both jaws offers many peculiarities, as they are placed in nearly horizontal, long sockets, and

* Geological Memoir on part of Western Sussex, p. 93, 1828.

† Geological Transactions, 2nd Series, vol. i. p. 48.

maintained by continual growth from the posterior extremity of each tooth. Details were given of the genera *Passalodon* and *Ameibodon*; and it was stated that *Edaphodon* and *Passalodon* offer combinations of the characters of cartilaginous and bony fishes. In the stratum in which these remains were found, Mr. Sibthorpe has also discovered portions of the carapace of an *Emys*, resembling that of the London clay; and Sir Philip Egerton possesses a fragment of a tooth found at Sheppy resembling the teeth of the *Edaphodon* of Goldworth Hill. From the agreement, therefore, in the fossils of that locality with those of the London clay, Mr. Lyell's opinion, that the Bagshot sand was deposited during the eocene period, has received additional support.

A notice, by Dr. Buckland, was afterwards read "On the discovery of a fossil wing of a Neuropterous Insect in the Stonesfield slate."

The elytra of several species of coleopterous insects have been, for some time, known to occur in the Stonesfield slate, but Dr. Buckland believes that this is the first discovery of any remains of *Neuroptera*. The wings of *Libellulæ* are not unfrequent at Solenhofen; and a neuropterous wing, resembling that of a *Corydalis*, has been discovered by Mr. Mantell in an ironstone nodule from Coalbrook Dale. To the notice was appended a description of the wing by Mr. Westwood, from which the following is an extract:—"I have compared the fossil insect wing with the various genera of neuropterous insects, both indigenous and exotic, but it agrees with none of them. I apprehend there can be no doubt that it belonged to a tetrapterous insect, and to the order *Neuroptera*."

Dr. Buckland proposes to call the fossil insect *Hemerobioïdes giganteus*, from its being more nearly allied to the recent genus *Hemerobius* than to any other at present known.

The last paper read was on some species of Orthocerata; by Charles Stokes Esq., F.G.S.

In Dr. Bigsby's paper on the geography and geology of Lake Huron* some *Orthocerata* of peculiar forms are described; but since the publication of that memoir, Mr. Stokes has received many other specimens, collected during the expeditions of Sir Edward Parry, Sir John Franklin, the late Capt. Lyon, and Capt. Back, and by Capt. Bayfield during his survey of the lakes and the river St. Lawrence. The object of the present communication is to describe some species indicating generic separations among the *Orthocerata*, and to call attention to certain considerations respecting the relations of the shells to the animals to which they belonged.

The first generic distinction adopted by Mr. Stokes consists in a large siphuncule, much dilated in each chamber, and contracted at the parts where the septa are attached to it. Within the siphun-

* Geological Transactions, 2nd Series, vol. i. p. 195 *et seq.* Pls. 25 and 26.

cule is a continuous tube which appears to have been capable of expansion or contraction, and is furnished with radii in verticillations, which connect the tube with the walls of the siphon. For this genus he retains the name of *Actinoceras*, given by Bronn* to figures 1—3, Pl. 25, vol. i. N.S. of the Geological Transactions. Four species have been established by Mr. Stokes; namely, *Actinoceras Lyonii* from Igloolik and Ooglit; *A. Bigsbii* from Thessalon Island, in Lake Huron; *A. Richardsonii* from Lake Winipeg; and *A. Simmsii* from Castle Espie, in the County of Down, Ireland.

The character of the second genus is a siphunculus, similar in external form to the preceding, but the inner part is divided into portions corresponding in number with the chambers, and deeply indented in the middle, where the septa of the shell are attached to them; so that one half of each division of the siphuncule is in one chamber, and the other half in the next chamber. The opening or interior passage is comparatively small, and the inner and outer walls of these divided portions, which are separated by a considerable space, are beautifully curved. From the resemblance of the siphuncule to a row of beads, Mr. Stokes proposes to call the genus Ormoceras. Three species were described, all of them obtained from Drummond Island in Lake Huron; *Ormoceras Bayfieldii*, *O. Backii*, and *O. Whitei*.

Among the fossils noticed in Dr. Bigsby's paper, were several which Mr. Stokes then considered to be corals from the internal plates, and to which he gave the generic name of *Huronia*†. He has, however, since discovered, that they do not possess the peculiar, central structure, exhibited by the greater number of the lamelliferous corals; but that they have a continuous central opening; and, from the examination of other specimens, he now considers that these bodies are the siphuncules of true *Orthocerata*. He proposes, nevertheless, to retain the generic name of *Huronia*; and has called the only species, yet found with traces of the septa, *Huronia Portlockii*.

Mr. Stokes then offered some remarks "respecting the relations of the shell to the animal to which it belonged." From the siphuncule being so often preserved without the external portion of the shell, and the latter, including the septa, being, when retained, extremely thin, he is of opinion that the shell must have been enveloped in the animal to protect it from injury. This view of the relation of the shell to the soft portions of the creature, he is of opinion, receives confirmation from his having observed only one instance of a parasitic body being attached to *Orthocerata*. In this instance, indeed, there are evidences that the parasite, a coral, must have been formed after the death of the animal of the shell (*Actinoceras Simmsii*), for the specimen exhibits in some parts, layers of earthy matter, alternating with layers of the coral; and, therefore, the growth of the latter must have been more than once interrupted by the deposition of sediment. The memoir concluded with

* *Lethæa geognostica*, vol. i. p. 98. tab. i. fig. 8. 1835.

† Geological Transactions, 2nd Series, vol. i. p. 202, Pl. 28.

some remarks on a peculiar subdivision in the septa towards the outer wall of one side of the chambers, noticed by the author in several specimens of *Ormoceras*, in an *Orthoceras* from Russia, and in *Lituites*; but he refrained from offering any opinion, whether this character is common to the family of *Orthoceratidæ*, or is confined to certain genera only.

This being the last evening of the Session, the Society adjourned to Wednesday, November the 7th.

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PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY

OF LONDON.

NOVEMBER 1838 TO JUNE 1842.

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PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. III. 1838. No. 59.

Nov. 7, 1838.—The Society assembled this evening for the Session: John Davies Gilbert, Esq., F.R.S., of Eastbourne, Sussex, was elected a Fellow of this Society.

A paper was first read, "On some Fossil Remains of Palæotherium, Anoplotherium, and Chæropotamus, from the freshwater beds of the Isle of Wight," by Richard Owen, Esq., F.G.S., Hunterian Professor in the Royal College of Surgeons.

Some years previous to 1825, Mr. Thomas Allan, of Edinburgh, found in the freshwater beds at Binstead in the Isle of Wight, a tooth which was subsequently determined by Mr. Pentland to be a molar of the *Anoplotherium commune* *; and in 1830, Mr. Pratt found in the same quarries teeth of one species of Anoplotherium and of two species of Palæotherium †; and thus the freshwater strata of the Hampshire basin were proved to contain remains of some of the Pachydermata which had been discovered in the gypsum quarries of Montmartre.

The specimens described by Mr. Owen in this paper were collected by the Rev. W. Darwin Fox, at Binstead and Seafield; and being numerous and well preserved they have enabled the author to establish a still greater agreement in the remains of the two localities. Of the genus Palæotherium, the collection contained teeth and bones of *P. medium*, *P. crassum*, *P. curtum?* and *P. minus*; and of the genus Anoplotherium, teeth of *A. commune* and *A. secundarium*.

The most important specimen, however, in the collection is a right ramus of the lower jaw of the Chæropotamus, wanting only one false molar, a small portion of the symphysis, and the top of the coronoid process.

This genus was established by Cuvier from an imperfect fragment of the base of the skull, with six molar teeth on each side, and a small portion of a ramus of the lower jaw with the canine? and two spurious molars. He nevertheless proved from the form of the teeth, the glenoid cavity, and the zygomatic arches, that the animal be-

* See a paper by Dr. Buckland, Annals Phil., New Series, vol. x. p. 360.

† Geological Transactions, Sec. Ser., vol. iii. p. 451.

longed to the Pachydermata and was most nearly allied to the Peccari. In some points, however, in which these remains deviate from the Peccari, they were shown by Mr. Owen to indicate an approach to the carnivorous type, and this affinity he showed is further exhibited in the specimen found by Mr. Fox, in the prolongation backward of the angle of the jaw, a character which in the class Mammalia has hitherto been found almost exclusively in the carnivorous order, and certainly in no pachydermatous or other ungulate species of Mammal. In the jaw from the Isle of Wight the angle is more compressed and deeper than in the bear, dog, or cat tribe; and it is not bent inwards in the way which peculiarly distinguishes the marsupial jaws, and which so neatly characterizes the Stonesfield mammiferous remains. The condyloid process in the Chæropotamus is raised higher above the angle of the jaw than in the true Carnivora; and it is less convex than in the hog or peccari; and the coronoid process is more developed than in the peccari. In the wavy outline of the inferior border of the lower jaw, and in the teeth, which are well developed in the jaw described by Mr. Owen, a close resemblance is displayed in the Chæropotamus to the peccari. The jaw contains three true tuberculated molars and three conical false molars with double fangs, which molars are relatively larger than in existing Suidæ, and an anterior tooth, which Cuvier in the Paris basin specimens considered to be a canine, but which is situated closer to the symphysis of the jaw than in any of the Suidæ.

Mr. Owen then observed, that the occasional canine propensities of the common hog are well known; and that they correspond with the organization of the genus which offers the nearest resemblance among the existing Pachydermata to the carnivorous type of structure. In the extinct Chæropotamus we have evidently another of those beautiful examples in palæontology of links tending to complete a chain of affinities which the revolutions of the earth's surface has interrupted, and for a time concealed from our view. It is interesting also to perceive that the living subgenus of the hog tribe which most resembles the Chæropotamus should be confined to the South American continent, where the Tapir, the nearest living analogue of the Anoplotherian and Palæotherian associates of the Chæropotamus, now exists.

The author then offered some remarks on a jaw discovered by Mr. Pratt in the Binstead quarries in 1830, and considered by him to be allied to the genus Moschus*. On comparing the jaw with the corresponding part of the *Moschus moschiferus*, which it resembles in size, Mr. Owen has found that in the fossil the grinders are relatively broader, that the last molar has the third or posterior tubercle divided by a longitudinal fissure, that the grinding surface is less oblique, and that the coronoid process differs from that of the Moschus and other ruminants, but strongly bespeaks an affinity with the Pachydermata.

Among the genera of the Paris basin established by Cuvier, the

* Geological Transactions, Sec. Ser., vol. iii. p. 451.

Dichobune exhibits characters which connect the Pachydermata with the Ruminantia, and thus exhibits another of those extraordinary unions of characters which in existing Mammalia belong to distinct orders. In the Dichobune the posterior molars begin to exhibit a double series of cusps, of which the external present the crescentic form, so that the teeth of the *Dichobune murina* might be mistaken for those of true Ruminantia. In the lower jaw of the Dichobune the antepenultimate and the penultimate grinders have two pairs of cusps, and the last grinder three pairs, of which the posterior are small and almost blended together, so that when worn down they appear single.

In this respect, as well as in the form of the ascending ramus of the lower jaw, Cuvier states, in the Ossemens Fossiles, that the Dichobune "prodigiously resembles" the young Musk Deer.

Now with respect to Mr. Pratt's specimen, Professor Owen observed, there is undoubtedly a close resemblance to the Musk Deer, but the differences are sufficiently great to forbid its being placed among the Ruminantia, while there is a still nearer resemblance between it and the genus Dichobune. The Isle of Wight specimen being somewhat larger than the *D. leporinum*, and the ascending ramus differing in form and approaching that of the true Anoplotheria, Mr. Owen considers that it indicates a new species, which until the form of the anterior molars and incisors is known, may be referred to the genus Dichobune, under the name of *Dichobune cervinum*.

A memoir "On the Drift from the Chalk and strata below the Chalk in the Counties of Norfolk, Suffolk, Essex, Cambridge, Huntingdon, Bedford, Hertford, and Middlesex," by James Mitchell, Esq., LL.D., F.G.S., was then read.

The drift which is so extensively distributed over the above counties, consists chiefly of stiff blue and yellow clay, varying from 4 to above 70 feet in thickness; and it contains masses and small fragments of chalk, chalk flints, primary, secondary and other rocks, and fossils from nearly every secondary formation in England. In some localities the clay forms the mass of the drift, but in others it contains or rests on beds of sand and gravel; and it is often overlaid by a deposit, occasionally exceeding 50 feet thick, of sand, gravel, and chalk flints.

The principal locality in Norfolk, mentioned by the author, is Cromer, the cliffs near which vary in height from 100 to 150 feet; the lower half consisting of blue clay charged with masses and fragments of chalk, unaltered chalk flints, and secondary and primary rocks; and the upper half of sand and gravel, capped by 2 feet of ferruginous sand, in some places black. The same general description, it is stated, will apply to the cliffs for 12 miles east and west of Cromer; but they occasionally present most extraordinary contortions of the beds. The other localities in Norfolk, alluded to by the author, are in the parishes of Pulham St. Mary Magdalen, Pulham St. Mary the Virgin; and a pit one mile from Harleston towards Diss, where 4 feet of blue clay, abounding with chalk pebbles, are overlaid by 2 feet and underlaid by 10 feet of gravel and flints: the author also states, that the clay with chalk pebbles extends between Harleston and Diss, the latter town and North Lopham, and thence to Norwich, Dereham, and Swaffham. In Suffolk it was examined by him at Lowestoff, particularly in the cliff on the north side of the town, where he obtained the following section:

Covered slope	15 feet.
Black sand	1 —
Red and yellow sand	15 —
Blue clay, with fragments of chalk, chalk flints, oolite, and lias	12 —
Red and yellow sand	2 —
Covered slope	20 —
	65

In the sea cliff a quarter of a mile north of Southwold, in Suffolk, the clay contains a bed of sand two feet thick; in the same county he likewise noticed it near Woodbridge, between Wrentham and Wangford, and near the road from Wangford to Southwold. The localities in Essex mentioned by the author are Maldon, Kelvedon, Braintree, Castle Hedingham near Halstead, Navestock, and Upminster; in Cambridgeshire, Ely and between Caxton and Arrington; in Huntingdonshire, the districts between Huntingdon and Peterborough and Huntingdon and Caxton; in Bedfordshire, Castle Hill, 6 miles east of Bedford; in Buckinghamshire, the line of the London and Birmingham railway, near Fenny Stratford and Leighton Buzzard, where it rests on the lower greensand, and is overlaid by gravel containing rounded fragments of ferruginous sandstone; in Middlesex the only localities mentioned are Finchley and Muswell Hill; in Hertfordshire the clay was not noticed by the author, though the gravel abounds with fragments of secondary and other formations.

A description is then given of the transported rocks either inclosed in the clay or accumulated in beds of gravel. They consist of hard and soft chalk, flints, oolite, cornbrash, lias, sandstones, mountain limestone, mica slate, trap, granite, syenite, porphyry, &c. The principal localities mentioned are the Stags Inn near Diss, the Holywell and Witlingham near Norwich, Ballingdon Hill near Sudbury; between Peterborough and Huntingdon and thence to Caxton, also between that place and Arrington; in Hertfordshire these accumulations are said to abound around Buntingford, Hare Street, Puckeridge, Much Haddam, and Newnham near Baldock: a few specimens occur around Hertford and at Ware Mill, and Wade's Mill, 1½ mile from Ware. The pits at Muswell are particularly noticed, and the collections from them formed by Mr. Wetherell and Mr. Frederick Pusey; but the specimens of rocks are said to be not nearly so numerous, nor the size of the masses so great as in Hertfordshire, Huntingdonshire, Suffolk, and Norfolk.

Besides the smaller fragments two large boulders are described. One, consisting of granite and computed to weigh a ton and a half, lies by the road-side on the north of the village of Hare Street; and it is so thoroughly rounded that the author had great difficulty in detaching a fragment. The other boulder occurs at Baldock, and consists of hard chalk containing common black flints. It is about 3 feet 9 inches high above-ground, $2\frac{1}{2}$ feet long, and nearly 2 feet broad.

The current by which the drift was accumulated, the author conceives came from a point to the east of north, and he is of opinion that the materials have been derived in part from Scandinavia and in part from the destruction of strata, which once occupied the site of the German Ocean. After the deposition of the clay, Dr. Mitchell believes, that there was a violent action which accumulated the beds of gravel in some places to the depth of above 100 feet (Beaumont Green, 110 feet; the Isle of Dogs, 124 feet); and that this action will account for the clay not being found in more places, and being occasionally associated with beds of gravel.

The paper concludes with a slight allusion to a similar north-east drift, north of the counties enumerated in the title; and it is stated that grey quartz boulders continue to be thrown in at Spurn Head, Yorkshire, similar to those which are found in some of the vales of the counties of Lincoln, Nottingham, and Leicester. Fragments of mountain limestone, lias, oolite, grey quartz, white quartz, and hard chalk are said to occur about Mount Sorrell.

Nov. 21, 1838.—A paper was first read " On the Jaws of the *Thylacotherium Prevostii** (Valenciennes) from Stonesfield," by Richard Owen, Esq., F.G.S., Hunterian Professor, Royal College of Surgeons.

Doubts having been recently expressed by M. de Blainville†, from inspection of casts, respecting the mammiferous nature of the fossil jaws found at Stonesfield, and assigned to the Marsupialia by Baron Cuvier, Mr. Owen brought the paper before the Society, to meet the objections and give a detailed account of the fossils from a careful inspection of the originals. In this communication, however, he confined his description chiefly to the jaws of one of the two genera which have been discovered at Stonesfield, and characterized by having eleven molars in each ramus of the lower jaw, reserving to a future occasion an account of the remains of the other genus‡.

Mr. Owen commences by observing that the scientific world possesses ample experience of the truth and tact with which the illustrious Cuvier formed his judgements of the affinities of an extinct animal from the inspection of a fossil fragment; and that it is only when so distinguished a comparative anatomist as M. de Blainville questions the determinations, that it becomes the duty of those who

* Comptes Rendus, 1838; Second Semestre, No. 11, Sept. 10, p. 580.

† Ibid., No. 8, Août 20, p. 402 *et seq.*; No. 9, Planche; No. 17, Oct. 22, p. 727; No. 18, Oct. 29, p. 750.

‡ See *postea*, p. 17.

possess the means to investigate the nature of the doubts, and reassure the confidence of geologists in their great guide.

When Cuvier first hastily examined at Oxford, in 1818, one of the jaws described in this paper, and in the possession of Dr. Buckland, he decided that it was allied to the Didelphys (me semblèrent de quelque Didelphe*); and when doubts were raised by M. Constant Prevost, in 1824†, relative to the age of the Stonesfield slate, Cuvier, from an examination of a drawing made for the express purpose, was confirmed in his former determination; but he added, that the jaw differs from that of all known carnivorous Mammalia, in having ten molars in a series in the lower jaw: ("il [the drawing] me confirme dans l'idée que la première inspection m'en avoit donnée. C'est celle d'un petit carnassier dont les mâchelières ressemblent beaucoup à celles des sarigues; mais il y a dix de ces dents en série, nombre que ne montre aucun carnassier connu." Oss. Foss. 111. 349. note.) It is to be regretted that the particular data, with the exception of the number of the teeth, on which Cuvier based his opinion, were not detailed; but he must have been well aware that the grounds of his belief would be obvious, on an inspection of the fossil, to every competent anatomist: it is also to be regretted that he did not assign to the fossil a generic name, and thereby have prevented much of the reasoning founded on the supposition that he considered it to have belonged to a true Didelphys.

Mr. Owen then proceeded to describe the structure of the jaw; and he stated that having had in his possession two specimens of the *Thylacotherium Prevostii* belonging to Dr. Buckland, he has no hesitation in declaring that their condition is such as to enable any anatomist conversant with the established generalizations in comparative osteology, to pronounce therefrom not only the class but the more restricted group of animals to which they have belonged. The specimens plainly reveal, first, a convex articular condyle; secondly, a well-defined impression of what was once a broad, thin, high, and slightly recurved, triangular, coronoid process, rising immediately anterior to the condyle, having its basis extended over the whole of the interspace between the condyle and the commencement of the molar series, and having a vertical diameter equal to that of the horizontal ramus of the jaw itself: this impression also exhibits traces of the ridge leading forwards from the condyle and the depression above it, which characterizes the coronoid process of the zoophagous marsupials; thirdly, the angle of the jaw is continued to the same extent below the condyle as the coronoid process reaches above it, and its apex is continued backwards in the form of a process; fourthly, the parts above described form one continuous portion with the horizontal ramus of the jaw, neither the articular condyle nor the coronoid being distinct pieces as in reptiles. These are the characters, Mr. Owen believes, on which Cuvier formed his opinion of the nature of the fossil; and they have arrested the attention of

* Ossemens Foss., tome iii. p. 349.

† Annales des Sciences Nat., Avril, 1825; also the papers of Mr. Broderip and Dr. Fitton in the Zoological Journal, 1828, vol. iii., p. 409.

M. Valenciennes in his endeavours to dissipate the doubts of M. de Blainville*.

From the examination of a cast, the latter, however, has been induced to infer that there is no trace of a convex condyle, but in place thereof an articular fissure, somewhat as in the jaws of fishes; that the teeth, instead of being imbedded in sockets, have their fangs confluent with or anchylosed to the substance of the jaws, and that the jaw itself presents evident traces of the composite structure.

In answer to the first of these positions, Mr. Owen states that the portion of the true condyle which remains in both the specimens of Thylacotherium examined by Cuvier and M. Valenciennes, clearly shows that the condyle was convex, and not concave. It is situated a little above the level of the grinding surface of the teeth, and projects beyond the vertical line, dropped from the extremity of the coronoid process, but not to the same extent as in the true Didelphys. In the specimen examined by M. Valenciennes, the condyle corresponds in position with that of the jaw of the Dasyurus rather than the Didelphys; it is convex, as in mammiferous animals, and not concave as in oviparous. The entire convex condyle exists in the specimen belonging to the other genus, Phascolotherium, now in the British Museum, but formerly in the cabinet of Mr. Broderip. Mr. Owen is of opinion that the entering angle or notch, either above or below the true articular condyle, has been mistaken for "une sorte d'échancrure articulaire, un peu comme dans les poissons."

The specimen of the half-jaw of the Thylacothere examined by M. Valenciennes, like that which was transmitted to Cuvier, presents the inner surface to the observer, and exhibits both the orifice of the dental canal and the symphysis in a perfect state. The foramen in the fossil is situated relatively more forward than in the recent Opossum and Dasyure, or in the Placental Insectivora, but has the same place as in the marsupial genus *Hypsiprymnus*. The symphysis is long and narrow, and is continued forward in the same line with the gently convex inferior margin of the jaw, which thus tapers gradually to a pointed anterior extremity, precisely as in the jaws of the Marsupial Insectivora. In the relative length of the symphysis, its form and position, the jaw of the Thylacotherium precisely corresponds with that of the Didelphys.

In addition, however, to these proofs of the mammiferous nature of the Stonesfield remains, and in part of their having belonged to Marsupialia, Mr. Owen stated that the jaws exhibit a character hitherto unnoticed by the able anatomists who have written respecting them, but which, if co-existent with a convex condyle, would serve to prove the marsupial nature of a fossil, though all the teeth were wanting.

In recent marsupials the angle of the jaw is elongated and bent inwards in the form of a process, varying in shape and development in different genera. In looking, therefore, directly upon the inferior margin of the marsupial jaw, we see in place of the edge of a

* Comptes Rendus, 1838; Second Semestre, No. 11, Sept. 10, p. 527 *et seq.*

vertical plate of bone, a more or less flattened triangular surface or plate of bone extended between the external ridge and the internal process or inflected angle. In the Opossum this process is triangular and trihedral, and directed inwards with the point slightly curved upwards and extended backwards, in which direction it is more produced in the small than in the large species of Didelphys.

Now, if the process from the angle of the jaw in the Stonesfield fossil had been simply continued backwards, it would have resembled the jaw of an ordinary placental carnivorous or insectivorous mammal; but in both specimens of Thylacotherium the half-jaws of which exhibit their inner or mesial surfaces, this process presents a fractured outline, evidently proving that when entire it must have been produced inwards or mesially, as in the Opossum.

Mr. Owen then described in great detail the structure of the teeth, and showed, in reply to M. de Blainville's second objection, that they are not confluent with the jaw, but are separated from it at their base by a layer of matter of a distinct colour from the teeth or the jaw, but evidently of the same nature as the matrix ; and secondly, that the teeth cannot be considered as presenting an uniform compressed tricuspid structure, and being all of one kind, as M. de Blainville states, but must be divided into two series as regards their composition. Five if not six of the posterior teeth are quinque-cuspidate and are *molares veri*; some of the *molares spurii* are tricuspid and some bicuspid, as in the Opossums. An interesting result of this examination is the observation that the five cusps of the tuberculate molares are not arranged, as had been supposed, in the same line, but in two pairs placed transversely to the axis of the jaw, with the fifth cusp anterior, exactly as in the Didelphys, and totally different from the structure of the molares in any of the Phocæ, to which these very small Mammalia have been compared: and in reference to this comparison, Mr. Owen again calls attention to the value of the character of the process continued from the angle of the jaw, in the fossils, as strongly contradistinguishing them from the Phocidæ, in none of the species of which is the angle of the jaw so produced. The Thylacotherium differs from the genus Didelphys in the greater number of its molars, and from every ferine quadruped known at the time when Cuvier formed his opinion respecting the nature of the fossil. This difference in the number of the molar teeth, which Cuvier urged as evidence of the generic distinction of the Stonesfield mammiferous fossils, has since been regarded as one of the proofs of their Saurian nature; but the exceptions by excess to the number seven, assigned by M. de Blainville to the molar teeth in each ramus of the lower jaw of the insectivorous Mammalia, are well established, and have been long known. The insectivorous Chrysochlore, in the order Feræ, has eight molars in each ramus of the lower jaw; the insectivorous Armadillos have not fewer; and in one subgenus (Priodon) there are more than twenty molar teeth on each side of the lower jaw. The dental formulæ of the carnivorous Cetacea, again, demonstrate the fallacy of the argument against the mammiferous character of the Thylacotherium founded upon the number of its molar teeth. From the occurrence of the above exceptions in recent placental Mammalia, the example of a like excess in the number of molar teeth in the marsupial fossil ought rather to have led to the expectation of the discovery of a similar case among existing marsupials, and such an addition to our zoological catalogues has, in fact, been recently made. In the Australian quadruped described by Mr. Waterhouse under the name of Myrmecobius an approximation towards the dentition of the Thylacotherium is exemplified, not only in the number of the molar teeth, which is nine on each side of the lower jaw in the Myrmecobius, but also in their relative size, structure, and disposition. Lastly, with respect to the dentition, Mr. Owen says it must be obvious to all who inspect the fossil and compare it with the jaw of a small Didelphys, that contrary to the assertion of M. de Blainville, the teeth and their fangs are arranged with as much regularity in the one as in the other, and that no argument of the Saurian nature of the fossil can be founded on this part of its structure.

With respect to M. de Blainville's assertion that the jaw is compound, Mr. Owen stated, that the indication of this structure near the lower margin of the jaw of the Thylacotherium is not a true suture, but a vascular groove similar to that which characterizes the lower jaw of Didelphys, Opossum, and some of the large species of Sorex.

In a memoir to be brought forward on another occasion, Mr. Owen intends to describe the other genus found at Stonesfield, and for which, on account of its marsupial affinities, he proposes the name of *Phascolotherium*.

A notice by R. W. Fox, Esq., was afterwards read, "On the Formation of Metallic Veins by Voltaic Agency."

In this communication Mr. Fox says, that he has succeeded not only in forming well-defined metalliferous veins in a crack in the middle of masses of clay by means of voltaic agency, but also in imparting to the clay a laminated or schistose structure; the veins and laminæ being perpendicular to the voltaic forces. In some instances only a pair of plates, or in preference copper pyrites and zinc, were employed to produce the voltaic action; but a constant battery consisting of several pairs of plates was much more effective. Among the veins thus produced in clay, Mr. Fox mentions oxide and carbonate of copper, carbonate of zinc, oxides of iron and tin. Veins of carbonate of zinc were formed, sufficiently firm to admit of being taken out in plates of the size of a shilling. Mr. Fox then describes a vein formed in pipeclay, by Mr. Jordan, by five pairs of cylinders, in three weeks. The clay divided an earthenware vessel into two cells, into one of which, containing the copper plate, a solution of sulphate of copper was put; and into the other, or zinc cell, a solution of common salt. Well-defined veins were thus produced of carbonate and oxide of copper, and carbonate of zinc parallel to the laminæ, into which the clay divided; as well as another of carbonate and oxide of copper at right angles to them. On dividing the mass of clay in the direction of the principal horizontal vein, the carbonate of zinc was found on the negative side, or towards the copper plate; and the carbonate of copper nearest the zinc plate: and as the former must have been derived from the zinc plate, it is curious to observe such a complete transposition of the respective metals.

Mr. Fox is of opinion that these results have a strong bearing on the numerous mineral veins and beds which are found conformable to the direction of the laminæ of the containing rocks, as well as on those veins which traverse the laminæ of the conformable veins.

An extract was afterwards read from a letter addressed by Captain Alexander to the Secretary, explanatory of casts of portions of Mastodon teeth from the crag, and on the occurrence of a particular bed containing Echini in the coralline crag at Sudbourne.

The larger cast was taken from a Mastodon tooth found on the shore at Sizewell Gap, about seven miles from Southwold. When the original came into Captain Alexander's possession, crag adhered to it in considerable quantity; and he has no doubt that it had been washed from Easton, about $1\frac{1}{2}$ mile north of Southwold. The weight of the tooth is 2 lbs. $5\frac{1}{2}$ oz., its length is about 6 inches, and its breadth $3\frac{1}{2}$ inches; and although it had been washed eight miles, only three of the crowns had been injured. The other cast is from a fragment of a young tooth found by the author in the crag at Bramerton.

Capt. Alexander found also the canine tooth of a large carnivorous animal in the crag at Easton. At Bramerton he obtained also five crabs, three of which were almost perfect. At Sudbourne, near Orford, in a bed of very fine coralline crag, he found several beautiful Echini; and in a thin, argillaceous layer in the centre of the same bed, the greater part of the vertebral column of a fish, the remains of crabs, and the ear bone of a whale, which had apparently been water-worn before it was enclosed in the crag. To this stratum Captain Alexander calls particular attention, as he believes it would be found to be rich in organic remains, if it were properly examined.

December 5th.—William Long, Esq., of Hart's Hall, Saxmundham; George Lloyd, Esq., M.D., Newbold Terrace, Leamington; Edward Wilson, Esq., of Abbot Hall, Kendal; Edward Strutt, Esq., M.P., of St. Helen's, Derby, and South-street, Grosvenor-square; Mr. Thomas Evans Blackwell, Hungerford, Wiltshire; John M. Herbert, Esq., Fellow of St. John's College, Cambridge; and Charles Collier, Esq., F.R.S., Deputy Inspector-General of Hospitals, Earl's Terrace, Kensington; were elected Fellows of this Society.

A paper was first read, entitled " A few brief Remarks on the Trap Rocks of Fife," by the Rev. John Fleming, D.D., and communicated by Charles Lyell, Esq., V.P.G.S.

The trap rocks of Fifeshire are referred by Dr. Fleming to three distinct epochs of volcanic action; and he says that the products of each epoch are not more decidedly characterized by dissimilarity in their relationship to the associated sedimentary rocks than by differences in their composition.

The traps of the first epoch occupy the northern portion of the county from Stratheden to the estuary of the Tay, constituting the eastern extremity of the Ochils. They appear to be coeval with the grey sandstone (Arbroath pavement), and to rest upon, as well as to be variously associated with the old red sandstone, and to be covered by the yellow sandstone which supports the mountain limestone. Viewed on a great scale, they consist of amygdaloids containing irregular masses of porphyry, clay-stone, clink-stone, compact felspar, green-stone, and trap tuff: they also contain thin layers of slate-clay and grey sandstone. The whole of the igneous rocks are decidedly stratified; and though the beds are thick and variously bent, they have, in general, the same dip as the superior and inferior sedimentary formations. The materials of which they are composed, Dr. Fleming conceives were spread out under water, partly as lava and partly as ashes; and that several of the peculiarities of rocky structure have been produced by corpuscular action.

Two vertical greenstone veins traverse this group in an easterly direction. One of them may be traced along the north side of the Ochils from the neighbourhood of Newburgh by Norman's Law to Luthrie, a distance of nearly six miles: the other, observable at Alva and Dollard, on the south side of the Ochils, may be traced nearly forty miles by Monymeal to Hilton Bridge, north of Cupar. Several cross veins of greenstone and felspar likewise occur.

The trap rocks of the second epoch form the southern margin of Stratheden, and may be considered as constituting a ridge parallel with the Ochils, from near St. Andrews to Stirling; but several branches or patches of the same age have been observed in the counties on the south of the Forth. These traps consist almost exclusively of greenstone, which in a few instances is earthy and amygdaloidal. They cover, in many places, the lower beds of the coal-measures; on the East Lomond they are intermixed with the mountain limestone; and at Wemyss Hall Hill, south of Cupar, they overlap the limestone, and are in contact with the yellow sandstone.

These two groups of trap rocks, the author is of opinion, were produced while the associated strata of old red sandstone and coal-measures were horizontal; and that they have undergone, equally with the sedimentary formations, the movements which gave the strata of the Ochils and the ridge south of Stratheden the southerly dip. He is also of opinion, that the greenstone of the second group may have furnished materials for the great veins, which traverse the older one.

The traps of the third epoch occur chiefly along the shores of the Forth, and in the higher coal-measures. They consist of basalt with olivine, amygdaloid, greenstone, wacke, and trap tuff; and they frequently contain fragments of limestone, flinty slate, slate-clay, bituminous shale, sandstone, and coal. They appear to have been produced while the associated sedimentary strata were horizontal, and to have undergone with them the same disturbing movements*.

An account of Footsteps of the Chirotherium†, and other unknown animals lately discovered in the quarries of Storeton Hill, in the peninsula of Wirrall, between the Mersey and the Dee, communicated by the Natural History Society of Liverpool, and illustrated with drawings by John Cunningham, Esq., was then read.

In the early part of last June, there were discovered in the Storeton quarries, on the under surface of several large slabs of sandstone, highly relieved casts of what the workmen believed to have been human hands; and the circumstance having been made known to the Natural History Society of Liverpool, a committee was appointed, who drew up the report communicated to this Society.

The peninsula of Wirrall consists of new red sandstone; and towards the northern extremity, the formation may be separated into three principal divisions. The lowest is composed of beds, slightly inclined towards the east, of red or variegated sandstone, occasionally abounding with pebbles partly derived from the coal-measures; and in the bottom strata either angular or little water-worn. Seams of marl are very rare in this division, the argillaceous matter being confined to nodules or concretions of clay of the same colour as the sandstone.

The middle division consists of white or yellow sandstone, in some places argillaceous, and frequently containing round concretions of clay, and pebbles. The strata are separated by seams of white or mottled clay, occasionally almost imperceptible, but sometimes several inches thick.

The uppermost division is formed of red or variegated sandstone, inclosing also nodules of clay and pebbles of quartz; and it abounds with strata of red marl.

The Storeton quarries are situated in the middle division; and the casts which have hitherto been noticed, occurred on the under surface of three beds of sandstone, about two feet thick each. The strata incline 8° to the north-east, but they are traversed by several faults, which range in the strike of the beds. The authors of the report are of opinion, that each of the thin seams of clay in which the sandstone casts were moulded, formed successively a dry surface, over which the Chirotherium and other animals walked, leaving impressions of their footsteps; and that each layer was submerged by

* For further particulars, see Mackenzie on the Ochils, Mem. Wern. Soc., vol. ii. p. 1; Fleming on Scales in the Old Red Sandstone of Fifeshire, Edinb. Journ. Nat. and Geograph. Science, Feb. 1831; and on the Mineralogy of the Neighbourhood of St. Andrews, Mem. Wern. Soc., vol. ii. p. 145; also Neill's Daubuisson, p. 215.

† This name was first applied provisionally by Professor Kaup, to similar casts discovered, towards the end of 1834, in the sandstone quarries at Hesseberg, near Hildburghausen. See Dr. F. R. L. Siekler's Letter to Blumenbach, 1834; also, Die Plastik der Urwelt im Werrathale bei Hildburghausen, with plates by C. Kepler, and an introduction by Dr. Siekler, 1st part, 1836; and Dr. Buckland's Bridgewater Treatise, 1836.

a depression of the surface. The lowest seam of clay was so thin, that the marks penetrated into the subjacent sandstone. The following account is then given of a hind foot and a fore foot, selected from slabs in the Museum of the Royal Institution, Liverpool.

Hind Foot, consisting of five digits; one of which, from its resemblance to a human thumb, has been generally distinguished by that designation.

	Inches.
Total length from the root of the thumb to the point of the second toe	9
Extreme breadth from the point of the thumb to the point of the fourth toe	6
Breadth across the toes	$5\frac{1}{2}$
Breadth across the palm	3
Length of the curved line extending from the root of the thumb to its point	$6\frac{1}{2}$
Breadth of the ball of the thumb	$1\frac{1}{2}$
Relief of the ball of the thumb from the surface of the slab	$\frac{1}{2}$
Length of the first toe from the root to the point	$5\frac{1}{4}$
Length of the second ditto	$5\frac{1}{2}$
Length of the third ditto	4
Length of the fourth ditto	$2\frac{1}{2}$
Average breadth of the first three toes	1
Average breadth of the fourth toe rather less than	1
Relief of the second toe, which presents the greatest prominence	$\frac{6}{10}$

One hind foot has been observed which measured 12 inches in its greatest length.

Judging from the appearance of the casts, the sole of the foot must have been amply supplied with muscles, the casts of the ball of the thumb and the phalanges of the fingers being prominent. The digit, which has been called a thumb, is of a tapering shape, and is bent backwards near the extremity, where it ends in a point. It is extremely smooth, and there is no satisfactory evidence of either a nail or a claw. The toes are thick and strong, and had probably three phalanges each, and at the terminations are traces of stout, conical nails or claws. The sole of the foot is supposed to have been covered by a slightly rugose skin, the folds of which are stated to be distinctly visible in the casts of the toes.

Fore Foot. Perfect impressions of the fore feet are extremely rare, owing either to the animal having used those feet lightly, or to the impressions having been obliterated by the tread of the hind feet. The best preserved cast exhibits a thumb and three toes, being deficient of the fourth. The dimensions, which are generally half those of the hind foot, are as follows:

	Inches.
Length from the root of the thumb to the point of the second toe	$4\frac{1}{2}$
Total breadth not ascertained in consequence of the absence of the fourth toe.	

	Inches.
Breadth of the palm	$1\frac{3}{4}$
Length of the thumb................................	$2\frac{1}{2}$
Breadth of the ball of the thumb	1
Length of the first toe	2
Length of the second toe	$2\frac{1}{4}$
Length of the third toe.	$2\frac{1}{4}$
Greatest breadth of the toes..........................	$\frac{3}{4}$

The thumb is slightly bent back, and pointed, and the toes were armed with nails.

Traces of one animal have been observed in a continuous line on a slab ten yards long. The length of the step varies a little, but in general, the distance between the point of the second toe of one hind foot and the point of the same toe in the hind foot immediately in advance, is between 21 and 22 inches. Each fore foot is placed directly in front of the hind, and the thumbs of both extremities are always towards the medial line of the walk of the animal. Some further observations are given by the authors with respect to the progression of the animal, on the supposition that the digit conjectured to be a thumb, was really the first. Conceiving such to be the case, they state, that the animal must have crossed its feet three inches in walking, for the right fore and hind feet are placed $1\frac{1}{2}$ inch on the *left* side of the medial line, and the left fore and hind feet $1\frac{1}{2}$ inch on the right side of the same line.

The casts of the Chirotherium, although the most remarkable, are by no means the most numerous, which exist on the Storeton sandstones. Many large slabs are crowded with casts in rilievo, some of which are supposed to have been derived from the feet of saurian reptiles, and others from those of tortoises. Occasionally the webs between the toes can be distinctly traced. "It is impossible," say the authors of the report, "to look at these slabs and not conclude, that the clay beds on which they rested, must have been traversed by multitudes of animals, and in every variety of direction."

A note by Mr. James Yates was then read, giving a brief account of sketches of four differently characterized footsteps, traced from casts procured at Storeton, each of which is distinct both from the casts of the Chirotherium and the web-footed animal mentioned in the preceding report.

A paper was afterwards read "On two Casts in Sandstone of the impressions of the Hind Foot of a gigantic Chirotherium, from the New Red Sandstone of Cheshire," by Sir Philip Grey Egerton, Bart., M.P., F.G.S.

These specimens first came under the notice of Colonel Egerton about 1824, and they were placed in the author's cabinet in 1836; but it was not until the recent discovery of the Chirotherium at Storeton, that their true nature was suspected. The exact locality, at which the specimens were discovered, is not known; but it is probable, that they were obtained from the neighbourhood of Colonel Egerton's residence, near Tarporley, and from one of the beds of sandstone, which alternate with the red and green marls in the upper part of the new red system in that part of Cheshire.

The casts, which consist of a rather soft and coarse sandstone, were evidently formed in the impressions of two hind feet; and though they have suffered from exposure to the weather for twelve years, yet they are sufficiently perfect to have enabled Sir Philip Egerton to take the measurements of the different parts, and draw up the accompanying comparative table. It is necessary to state, that though he preserves the use of the term thumb for the convenience of comparison with previous descriptions, yet he is of opinion that the marginal digit which has been so designated, is not the representative of the fifth, but of the first toe.

Direction of the Measurements.	Hessberg Chirotherium.			Storeton Chirotherium.			Large Chirotherium from near Tarporley.	
Length from the heel to the point of the 2nd toe	7	8	..	8	7	..	15	0
Length from the heel to the point of the thumb	3	4	..	4	3	..	8	0
Length from the heel to the angle between the 1st and 2nd toes	4	8	..	5	6	..	10	0
———————— 2nd and 3rd toes	4	4	..	5	8	..	11	0
———————— 3rd and 4th toes	4	0	..	5	3	..	11	0
Greatest breadth across the insertions of the toes	5	0	..	4	2	..	8	5
Breadth from the point of the thumb to 4th toe	5	5	..	5	0	..	9	0
Breadth from the thumb to point of 4th toe	6	3	..	6	0	..	10	6
Breadth across the sole below the thumb ..	3	6	..	3	0	..	6	0
Breadth from 1st toe-point to 4th toe-point	4	6	..	4	6	..	9	0

From these measurements it appears, that considerable differences exist in the three specimens of Chirotherium. Upon comparing the footstep from Hessberg with that from Storeton, it will be found, that the former is thicker and more clumsy than the latter; that the sole is shorter and broader, and the toes wider and longer. The most important discrepancy, however, is in the position of the thumb, which is placed much nearer the heel in the Hessberg specimens than in those from Storeton. The cast from near Tarporley resembles the latter more than the former; it nevertheless differs considerably in the proportion of the breadth to the length of the sole, which is greater; and in the proportions of the length of the toes to the length of the sole, which is less than in the Storeton specimens. It is also distinguished by the greater divergence of the toes from each other. From these differences and the gigantic size of the Tarporley specimen, the author conceives that the animal which made the impression was a distinct species; and he proposes for it, in compliance with the adage *ex pede Herculem,* the name of *Chirotherium Herculis.*

PROCEEDINGS

OF

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Dec. 9, 1838.—A paper on the "Phascolotherium," being the second part of the "Description of the Remains of Marsupial Mammalia from the Stonesfield Slate," by Richard Owen, Esq., F.G.S., was read.

Mr. Owen first gave a brief summary of the characters of the "Thylacotherium," described in the first part of the memoir, and which he conceives fully prove the mammiferous nature of that fossil He stated, that the remains of the split condyles in the specimen demonstrate their original convex form, which is diametrically opposite to that which characterizes the same part in all reptiles and all ovipara;—that the size, figure and position of the coronoid process are such as were never yet witnessed in any except a zoophagous mammal endowed with a temporal muscle sufficiently developed to demand so extensive an attachment for working a powerful carnivorous jaw;—that the teeth, composed of dense ivory with crowns covered with a thick coat of enamel, are every where distinct from the substance of the jaw, but have two fangs deeply imbedded in it;—that these teeth, which belong to the molar series, are of two kinds; the hinder being bristled with five cusps, four of which are placed in pairs transversely across the crown of the teeth, and the anterior or false molars, having a different form, and only two or three cusps—characters never yet found united in the teeth of any other than a zoophagous mammiferous quadruped;—that the general form of the jaw corresponds with the preceding more essential indications of its mammiferous nature. Fully impressed with the value of these characters, as determining the class to which the fossils belonged, Mr. Owen stated, that he had sought in the next place for secondary characters which might reveal the group of mammalia to which the remains could be assigned, and that he had found in the modification of the angle of the jaw, combined with the form, structure and proportions of the teeth, sufficient evidence to induce him to believe, that the *Thylacotherium* was a marsupial quadruped.

Mr. Owen then recapitulated the objections against the mammiferous nature of the *Thylacotherian* jaws from their supposed imperfect state; and repeated his former assertion, that they are in a condition to enable these characters to be fully ascertained: he next reviewed, first the differences of opinion with respect to the actual structure of the jaw; and, secondly, to the interpretation of admitted appearances.

1. As respects the structure.—It has been asserted that the jaws must belong to cold-blooded vertebrata, because the articular surface is in the form of an entering angle; to which Mr. Owen replies, that the articular surface is supported on a convex condyle, which is met with in no other class of vertebrata except in the mammalia. Again, it is asserted, that the teeth are all of an uniform structure, as in certain reptiles; but, on reference to the fossils, Mr. Owen states, it will be found that such is not the case, and that the actual difference in the structure of the teeth strongly supports the mammiferous theory of the fossils.

2. With respect to the argument founded on an interpretation of structure, which really exists, the author showed, that the *Thylacotherium,* having eleven molars on each side of the lower jaw is no objection to its mammiferous nature, because among the placental carnivora, the *Canis Megalotis* has constantly one more grinder on each side of the lower jaw than the usual number; because the *Chrysochlore* among the *Insectivora* has also eight instead of seven molars in each ramus of the lower jaw; and the *Myrmecobius,* among the Marsupialia, has nine molars on each side of the lower jaw; and because some of the insectivorous *Armadillos* and zoophagous *Cetacea* offer still more numerous and reptile-like teeth, with all the true and essential characters of the mammiferous class. The objection to the false molars having two fangs, Mr. Owen showed was futile, as the greater number of the spurious molars in every genus of the placental *feræ* have two fangs, and the whole of them in the Marsupialia. If the ascending ramus in the Stonesfield jaws had been absent, and with it the evidence of their mammiferous nature afforded by the condyloid, coronoid and angular processes, Mr. Owen stated, that he conceived the teeth alone would have given sufficient proof, especially in their double fangs, that the fossils do belong to the highest class of animals.

In reply to the objections founded on the double fangs of the *Basilosaurus,* Mr. Owen said, that the characters of that fossil not having been fully given, it is doubtful to what class the animal belonged; and, in answer to the opinion, that certain sharks have double fangs, he explained, that the widely bifurcate basis supporting the tooth of the shark, is no part of the actual tooth, but true bone, and ossified parts of the jaw itself, to which the tooth is anchylosed at one part, and the ligaments of connexion attached at the other. The form, depth and position of the sockets of the teeth in the *Thylacothere* are precisely similar to those in the small opossums. The colour of the fossils, Mr. Owen said, could be no objection to those acquainted with the diversity in this respect, which obtains in the fossil remains of Mammalia. Lastly, with respect to the *Thylacothere,* the author stated, that the only trace of compound structure is a mere vascular groove running along its lower margin, and that a similar structure is present in the corresponding part of the lower jaw of some species of opossum, of the *Wombat,* of the

Balæna antarctica, and of the *Myrmecobius,* though the groove does not reach so far forwards in this animal; and that a similar groove is present near the lower margin, but on the outer side of the jaw, in the *Sorex Indicus.*

Description of the Half Jaw of the Phascolotherium—This fossil is a right ramus of the lower jaw, having its internal or mesial surface exposed. It once formed the chief ornament of the private collection of Mr. Broderip, by whom it has since been liberally presented to the British Museum. It was described by Mr. Broderip in the Zoological Journal, and its distinction from the *Thylacotherium* clearly pointed out. The condyle of the jaw is entire, standing in bold relief, and presents the same form and degree of convexity as in the genera *Didelphys* and *Dasyurus.* In its being on a level with the molar teeth, it corresponds with the marsupial genera *Dasyurus* and *Thylacynus* as well as with the placental zoophaga. The general form and proportions of the coronoid process closely resemble those in zoophagous marsupials; but in the depth and form of the entering notch, between the process and the condyle, it corresponds most closely with the *Thylacynus.* Judging from the fractured surface of the inwardly reflected angle, that part had an extended oblique base, similar to the inflected angle of the *Thylacynus.* In the *Phascolotherium* the flattened inferior surface of the jaw, external to the fractured inflected angle, inclines outwards at an obtuse angle with the plane of the ascending ramus, and not at an acute angle, as in the *Thylacyne* and *Dasyurus;* but this difference is not one which approximates the fossil in question to any of the placental zoophaga; on the contrary, it is in the marsupial genus *Phascolomys,* where a precisely similar relation of the inferior flattened base to the elevated plate of the ascending ramus of the jaw is manifested. In the position of the dental foramen, the *Phascolothere,* like the *Thylacothere,* differs from all zoophagous marsupials, and the placental *feræ;* but in the *Hypsiprymnus* and *Phascolomys,* marsupial herbivora, the orifice of the dental canal is situated, as in the Stonesfield fossils, very near the vertical line dropped from the last molar teeth. The form of the symphysis, in the *Phascolothere,* cannot be truly determined; but Mr. Owen is of opinion that it resembles the symphysis of the *Didelphys* more than that of the *Dasyurus* or *Thylacynus.*

Mr. Owen agrees with Mr. Broderip in assigning four incisors to each ramus of the lower jaw of the *Phascolothere,* as in the *Didelphys;* but in their scattered arrangement they resemble the incisors of the *Myrmecobius.* In the relative extent of the alveolar ridge occupied by the grinders, and in the proportions of the grinders to each other, especially the small size of the hindermost molar; the *Phascolothere* resembles the *Myrmecobius* more than it does the *Opossum, Dasyurus* or *Thylacynus;* but in the form of the crown, the molars of the fossil resemble the *Thylacynus* more closely than any other genus of marsupials. In the number of the grinders the *Phascolothere* resembles the *Opossum* and *Thylacine,* having four true and three false in each maxillary ramus; but the *molares veri* of the fossil differ from those of the *Opossum* and *Thylacothere* in wanting a pointed tubercle on the inner side of the middle large tubercle, and in the same transverse line with it the place being occupied by a ridge which extends along the inner side of the base of the crown of the true molars,and projects a little beyond the anterior and posterior smaller cusps, giving the quinquecuspid appearance to the crown of the tooth. This ridge, which, in *Phascolotherium,* represents the inner cusps of the true molars in *Didelphys* and *Thylacotherium,* is wanting in *Thylacynus,* in which the true molars are more simple than in the *Phascolothere,* though hardly less distinguishable from the false molars. In the second true molar of the *Phascolothere,* the internal ridge is also obsolete at the base of the middle cusp, and this tooth presents a close resemblance to the corresponding tooth in the *Thylacine;* but in the *Thylacine* the two posterior molars increase in size, while in the *Phascolothere* they progressively diminish, as in the *Myrmecobius.* As the outer sides of the grinders in the jaw of the *Phascolothere* are imbedded in the matrix, we cannot be sure that there is not a smaller cuspidated ridge sloping down towards that side, as in the crowns of the teeth of the *Myrmecobius.* But, assuming that all the cusps of the teeth of the *Phascolothere* are exhibited in the fossil, still the crowns of these teeth resemble those of the *Thylacine* more than they do those of any placental *Insectivora* or *Phoca,* if even the form of the jaw permitted a comparison of it with that of any of the seal tribe. Connecting then the close resemblance which the molar teeth of the *Phascolotherium* bear to those of the *Thylacynus* with the similiarities of the ascending ramus of the jaw, Mr. Owen is of opinion that the Stonesfield fossil was nearly allied to *Thylacynus,* and that its position in the marsupial series is between *Thylacynus* and *Didelphys.* With respect to the supposed compound structure of the jaw of the *Phascolotherium,* Mr. Owen is of opinion that, of the two linear impressions which have been mistaken for *harmoniæ* or toothless sutures, one, a faint shallow linear impression continued from between the antepenultimate and penultimate molars obliquely downwards and backwards to the foramen of the dental artery, is due to the pressure of a small artery, and that the author possesses the jaw of a *Didelphys Virginiana* which exhibits a similar groove in the same place. Moreover, this groove in the *Phascolothere* does not occupy the same relative position as any of the contiguous margins of the opercular and dentary pieces of a reptile's jaw. The other impression in the jaw of the *Phascolotherium* is a deep groove continued from the anterior extremity of the fractured base of the inflected angle obliquely downwards to the broken surface of the anterior part of the jaw. Whether this line be due to a vascular impression, or an accidental fracture, is doubtful; but as the lower jaw of the *Wombat* presents an impression in the precisely corresponding situation, and which is undoubtedly due to the presence of an artery, Mr. Owen conceives that this impression is also natural in the *Phascolothere,* but equally unconnected with a compound structure of the jaw; for there is not any suture in the compound jaw of a reptile which occupies a corresponding situation.

The most numerous, the most characteristic, and the best marked sutures in the compound jaws of a reptile, are those which define the limits of the coronoid, articular, angular, and surangular pieces, and which are chiefly conspicuous on the inner side of the posterior part of the jaw. Now the corresponding surface of the jaw of the *Phascolothere* is entire; yet the smallest trace of sutures, or of any indication that the coronoid or articular processes were distinct pieces, cannot be detected; these processes are clearly and indisputably continuous, and confluent with the rest of the ramus of the jaw. So that where sutures ought to be visible, if the jaw of the *Phascolothere* were composite, there are none; and the hypothetical sutures that are apparent do not agree in position with any of the real sutures of an oviparous compound jaw.

Lastly, with reference to the philosophy of pronouncing judgment on the saurian nature of the Stonesfield fossils from the appearance of sutures, Mr. Owen offered one remark, the justness of which, he said would be obvious alike to those who were, and to those who were not, conversant with comparative anatomy. The accumulative evidence of the true nature of the Stonesfield fossils, afforded by the shape of the condyle, coronoid process, angle of the jaw, different kinds of teeth, shape of their crowns, double fangs, implantation in sockets,—the appearance, he repeated, presented by these important particulars cannot be due to accident; while those which favour the evidence of the compound structure of the jaw may arise from accidental circumstances.

A paper was afterwards read, entitled "Observations on the Structure and Relations of the presumed Marsupial Remains from the Stonesfield Oolite," by William Ogilby, Esq., F.G.S.

These observations are intended by the author to embody only the most prominent characters of the fossils, and those essential points of structure in which they are necessarily related to the class of mammifers or of reptiles respectively. For the sake of putting the several points clearly and impartially, he arranged his observations under the two following heads:—

1. The relations of agreement which subsist between the fossils in question and the corresponding bones of recent marsupials and insectivora.

2. The characters in which the fossils differ from those families. Mr. Ogilby confined his remarks to marsupialia and insectivora, because it is to those families only of mammifers that the fossils have been considered by anatomists to belong; and to the interior surface of the jaw, as the exterior is not exhibited in any of the fossil specimens.

1. In the general outline of the jaws, more especially in that of the *Didelphys* (*Phascolotherium*) *Bucklandii*, the author states, there is a very close resemblance to the jaw in recent insectivora and insectivorous marsupials; but he observes, that with respect to the

uniform curvature along the inferior margin, Cuvier has adduced the same structure as distinctive of the Monitors, Iguanas, and other true saurian reptiles, so that whatever support these modifications of structure may give to the question respecting the marsupial nature of the Stonesfield fossils, as compared with other groups of mammals, they do not affect the previous question of their mammiferous nature, as compared with reptiles and fishes. The fossil jaws, Mr. Ogilby says, agree with those of mammals, and differ from those of all recent reptiles, in not being prolonged backward behind the articulating condyle ; a character in conjunction with the former relation, which would be, in this author's opinion, well nigh incontrovertible, if it were absolutely exclusive ; but the extinct saurians, the *Pterodactyles, Ichthyosauri,* and *Plesiosauri,* cotemporaries of the Stonesfield fossils, differ from their recent congeners in this respect and agree with mammals. Mr. Ogilby is of opinion that the condyle is round both in *D. Prevostii* and *D. Bucklandii,* and is therefore a very strong point in favour of the mammiferous nature of the jaws. The angular process, he says, is distinct in one specimen of *D. Prevostii,* and, though broken off in the other, has left a well-defined impression ; but that it agrees in position with the insectivora, and not the marsupialia, being situated in the plane passing through the coronoid process and the ramus of the jaw. In the *D. Bucklandii,* he conceives, the process is entirely wanting; but that there is a slight longitudinal ridge partially broken, which might be mistaken for it, though placed at a considerable distance up the jaw, or nearly on a level with the condyle, and not at the inferior angular rim of the jaw. He is therefore of opinion that the *D. Bucklandii* cannot be properly associated either with the marsupial or insectivorous mammals. The composition of the teeth, he conceives, cannot be advanced successfully against the mammiferous nature of the fossils, because animal matter preponderates over mineral in the teeth of the great majority of the Insectivorous *Cheiroptera,* as well as in those of the *Myrmecobius,* and other small marsupials. In the jaw of the *D. Prevostii,* Mr. Ogilby cannot perceive any appearance of a dentary canal, the fangs of the teeth, in his opinion, almost reaching the inferior margin of the jaw, and being implanted completely in the bone ; but in the *D. Bucklandii,* he has observed, towards the anterior extremity of the jaw, a hollow space filled with foreign matter, and very like a dentary canal. The double fangs of the teeth of *D. Prevostii,* and probably of *D. Bucklandii,* he says, are strong points of agreement between the fossils and mammifers in general; but that double roots necessarily indicate, not the mammiferous nature of the animal, but the compound form of the crowns of the teeth.

2. With respect to the most prominent characters by which the Stonesfield fossils are distinguished from recent mammals of the insectivorous and marsupial families, Mr. Ogilby mentioned, first, the position of the condyle, which is placed in the fossil jaws in a line rather below the level of the crowns of the teeth ; and he stated that the condyle not being elevated above the line in the *Dasyurus*

Ursinus and *Thylacinus Harrisii,* is not a valid argument, because those marsupials are carnivorous. The 2nd point urged by the author against the opinion, that the fossils belonged to insectivorous or marsupial mammifers, is in the nature and arrangement of the teeth. The number of the molars, he conceives, is a secondary consideration ; but he is convinced that they cannot be separated in the fossil jaws into true and false, as in mammalia ; the great length of the fangs, equal to at least three times the depth of the crowns, he conceives, is a strong objection to the fossils being placed in that class, as it is a character altogether peculiar and unexampled among mammals ; the form of the teeth also, he stated, cannot be justly compared to that of any known species of marsupial or insectivorous mammifer, being, in the author's opinion, simply tricuspid, and without any appearance of interior lobes. As to the canines and incisors, Mr. Ogilby said, that the tooth in *D. Bucklandii,* which has been called a canine, is not larger than some of the presumed incisors, and that all of them are so widely separated as to occupy full five-twelfths of the entire dental line, whilst in the *Dasyurus viverrinus,* and other species of insectivorous marsupials, they occupy one-fifth part of the same space. Their being arranged longitudinally in the same line with the molars, he conceives, is another objection, because, among all mammals, the incisors occupy the front of the jaw, and stand at right angles to the line of the molars. With respect to the supposed compound structure of the jaw, Mr. Ogilby offered no formal opinion, but contented himself with simply stating the appearances ; he, nevertheless, objected to the grooves being considered the impression of blood vessels, though he admitted that the form of the jaws is altogether different from that of any known reptile or fish.

From a due consideration of the whole of the evidence, Mr. Ogilby stated, in conclusion, that the fossils present so many important and distinctive characters in common with mammals on the one hand, and cold-blooded animals on the other, that he does not think naturalists are justified at present in pronouncing definitively to which class the fossils really belong.

Jan. 9, 1839.—Alexander Jack, Esq., Captain in the 30th Regiment of Bengal Native Infantry ; George Cunningham, Esq., Harley-street ; Rev. Samuel Wilberforce, M.A., Brighston, near Newport, Isle of Wight ; Rev. William Bilton, of Port Hill, near Bideford ; and Richard Clewin Griffith, M.D., Gower-street, Bedford-square ; were elected Fellows of this Society.

A notice was first read on the discovery of the Basilosaurus and the Batrachiosaurus, by Dr. Harlan.

The first remains of the Basilosaurus, which came under Dr. Harlan's notice, were a vertebra and some other bones found in the marly banks of Washeta river, Arkansas territory. In the autumn of 1834, he examined another collection discovered in a hard limestone in Alabama, and consisting of several enormous vertebræ, a humerus, portions of jaws with teeth, and some other fragments supposed to belong to the same animal. In the matrix of the vertebra from the Washeta river was a fossil corbula, common in the Alabama tertiary deposits, and specimens of nautilus, scutella, and modiolus of extinct and new species; sharks' teeth have also been found in a similar rock in the vicinity of the locality from which the other collection was procured. Dr. Harlan was originally inclined, from the structure of the teeth, to consider these fossil remains as having belonged to a marine carnivorous animal; but from an examination of the bones he was induced to conclude, that they were portions of a new genus of Saurians, for which he proposed the name of Basilosaurus.

Dr. Harlan then briefly described a portion of an upper jaw of a Saurian discovered by a beaver trapper, on or near the banks of the Yellowstone river in the territory of the Missouri, imbedded in a hard blue limestone rock. On first inspection Dr. Harlan believed, from the structure of the teeth, the mode of dentition, and the position of the *anterior nares*, the fragment belonged to an Ichthyosaurus; but as it differs entirely from that genus in having separate alveoli, and in the form and position of the intermaxillary bones, while it approaches in the latter characters the batrachian reptiles, he has formed for the fossil a new genus designated by the name of Batrachiosaurus.

A paper was afterwards read, entitled, "Observations on the Teeth of the Zeuglodon, Basilosaurus of Dr. Harlan," by Richard Owen, Esq., F.G.S. Hunterian Professor in the Royal College of Surgeons, London.

During the recent discussions respecting the Stonesfield fossil jaws, one of the strongest arguments adduced and reiterated by M. de Blainville and others in support of their saurian nature, was founded on the presumed existence in America of a fossil reptile possessing teeth with double fangs, and called by Dr. Harlan, the Basilosaurus. To the validity of this argument, Mr. Owen refused to assent, until the teeth of the American fossil had been subjected to a re-examination with an especial view to their alleged mode of implantation in the jaw; and until they had been submitted to the test of the microscopic investigation of their intimate structure with reference to the true affinities of the animal to which they belonged. The recent arrival of Dr. Harlan in England with the fossils, and the permission which he has liberally granted Mr. Owen of having the necessary sections made, have enabled him to determine the mammiferous nature of the fossil.

Among the parts of the Basilosaurus brought to England by Dr. Harlan, are two portions of bone belonging to the upper jaw; the larger of them contains three teeth; the other, the sockets of two teeth. In the larger specimen, the crowns of the teeth are more or less perfect, and they are compressed and conical, but with an obtuse apex. The longitudinal diameter of the middle, and most perfect one, is three inches, the transverse diameter one inch two lines, and the height above the alveolar process two inches and a half. The crown is transversely contracted in the middle, giving its horizontal section an hour-glass form; and the opposite wide longitudinal grooves which produce this shape, becoming deeper as the crown approaches the socket, at length meet and divide the root of the tooth into two separate fangs. The two teeth in the fore part of the jaw are smaller than the hinder tooth, and the anterior one appears to be of a simpler structure.

A worn-down tooth contained in another portion of jaw, Mr. Owen had sliced, and it presented the same hour-glass form, the crown being divided into two irregular, rounded lobes joined by a narrow isthmus or neck. The anterior lobe is placed obliquely, but the posterior parallel with the axis of the jaw. The isthmus increases in length as the tooth descends in the socket until the isthmus finally disappears, and the two portions of the tooth take on the character of separate fangs. It is evident that the pulp was originally simple, but that it soon divided into two parts, from which the growth of the ivory of the teeth proceeded as from two distinct centres, now separately surrounded by concentric striæ of growth, the exterior sending an acute-angled process into the isthmus. The cavitas pulpi, which is very small in the crown of the tooth, contracts as the crown descends, and is almost obliterated near the extremity, proving that the teeth were developed from a temporary pulp.

The sockets in the anterior fragment of the upper jaw are indistinct and filled with hard calcareous matter, but a transverse horizontal section of the alveolar margin proves, that these sockets are single, and that the teeth lodged therein had single fangs. In the anterior socket, there is an indication of the transverse median contraction, showing that this tooth resembled in form, to a certain degree, the posterior tooth. A plaster cast of a portion of the lower jaw afforded the only means of studying this part of the fossil. It contains four teeth, of which the two posterior are nearly contiguous, the next is at an interval of an inch and a half, and the most anterior of two inches from the preceding. The last tooth is more simple in form than those behind, and it has been described as a canine. This fragment of the lower jaw thus confirms the evidence afforded by the fragments of the upper jaw, that the teeth in the Basilosaurus were of two kinds, the anterior being smaller and simpler in form, and further from each other than those behind.

Mr. Owen then proceeds to compare the Basilosaurus with those animals which have their teeth lodged in distinct sockets, as the Sphyræna, and its congeners among fishes, the Plesiosauroid and Crocodilean Sauria, and the class Mammalia; but as there is no instance of either fish or reptile having teeth implanted by two fangs in a double socket, he commences his comparison of the Basilosaurus with those Mammalia which most nearly resemble the fossil in other respects. Among the zoophagous Cetacea the teeth are always similar as to form and structure, and are invariably implanted in the socket by a broad and simple basis, and they never have two fangs. Among the herbivorous Cetacea however, the structure, form, number and mode of implantation of the teeth differ considerably. In the Manatee, the molars have two long and separate fangs lodged in deep sockets, and the anterior teeth, when worn down, present a form of the crown similar to that of the Basilosaurus, but the opposite indentations are not so deep; and the entire grinding surface of the molars of the Manatee differs considerably from those of the Basilosaurus, the anterior supporting two transverse conical ridges, and the posterior three. The Dugong resembles more nearly the fossil in its molar teeth; the anterior ones being smaller and simpler than the posterior, and the complication of the latter being due to exactly the same kind of modification as in the Basilosaurus, viz. a transverse constriction of the crown. The posterior molar has its longitudinal diameter increased, and its transverse section approaches to the hour-glass figure, produced by opposite grooves. There is in this tooth also a tendency to the formation of a double fang, and the establishment of two centres of radiation for the calcigerous tubes of the ivory, but the double fang is probably never completed. The teeth in the Dugong moreover are not scattered as in the Basilosaurus.

Mr. Owen then briefly compared the teeth of the fossil with those of the Saurians, and stated that he had not found a single instance of agreement in the Basilosaurus with the known dental peculiarities of that class. From the Mosasaurus the teeth of the American fossil differ in being implanted freely in sockets and not anchylosed to the substance of the jaw ; from the Ichthyosaurus and all the lacertine Sauria in being implanted in distinct sockets, and not in a continuous groove; from the Plesiosaurus and crocodilian reptiles from the fangs not being simple and expanding as they descend, but double, diminishing in size as they sink in the socket, and becoming consolidated by the progressive deposition of dental substance from temporary pulp in progress of absorption. In the Enaliosauria and the Crocodilia, moreover, there are invariably two or more germs of new teeth in different stages of formation close to or contained within the cavity of the base of the protruded teeth ; but the Basilosaurus presents no trace of this characteristic Saurian structure. From the external characters only of the teeth, Mr. Owen therefore infers, that the fossil was a Mammifer of the cetaceous order, and intermediate to the herbivorous and piscivorous sections of that order, as it now stands in the Cuvierian system.

In consequence however of the Basilosaurus having been regarded as affording an exceptional example among reptilia of teeth having two fangs, though contrary to all analogy, and as the other characters stated above, may be considered by the same anatomists to be only exceptions, Mr. Owen procured sections of the teeth for microscopic examination of their intimate structure and for comparing it with that of the teeth of other animals.

In the Sphyræna and allied fossil fishes which are implanted in sockets, the teeth are characterised by a continuation of medullary canals, arranged in a beautifully reticulated manner, extending through the entire substance of the tooth, and affording innumerable centres of radiation to extremely fine calcigerous tubes.

In the Ichthyosaurus and Crocodile the pulp cavity is simple and central, as in Mammalia, and the calcigerous tubuli radiate from this centre to every part of the circumference of the tooth, to which they are generally at right angles. The crown of the tooth in these Saurians is covered with enamel, while that part of the tooth which is in the alveolus is surrounded with a thick layer of cortical substance. In the Dolphins which have simple conical teeth like the higher reptiles, the crown is also covered with enamel and the base with cæmentum. But in the Cachalot and Dugong the whole of the teeth is covered with cæmentum. In the Dugong this external layer presents the same characteristic radiated purkingian corpuscles or cells as in the cæmentum of the human teeth, and those of other animals; but the cæmentum of the Dugong differs from that of the Pachyderms and Ruminants in being traversed by numerous calcigerous tubes, the corpuscles or cells being scattered in the interstices of these tubes. Now the crowns of the teeth of the Basilosaurus evidently exhibit in many parts a thin investing layer of a substance distinct from the body or ivory of the tooth, and the microscopic examination of a thin layer of this substance proves it to possess the same characters as the cæmentum of the crown of the tooth of the Dugong. The purkingian cells are, in some places, scattered irregularly, but in others are arranged in parallel rows. The tubes radiating from the cells are wider than usual at the commencement; but soon divide and subdivide, forming rich reticulations in the interspaces, and communicating with the branches of the parallel larger tubes. These are placed, as in the Dugong, perpendicular to the surface of the tooth, but they are less regularly arranged than the calcigerous tubes of the ivory, with which, however, they form numerous continuations. There is a greater proportion of cæmentum in the isthmus of the tooth than elsewhere; and the worn-down crown of the tooth must therefore have exhibited a complicated structure. The entire substance of the ivory of the teeth consists of fine calcigerous tubes radiating from the centres of the two lobes, without any intermixture of coarser medullary tubes which characterize the teeth of the Iguanodon; or the slightest trace of the reticulated canals, which distinguish the texture of the teeth of the Sphyræna and its congeners. The calcigerous tubes undulate regularly, and like those of the Dugong, exhibit more plainly the primary dichotomous bifurcations, and the subordinate lateral branches given off at acute angles: they also communicate with numerous minute cells arranged in concentric lines.

Thus, the microscopic characters of the texture of the teeth of the great Basilosaurus are strictly of a mammiferous nature; and Mr. Owen further showed that they differ from those of the fossil Edentata, which are also surrounded by cæmentum, in the absence of the coarse central ivory; and confirm the inference respecting the position of the fossil in the natural system drawn from the external aspect of the teeth.

Mr. Owen then adduced further proofs of the mammiferous and cetaceous character of the Basilosaurus, from the structure of the vertebræ which proves that the epiphyseal laminæ were originally separated from the body of the vertebræ, but were afterwards united to it. In the bodies of the smaller vertebræ the epiphyses are wanting, and Mr. Owen agrees with Dr. Harlan in infering from the common occurrence of this condition, that there were originally three separate points of ossification in the body of the vertebræ; a character never noticed in the vertebræ of Saurians, but a most prominent one in those of the Cetacea. Another argument in favour of the mammiferous and cetaceous nature of the Basilosaurus is deduced from the great capacity of the canal for the spinal chord, which in the Cetacea is surrounded by an unusually thick plexiform stratum of both arteries and veins. The cetaceous character is further manifested in the short antero-posterior extent of the neurapophyses as compared with that of the body of the vertebræ; in their regular concave posterior margin, and the development of the articular apophyses only from their anterior part: also in the form and position of the transverse processes, which however present a greater vertical thickness than in the true Cetacea, and approach in this respect to the vertebræ of the Dugong.

With respect to the other bones of the Basilosaurus, Mr. Owen stated, that the ribs in their excentric laminated structure are peculiar, and unlike those of any mammal or Saurian. The hollow structure of the lower jaw of the Basilosaurus, which has been advanced as a proof of its saurian nature, Mr. Owen showed occurs also in the lower jaw of the Cachalot, and is therefore equally good for the cetaceous character of the fossil.

In the compressed shaft of the humerus, and its proportion to the vertebræ, the Basilosaurus again approximates to the true Cetacea, as much as it recedes from the Enaliosaurians; but in the expansion of the distal extremity and the form of the articular surface, this humerus stands alone; and no one can contemplate the comparative feebleness of this, the principal bone of the anterior extremity, without agreeing with Dr. Harlan, that the tail must have been the main organ of locomotion.

Mr. Owen, in compliance with the suggestion of Dr. Harlan, who, having compared with Mr. Owen the microscopic structure of the teeth of the Basilosaurus with those of the Dugong and other animals, admits the correctness of the inferences of its mammiferous nature, proposes to substitute for the name of Basilosaurus that of Zeuglodon, suggested by the form of the posterior molars which resemble two teeth tied or yoked together.

A paper, " On the Geology of the Neighbourhood of Lisbon," by Daniel Sharpe," Esq., F.G.S., was commenced.

Jan. 23, 1839.—H. Sockett, Esq., Barrister at Law, Swansea; John Thomas Barber Beaumont, Esq., County Fire Office, Regent-street; and Rev. Thomas Rees, LL.D., F.S.A., Woburn-place, were elected Fellows of this Society,

A notice on " the Occurrence of Graptolites in the Slate of Galloway in Scotland," by C. Lyell, Esq., V.P.G.S., was first read.

On examining some specimens of slaty sandstone and shale, collected by Mr. John Carrick Moore, on the shore of Loch Ryan in

Galloway, Mr. Lyell discovered distinct remains of Graptolites, resembling those found in the Silurian strata of England and Sweden. As Mr. Lyell is not aware of these zoophytes having been before observed in Scotland, and as organic remains are exceedingly rare in the great range of slaty sandstone and shale, which extends from St. Abb's Head to Galloway, he considers the discovery of a fossil, affording a test of the relative age of those beds, not unimportant. The strata containing the Graptolites are nearly vertical, and their strike is west-south-west and east-north-east.

Mr. Sharpe's paper "On the Geology of the Neighbourhood of Lisbon," commenced at the meeting held on the 9th of January, was then concluded.

In 1832, Mr. Sharpe laid before the Society, a short account of the geological structure of the neighbourhood of Lisbon*; but having since that period resided for a considerable time in the same district, he gave in the paper read on the 23rd instant, the result of his more extended and matured acquaintance with the country.

The tract described by Mr. Sharpe, is bounded towards the north by a line extending from Torres Vedras by Sobral to Villa Franca, and in the south by the coast from Cape Espichel to St. Ubes; and the whole of its area is about 650 square miles.

The formations are arranged by the author in the following order, the local names having been taken from the points where the strata are best exhibited:

Tertiary. (*a*.) Upper tertiary sand.—(*b*.) Almada beds.—(*c*.) Lower tertiary conglomerate.

Secondary. (*d*.) Hippurite limestone.—(*e*.) Red sandstone.—(*f*.) Espichel limestone.—(*g*.) Slate clay and shale.—(*h*.) San Pedro limestone.—(*i*.) Older red conglomerate.

Igneous Rocks.—Basalt.—Granite.

TERTIARY FORMATIONS.

The tertiary deposits occupy a tract, only a portion of which is included within Mr. Sharpe's district, as they extend in a north-east direction to Abrantes, a distance of eighty miles, and in a south-east to Alcacer do Sal, a distance of fifty miles. The Tagus flows through the tract from Abrantes to the sea, but the greater part of the tertiary strata are situated to the south of the river.

(*a*.) *Upper Tertiary Sand*.—This formation consists of about 100 feet of fine gray quartzose sand, and 150 feet of coarse quartzose ferruginous sand and gravel. It constitutes nearly the whole of the tertiary district, south of the Tagus, included within the author's survey. The strata are usually quite horizontal, except at the edges of the basin, where they rest upon the inclined beds of the subjacent deposits; and the author did not observe any instance of their having been disturbed. They generally repose upon the Almada limestone, but near Aldea do Meco, to the north of Cape Espichel, they are in contact with the red sandstone formation. No traces of

* Proceedings, vol. i. p. 394.

organic remains have been noticed in any part of these sands. In the lower beds a mine of quicksilver was worked profitably during the last century near Coina, south of the Tagus; and the gold dust for which the sands of that river have been so long celebrated, Mr. Sharpe believes, is derived also from the lower or ferruginous sands.

(*b.*) *Almada Beds.*—A complete section of this deposit is not exhibited in the neighbourhood of Lisbon, and the strata are so very irregular both in thickness and composition, that it is difficult to connect the sections displayed at different localities. The strata are best exposed in the cliff south of the Tagus, between Trafaria and Almada. The whole of the series is arranged by Mr. Sharpe in three groups, the uppermost consisting of limestone and sands, the middle of blue clay, and the lowest of another series of limestones and sands: but Mr. Sharpe does not attach much value to the subdivision; as the same fossils are found in the beds above and below the blue clay. The deposit constitutes a triangular tract on the Lisbon side of the Tagus, extending from that city to Verdelha, a distance of about fourteen miles; it also caps some hills between Belem and Fort St. Julian. South of the Tagus, it forms the cliffs already mentioned; and a band which ranges from St. Ubes northwards to Palmella, and thence south-west to within a mile of Aldea do Meco, skirting the flanks of a ridge of secondary formations. A detached mass of the Almada beds occurs at the western end of the Serra de San Luiz, between St. Ubes and Azeitão, abutting unconformably against the elevated edges of the beds of red sandstone, and another is on the shore at the foot of San Felippa near St. Ubes. North of the Tagus, the beds incline from 5° to 10° to the south-east; but to the south of the river between St. Ubes and Aldea do Meco, the dip varies from 25° to 30°, and conforms to the position of the band with respect to the ridge of secondary rocks, being to the south-east between St. Ubes and Palmella, and to the north-west between the latter town and Azeitão. The beds of the detached mass near the western end of the Serra de San Luiz, dip about 30° north, and those of the mass on the shore at the foot of San Felippa, 80° towards the older red conglomerate, having been thrown over beyond the perpendicular. On the coast at Casilhas near Almada, the level of the strata is affected very considerably by faults. North of the Tagus a fault cuts off the tertiary strata at Oeiras, the Almada beds forming one bank of the stream, and the Hippurite limestone the opposite; but the strata of each deposit are horizontal. In Lisbon the Almada beds rest unconformably on the Hippurite limestone; but between the city and Verdelha, conformably on the lower tertiary conglomerate. In the band ranging from St. Ubes by Palmella towards Aldea do Meco, they repose in general also conformably on the red sandstone. The greatest height attained by the formation is the Castle Hill near Palmella, the summit of which is 930 feet above the level of the sea, and at this point two lines of disturbance meet. Fossils are very abundant in some of the beds, but sufficient attention has not yet been paid to them to permit their being compared with the organic remains of other tertiary districts. A long-hinged oyster, *Ostrea* *longirostris,* Mr. Sharpe considers identical with a species common in the tertiary deposits of the south of Spain. Small quantities of quicksilver have been found in several places in a bed of sand immediately above the blue clay or central division of the formation.

(*c.*) *Lower Tertiary Conglomerate.*—This deposit consists in the upper part of distinctly stratified conglomerates, composed of limestone pebbles imbedded in a calcareous matrix; and in the lower of sands, grits, gravel, and marl. Within the district examined by Mr. Sharpe, it occurs only on the Lisbon side of the Tagus, forming a band from that city by Odivellas, Camarate, Loures, and Tojal, to the neighbourhood of Alhandra, on the banks of the Tagus, and skirting the western and north-western boundary of the Almada beds. The conglomerate occurs also on some of the detached hills between Belem and the Bay of Cascaes. The deposit dips to the south-east under the Almada beds at an angle of 10° or 15°, but in the lowest strata the dip is 30°. For a short distance south of Alhandra, the conglomerate rests upon the red sandstone, but throughout the remainder of its range upon basalt. No organic remains were noticed in the deposit.

SECONDARY FORMATIONS.

In few countries can the separation between the tertiary and secondary formations be more strongly marked than in the neighbourhood of Lisbon. The deposits of the older class of rocks, Mr. Sharpe states, were disturbed and denuded previously to the commencement of the tertiary epoch, and an immense mass of basalt is interposed between the newest of the secondary rocks and the most ancient of the tertiary series.

(*d.*) *Hippurite Limestone.*—The upper part of this formation consists of alternations of marl and limestone, succeeded by beds of limestone containing thin horizontal beds of flint; and the lowest part of various strata of compact limestone; amounting in the whole to a thickness of above 500 feet. The formation is confined to the north of the Tagus, where it presents several distinct bands, which rest upon the red sandstone, and are overlaid by basalt. The most southern tract extends from Cascaes Bay nearly to Loures; another irregular strip ranges from Montelavar to a little to the eastward of Bucellas; and a third district, commencing near Villa Franca, stretches to the north beyond the range of Mr. Sharpe's district. A portion of Lisbon also stands upon Hippurite limestone. In some parts, especially on the coast, the dip is slightly towards the south-east, but from Loures to beyond Bellas it varies from 30° to 50° in the same direction. The strata do not always rest conformably on those of the subsequent red sandstone, for near Cascaes, the limestone beds are horizontal, and the sandstone on which they lie is inclined at a considerable angle. The narrow valley of Alcantara, close to Lisbon, is the line of a considerable fault, the strata dipping in opposite directions from the valley, or 15° towards the west, and 10° towards the east. Another anteclinal line intersects the upper part of this valley; and at the point where the two disturbances cross, considerable derangement of the strata is produced. In one quarry Mr. Sharpe noticed eight small faults, and the walls of the rocks on each side of the fissures had a beautiful polish. Though the author has adopted the term Hippurite limestone for this deposit, yet he did not discover any remains of that genus, but great abundance of spherulites, some of them probably of known species, and other fossils of the family of Rudista. He obtained also a considerable number of shells including *Exogyra flabellata*, *Pecten quadricostatus* and *Pecten striato-costatus*.

(*e.*) *Red Sandstone.*—This formation consists of various sands, sandstones, marls, and limestone, which are grouped by Mr. Sharpe in the following manner:

Upper Division.—Ferruginous sands, sandstones, and coloured marls.

Middle Division.—Calcareous sandstones and coarse limestones.

Lowest Division.—Coarse sands, sandstones, and grits.

The extent of country, composed of this formation, is very considerable. North of the Tagus, the red sandstone covers the greater portion of the area to the westward of the tertiary strata and Hippurite limestone, the only tract belonging to other deposits being the hills at Cintra, and the lower ridges immediately surrounding them. A denuded strip of sandstone is also exposed between Loures and Cape Sinchette. South of the Tagus, the red sandstone forms a tract of variable breadth, extending from Palmella to the coast, a little north of Cape Espichel. The beds of this formation are greatly affected by faults and vary much in the angle of inclination, but the prevailing dip is towards the south-east throughout the districts on the Lisbon side of the Tagus. In the tract between Palmella and the coast, the strata have also been disturbed by considerable faults, but their usual dip is north, or north-west, at a high angle. Near Lisbon, the connexion of the red sandstone with the subjacent formations is not often exposed. North of Cintra the sandstone rests almost horizontally upon inclined strata of Espichel limestone, shale, San Pedro limestone and granite. South of the Cintra hills, it reposes very irregularly upon the Espichel limestone: and south of the Tagus, with every degree of want of conformity, upon the limestone of the Serra d'Arrabida (Espichel limestone); and in a great variety of positions upon the lofty peaks of the older red conglomerate of the Cavoens and the Serra de San Luiz near St. Ubes. Lignite occurs in several places, and in sufficient quantities to have led to unsuccessful researches for coal. Sulphur also thickly encrusts some of the sandstone strata; and gypsum has been worked near Santa Anna, south of the Tagus. Mr. Sharpe is of opinion, that the tepid springs of Estoril, near Cascaes, may derive their virtues from the sulphureous strata; and that the hot springs of Caldas da Rainha may owe their sulphureous qualities to similar strata. The only organic remains found in the sandstones, are vegetable impressions and seed-vessels; but in the calcareous beds, corals and shells occur, and Mr. Sharpe has been able to identify some of the latter with the *Perna rugosa, Trigonia literata* and *Terebratula intermedia,* of the English secondary oolitic series.

(*f.*) *Espichel Limestone.*—This formation constitutes the flat, outer band which encircles the Cintra hills, also the range of hills between Cape Espichel and Cezimbra, and most probably the Serra d'Arrabida near St. Ubes. At the first of these localities, it consists of thick beds of gray coarse limestone, alternating with thinner ones of shale or marl; at the second, of a similar limestone with fewer layers of shale; and at the Serra d'Arrabida, of compact gray limestone with no partings of shale, except towards the bottom of the formation. Around the hills of Cintra, the strata dip as from a centre, at angles varying from 20° to 75°; between Cape Espichel and Cezimbra their inclination is from 45° to 70° to the north; and in the Serra d'Arrabida the prevailing dip is also to the north at a high angle, but at the west end of the Serra it varies from north to north-west and north-east; whilst in the northern side of the Serra de Vizo, or the eastern prolongation of the Serra d'Arrabida, the dip is toward the south. In the Cintra district the limestone rests conformably on the subjacent formation of shale; between Cape Espichel and Cezimbra, and in the Serra d'Arrabida the bottom beds are not exposed, and consequently the connexion with the inferior deposits is not visible; but in the Serra de Vizo the limestone reposes quite unconformably upon highly inclined strata of the older red conglomerate. The organic remains of this formation are principally casts of shells, which are not easily separable from the matrix. One of the specimens obtained by Mr. Sharpe closely resembles a Trigonia from the green sand of Blackdown.

(*g.*) *Shale.*—The upper portion of this deposit consists principally of shale, varying a good deal in character; the middle of indurated shale alternating regularly and conformably with beds of trap from five to twenty feet thick, and the lowest of dark shale. Near Ramalhão, where the formation is best displayed, there are from twenty to thirty distinct alternations of igneous rocks and shale, the latter being altered and indurated; but in the cliff at the Praia de Adraga, where the deposit is diminished to about 200 feet, there is only one bed of igneous origin. The formation rests with perfect conformity on the San Pedro limestone, dipping on all sides from the central granite axis of Cintra, at angles from 30° to 60°.

(*h.*) *The San Pedro Limestone* forms an inner zone around the Cintra hills, resting upon the granite. The upper beds are dark gray and earthy; but as the limestone approaches the granite, it gradually passes into a crystalline marble. At the village of San Pedro the following series is exposed:—

Dark gray compact limestone several hundred feet thick.	
Gray limestone with very slight traces of crystalline texture, and towards the bottom granular......	200 feet
Coarse crystalline marble, white or gray and white	100

Coarser crystalline marble, usually gray, but towards
the bottom bluish white, and still coarser ...... 100 feet
Granite.

The same gradual change may be traced all around the Cintra hills, wherever the limestone can be seen resting upon or approaching the granite. The lines of stratification are scarcely affected by the change in the structure of the stone, and the dip is from the granite at angles between 40° and 70°. Imperfect casts of a bivalve and an univalve were found in this limestone by the author.

(i.) Older Red Conglomerate.—This formation occurs only west of St. Ubes; and though Mr. Sharpe describes it the last of the sedimentary series, yet he is not certain respecting its relative geological antiquity. Near St. Ubes it rises from beneath the red sandstone and the Espichel limestone, and it is therefore older than either of those rocks. The conglomerate consists of rounded pebbles of white or ferruginous quartz, with a few of jasper, mica slate, and limestone. They vary from half an inch to more than a foot in diameter, and are firmly imbedded in a coarse ferruginous sandstone. The highest ridge of the Serra de Covoens consists of this formation, also the eastern end of the Serra de San Luiz, the higher parts of the Serra de Vigo, and the coast from St. Ubes to the foot of the Serra d' Arrabida. At the eastern end of the Serra de Covoens and in the Serra de San Luiz, the dip of the beds is to the north, at angles varying from 30° to 50°; at the eastern end of the Serra de Vigo they incline about 30° to the south; more to the westward, in the same serra, they are in some places vertical, in others they dip about 50° to the north; and at the Torre de Outão, at the foot of the Serra d' Arrabida, they are inclined about 70° north-east.

The description of the sedimentary rocks is followed by an attempt to compare each formation with its probable equivalent in other parts of Europe; but as the Lisbon fossils have not yet been examined with sufficient care, Mr. Sharpe does not venture to draw any positive conclusions.

Of the tertiary series, the Almada beds alone offer any terms of comparison, and these are not very satisfactory. The fossils collected by the author are said to differ from those of the London clay, with the exception of one species, which is considered identical with *Natica similis;* but a long-hinged oyster, *Ostrea longirostris,* abundant in the Almada beds, agrees with a fossil common in the tertiary strata of Baza, Lorca and Alhama, in the south of Spain, described by Brigadier Silvertop; and Mr. Sharpe from an examination of these deposits, as well as from the agreement in the oyster, is induced to consider the Murcia and the Lisbon series as of the same age.

The Hippurite limestone, Mr. Sharpe has no doubt, is the equivalent of the extensive formation in the south of Europe characterized by the abundance of remains belonging to the family of *Rudista,* and considered the representative of the chalk and greensand series of England and the north of France.

The red sandstone Mr. Sharpe considers to belong also to the secondary system, in consequence of his having obtained from it specimens of *Terebratula intermedia, Perna rugosa,* and *Trigonia literata.*

Of the formations below the red sandstone, the author offers no data for establishing a comparison with deposits in other parts of Europe further than that the Espichel and Arrabida limestones may be of the same age as the limestone of the rock of Gibraltar, and that the shale near Cintra may be the equivalent of the shale which underlies the Gibraltar limestone, and constitutes a considerable portion of Andalusia. He is also of opinion, that the Cintra shale is of the same age with the immense deposit of similar composition, which covers the centre of the province of Alentejo, extending from Alcacer do Sol to the confines of Algarve.

The older red conglomerate of the neighbourhood of St. Ubes, Mr. Sharpe considers as probably identical with the conglomerate largely developed on the banks of the Vonga, and which rests upon mica slate a little to the south of Oporto.

IGNEOUS ROCKS.

Basalt.—The principal deposit of this rock forms one of the most important features in the geology of the district to the north and west of Lisbon, occupying an irregular area, estimated to be not less that eighty square miles. It is difficult to define its limits without reference to an accurate map; but it may be stated to form a tract of very varying breadth, from the shore west of Belem by Queluz, and Odivellas to Loures. In the neighbourhood of the last village, in turns S.W. and N.E., ranging in the former direction to the neighbourhood of Montelavar, and in the latter nearly to Verdelha on the banks of the Tagus. Besides this immense continuous mass, many of the hills north of Oeiras, near the mouth of the Tagus, are capped by basalt, evidently outlying patches, once connected with the great deposit. Basalt also forms the summit of the hills near Sobral and St. Sebastiano, resting upon the red sandstone. It has been already stated, that beds of trap alternate regularly and without any appearance of disturbance with the central division of the shale formation near Cintra.

The rock varies considerably in character, and is occasionally columnar. It is stated to have frequently the appearance of a black indurated clay with an irregular schistose cleavage, and breaking into very irregular rhombs.

The only beds which rest upon the basalt belong to the tertiary series, but it overlies both the Hippurite limestone and the red sandstone. To the westward of Loures, it cuts through these formations; and the red sandstone, to the south of the line of intersection, has been brought to a level with the Hippurite limestone to the north of the line. The strata of Hippurite limestone to the north are nearly horizontal, while those of the red sandstone, and limestone to the south, are highly inclined. Hence Mr. Sharpe infers that the great mass of basalt was poured forth from fissures in the neighbourhood of Loures.

The cliffs in the bay of Cascaes exhibit fine sections of basaltic dykes and disturbances; and on the beach west of Cezimbra masses of basalt are intruded into strata of red sandstone, which exhibit great marks of disturbance. The Espichel limestone and the red sandstone have been also greatly elevated at the Castle Hill at Cezimbra, by a trap rock of which the date is uncertain.

Although the author had innumerable opportunities of observing the junction of the basalt with the beds below it, yet in no instance did he observe any change in the characters of the subjacent rocks. The alteration produced in the beds of shale, which alternate with trap rocks near Cintra, has been already noticed. Mr. Sharpe considers these igneous strata to have been ejected contemporaneously with the deposition of the shale, and to be consequently older than the great coating of basalt. The Espichel limestone, in contact with the trap near Cezimbra, is also altered, being of a crystalline texture to a distance of fifty feet from the igneous rock.

Granite is found only in the neighbourhood of Cintra, forming a range of hills about seven miles in length and five in breadth. Their greatest altitude is less than 2000 feet. The prevailing rock is a true granite consisting of nearly equal proportions of quartz and felspar with a little mica; but towards the western end of the chain, syenite and porphyry occur. In the central portions of the hills, the granite is coarsely grained, and splits into large irregular blocks; but on the flanks it is schistose, finely grained, cleaves into rhombs, and might be mistaken for a sandstone. Veins of large-grained granite, however, occur in the schistose variety, and veins of finely-grained in the coarse central masses.

Mr. Sharpe then describes, in detail, the dislocations in the sedimentary strata on the flanks of the granitic hills; and he shows that all the formations, from the San Pedro limestone to the Espichel, have been dislocated, and thrown into highly inclined positions, but the details cannot be clearly understood without the aid of sections. It may however be stated, that in consequence of the red sandstone resting in nearly horizontal strata against the inclined beds of the lower formation, the latter was disturbed previously to the deposition of the sandstone, and that consequently the irruption of the granite of Cintra took place at a period anterior to the origin of the sandstone.

Mr. Sharpe describes also with considerable minuteness the disturbance near Palmella, south of the Tagus; and he infers, from the relative position of the strata, that there have been, in that district, considerable elevations at four distinct periods.

The paper concludes with some observations on the earthquake of 1755; and the author shows, that its effects were entirely confined to the tertiary strata, and were most violently felt on the blue clay belonging to the Almada beds, on which the lower part of the city is constructed. Not a building on the Hippurite limestone, or the basalt, was injured.

Feb. 6.—Matthew Dawes, Esq. of Southwield, Bolton ; Capt. Alexander, H. P. Royal Staff Corps, Acre's Fold, Suffolk; John Cunningham, Esq., Hope Street, Liverpool; and S. R. Pattison, Launceston, were elected Fellows of this Society.

A paper " On a probable Cause of certain Earthquakes," by M. Louis Albert Necker, For. Mem. G. S., was read.

The object of this memoir is to show, that some earthquakes may be due to the falling in of the roof of cavities, produced by the solvent or erosive powers of subterranean bodies of water on beds and masses of gypsum, rock salt, limestone, marl, clay or sand.

M. Necker was induced to enter upon the inquiry in consequence of the earthquake which desolated, in 1829, a considerable part of the country on the banks of the Segura, in Murcia, having occurred in a district, which is stated to contain no volcanic or trappean rocks; and because the event was unaccompanied by any of those phenomena which, he conceives, precede, attend, or follow true volcanic earthquakes.

Of the places where earthquakes have been felt without there being any traces of volcanic or trap rocks, but where gypsum is known to occur, and in which, from that mineral being, in his opinion, of comparatively easy renewal, he supposes, caverns exist, M. Necker more particularly mentions Bâle, Nice, Navarroux, Oleron, Maulen, Bagnorre de Bigorre, and the Gave Maulen, in the Pyrenees; he also alludes to the shocks which were felt at Clanssaye, near St. Paul-trois-Chateaux; in the department of the Drome, from the 1st of June, 1772, to the end of December, 1773, and he states, that though Clanssaye stands upon a tertiary deposit, yet it is probable that the gypseous formation of the hills to the eastwards having a westerly dip may pass beneath it: likewise to the earthquakes which affected Kronstadt in Transylvania, Odessa, Bucharest, Lembourg in Gallicia, and Kieff, with other towns in that part of Russia, early in 1838, and in the vicinity of which gypsum is believed to exist. Among the limestone tracts, in which caverns abound, and earthquakes are not unfrequently felt, M. Necker enumerates Fiume, Buchari, Trieste, Lissa in the Adriatic, and Foligno.

In the above instances M. Necker supposes, that cavities having been formed by the action of bodies of water, the roof gave way, and, falling upon a solid floor, produced in the strata a motion which extended laterally and vertically, and gave rise to the phenomenon of an earthquake. He is further of opinion, that air confined in the caverns being also set in motion by the subsidence of the roof, would cause undulations in the overlying strata. To illustrate his views, M. Necker described the vibrations produced in the walls of a house which he occasionally inhabits at Geneva, by the blows of a blacksmith's hammer upon an anvil placed in a vault, and these vibrations always appeared to him completely analogous to the motion which he experienced in the same room during the earthquake on the 19th of February, 1812. He likewise stated, that M. Virlet perceived, in a coal-mine, a shock resembling that of an earthquake, by the falling in of some works at the distance of a quarter of a league.

With respect to the shocks felt at Nice, the author says, that he had carefully compared the list published by M. Risso, with the accounts of eruptions of Vesuvius and Etna; and that though some of the earthquakes had preceded, by very short intervals, certain powerful eruptions of those volcanoes; yet, in very many instances, the shocks appear to have been quite independent; and that a considerable number of eruptions, both of Vesuvius and Etna, had not been felt at Nice. Hence, he infers, that, in this case, there may have been earthquakes due to volcanic, as well as non-volcanic, agents; and that Nice, standing upon a gypsum formation, may have felt the effects of volcanic eruptions in consequence of a predisposition in the undermined ground, without which they would not have been perceptible at the surface.

M. Necker objects to the earthquake in Calabria, in 1783, being considered of true volcanic origin, because it was unaccompanied by any disengagement of heat, lava, smoke, acid, or sulphureous products; because the surface of the ground was depressed, not elevated; because only sand and water were ejected through the fissures and circular or star-like cavities formed in the ground, and because there was no eruption of Vesuvius or Etna. The earthquakes in the valley of the Mississippi, during 1812, he conceives were non-volcanic, in consequence of no lava having been poured forth, nor any acid or other vapours emitted. He alluded to a letter by Mr. Stanley Griswold, dated Kaskahia, Illinois, the 22nd of Dec. 1812, which describes some of the phenomena of the earthquakes,—particularly the subterranean noises resembling thunder, the cracks formed in the ground, the issuing of "a something" like smoke, or warm aqueous vapour, accompanied by a great quantity of sand, the ejection of carbonised wood, coal, and pumice, a quantity of which is said to have been collected on the Mississippi, the drying up of lakes, and the raising of the bed of the river. To some of these statements M. Necker objects. He conceives that the smoke, or warm aqueous vapour, which is mentioned only from the reports of others, and not decidedly, may have been mistaken for vapour produced by water striking against an immoveable obstacle. The occurrence of pumice, he conceives, is very doubtful; and, as it is mentioned by no other author, he withholds his assent till the substance has been examined by a competent mineralogist.

M. Necker dissents from the Cutch earthquake in June, 1819, being considered volcanic. The elevation of the Ullah Bund, he conceives, was effected by the subsidence of the ground towards Sindree, or to a movement on a fixed axis. The materials thrown out by the shocks were only black mud, sand, wrought iron, and nails, and could not therefore, he says, have been produced from any great depth.

The earthquakes on the coast of Cumana, and the Caraccas, M. Necker considers to be non-volcanic; and that when the number and violence of the shocks felt in that part of America are considered, he is of opinion, that the agreement of the earthquakes, in April, 1812, with the simultaneous eruption of the volcano of St. Vincent, was fortuitous.

In 1772, the little group, situated some leagues to the north of the chain of the Caucasus, and composed of the trachytic mountains called Pechstein, and the calcareous hill Metschuka, was shaken by an earthquake. The warm springs, known by the name of the baths of the Caucasus, issue from the foot of the limestone hill, and deposit, as well as all the cold brooks, considerable quantities of calcareous tuff. It might be supposed, observes M. Necker, that the thermal springs indicate the existence of some portion of the original heat of the trachyte; and that the earthquake of 1772, by which a portion of the hill, Metschuka, was engulphed, was only the effect of volcanic activity. This, he says, is possible; but it appears to him much more probable, that the cold and warm springs had formed large cavities in the limestone hill, the falling in of the roof of which produced the shock and attending phenomena.

The earthquakes in Jamaica in 1692, M. Necker is of opinion were non-volcanic, because there were only subsidences of the ground, and because only water, sand, and gravel were ejected.

The earthquake in the plain of Bogota, 16th November, 1827, he is tempted to consider non-volcanic, the country being gypsiferous and saliferous; but he admits that it may have been of a mixed nature, in consequence of the great adjacent volcano of Popayan being, at the same time, in activity. The earthquakes on the coast of Chili, he is of opinion, may have a similar origin.

M. Necker gives a list of earthquakes extracted from Mr. Lyell's "Principles of Geology," and arranges them under the heads—volcanic, non-volcanic, and of doubtful origin.

In the first list he includes the earthquakes felt at Ischia, February 2nd, 1828; Java, 1699, 1772, and 1786; Sumbana, April, 1815; Quito, Feb. 4, 1797; Sicily, March, 1693, 1790; Guatimala, 1773; Kamtschatka, 1737; Peru, Oct. 28, 1746; Iceland, 1725; Teneriffe, May 5, 1706; Sorea, (Moluccas) 1693; Lisbon, Nov. 1, 1755.

Non-Volcanic.—Murcia, 1829; Lahore, Sept. 1827; Lissa, in the Adriatic, 1833; Foligno, Jan. 15, 1832; Cutch, June 16, 1819; Cumana, Dec. 14, 1797; the Caraccas, March 26, 1790; Calabria, 1783 to 1786; Bechstan, 1772; and Jamaica, 1692.

Doubtful Origin.—Bogota, Nov. 16, 1827; Chili; Quebec, Dec. 1791; Nipon, Japan, August 1, 1783; and Martinique, 1772.

Thus, though M. Necker reduces considerably the power of volcanic agents, yet he is far from denying that a weak volcanic movement may be propagated over considerable surfaces; and he mentions, in conclusion, the following instances, as not generally known, of probable connexions between earthquakes and volcanic eruptions. The great eruption of Vesuvius, which commenced the 21st of February, 1822, was preceded by an earthquake at Geneva, and in the province of Bugey, in France, on the 19th of February; and, before the eruption of October of the same year, the environs of Aleppo, in Syria, had been convulsed during the whole of August; the most violent shocks having taken place the 13th of the same month; and on the 14th of August an earthquake was experienced at Laybach in Carniola. On the 19th of February, 1825, the town of St. Maure, in the Ionian Islands, was almost destroyed by an earthquake, felt also at Corfu and Prevesa. During the night of the 20th and 21st of February, 1825, there were several shocks at San Veit in Carinthia; and on the 21st of February, and for five days after, dreadful earthquakes were felt at Alger and its environs. The 25th of February, 1828, Vesuvius, which had been very quiet from 1822, commenced a new eruption. There were earthquakes at Trieste during the night of the 13th and 14th January, 1828, at the Island of Ischia on the 2nd of February, and all over Belgium the 23rd of the same month. Lastly, M. Necker deems it not improbable, that the earthquakes felt in Hungary, Transylvania, Gallicia, Wallachia, and the south of Russia, at the commencement of 1838, were the precursors of the eruptions of Vesuvius and Etna during the summer of the same year.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. III. 1839. No. 61.

AT THE

ANNUAL GENERAL MEETING,

15*th February*, 1839,

The following Report from the Council was read:—

The Council have again the satisfaction of congratulating the Society on the increased number of its Fellows, and of stating that the number of its members now amounts to 831, thereby not only proving the prosperity of the Society, but showing that the interest taken by the public in Geological Researches continues undiminished and unabated. The number of Fellows at the close of 1837 was, according to the annual report, 738; but in consequence of errors which had crept into the returns of former years, the real number of Fellows at the close of 1837 (exclusive of Honorary and Foreign Members, and Personages of Royal Blood,) was only 731. During the year 1838, 31 Fellows were elected and admitted, besides 5 more who had not paid their admission fees at the close of the year During the same period there were 16 deaths and 4 resignations, the number of Fellows therefore increased from 731 to 742, but that of Honorary Members was reduced from 41 to 37, and that of Foreign Members from 53 to 49. In consequence of these alterations the total number of Members, as compared with the returns of last year, appears to be reduced from 837 to 831; whereas, owing to the circumstances mentioned above, there is really an increase from 828 to 831.

It was stated in the Report of last year, that the Council considered it desirable, that the laborious and difficult duty of cataloguing and arranging the collections should devolve upon an officer whose time should be given to that single object; but that there was great difficulty in finding any one with the necessary qualifications willing to undertake the office. Since that period, a Curator was appointed, a gentleman in every way competent to the office; and the Council hoped, that under Mr. Wood's care the arrangement and cataloguing of the collections would have been rapidly carried on, in a manner no less satisfactory to the wishes of the Members than advantageous to the interests of the Society, and the advancement of Geology. They have to state, however, with regret, that Mr. Wood has been compelled, in consequence of ill health, to give in his resignation, which they have felt it their duty to accept. For the great value of his services the Council refer to the Report of the Museum Committee.

The Council have also great satisfaction in calling the attention of the Society to the state of the finances. The receipts of the last year have exceeded the expenditure by the sum of 440*l.* 2*s.* 2*d.*; but it should be observed that the largeness of this surplus is mainly owing to the fact, that no expenses have been incurred by the publication of Transactions.

In furtherance of the recommendation contained in the Auditors' Report for 1833, that the Council should, from the surplus income of the Society, make such investments in the Government Funds as would create a capital equal to the amount of sums paid in lieu of annual contributions, they have to state that they have invested all the compositions received during the past year, amounting to the sum of 155*l.* 18*s.* 6*d.*, and a further sum of 138*l.* 11*s.* 6*d.* from the balance in the banker's hands, making altogether the sum of 294*l.* 10*s.* The value of the funded property of the Society is now about 1790*l.*, or within 1549*l.* of the sums (3339*l.*) received from 106 compounders, and exceeds by 836*l.* the sums received for compositions since the recommendation of the Auditors in 1833.

The Council have resolved "that the Wollaston Gold Medal and 20*l.* be assigned to Professor Ehrenberg of Berlin for his researches and discoveries respecting Fossil Infusoria."

Report of the Committee appointed to examine and report on the state of the Museums and Library.

Your Committee have to report that Mr. Wood, having been appointed in May last Curator of the Museum, entered immediately upon the duties of his office. The result of his labours during the last eight months may be mentioned under the two following heads: first, the British; and secondly, the Foreign Collection.

British Collection.—The Curator has been employed in completing the arrangement of the rocks and organic remains belonging to formations ranging from the newest tertiary to the lias inclusive. To begin with the crag; it was stated in the Report of the Museum Committee of last year, that Mr. Lonsdale had then for the first time set in order and named the suite of fossils of that formation which were in the possession of the Society, and that they then filled ten drawers. Mr. Wood finding this series very incomplete, has added to it most liberally from his private cabinet, and has by this means augmented the species of mollusca and corals from about 100, of which they before consisted, to no less than 400, besides inserting many specimens in a more perfect state, of species of which the Society already possessed some individuals. Duplicates, moreover, of many species common to the upper and lower crag have been introduced for the sake of comparison; and the localities of all Mr. Wood's specimens, verified from his own observations, have been carefully noted on the tablets. By these important donations the number of drawers containing organic remains of the crag has been increased from 10 to 27. Mr. Wood has at the same time prepared a new catalogue of the whole of this part of the collection.

Three drawers of shells from the freshwater and upper marine strata from Headon Hill and Hordwell Cliff have now been introduced for the first time, the specimens having been almost all presented by Mr. Wood from his private cabinet.

Of the Wealden beds (including the Purbeck) 6 drawers of organic remains and several of rocks have been arranged, which contain specimens presented by Dr. Fitton.

Of the Kimmeridge clay, 3 drawers of organic remains, besides several of rocks also, principally given by Dr. Fitton; of the Coral Rag, 8 drawers, containing organic remains from various contributors; of the lower calcareous grit, 3 drawers, the specimens of which were previously unnamed; of the Oxford clay, 2 drawers of organic remains; of Kelloway rock, 2; of cornbrash, 3; of forest marble, 4; of Bradford clay, 3; of great oolite, 12; of inferior oolite, 9; of marlstone, 4, consisting principally of specimens presented by Mr. Murchison.

Of lias, 12 drawers, into which fossils presented by Lord Cole have been introduced.

Of all the above 73 drawers of organic remains from the British Secondary Rocks Mr. Wood has provided new catalogues.

The labours of the Curator have not extended to the arrangement of the fossils of the formations below the Oolitic series, including the Lias: we beg however to state shortly the condition of the Museum as respects these deposits.

The New Red Sandstone has hitherto presented few organic remains, but most of those which have been found, including the shells and ichthyolites of the Keuper, and some of the plants of the "Bunter Sandstein" are in our collection.

Of the Magnesian Limestone we possess some good and characteristic specimens (a few of which still require to be named), but the donation of some of the characteristic fishes and rarer saurians of this formation are still important desiderata.

The Museum is pretty abundantly stored with Organic remains of the Carboniferous System, particularly with plants of the Coal beds and shells of the Mountain Limestone, but still we beg to invite collectors to enrich it by donations, particularly of fishes from the different strata of this vast group.

The arrangement of the Fossils of the Old Red Sandstone and Silurian Systems has been undertaken by Mr. Murchison.

Foreign Collection.—This collection consists of 700 drawers of specimens of rocks and organic remains from all parts of the world, exclusive of the British Isles, arranged topographically. The Curator has drawn up an index catalogue, and affixed letters and numbers to the drawers referred to in the catalogue. This work, recommended by the Museum Committee of last year, has, from the extent of the collection, occupied a considerable portion of the Curator's time and labour.

Your Committee have to report that there are now no more vacant drawers in the Museum, and recommend that no time be lost in procuring 4 new sets of drawers, to be placed in the Lower Museum.

In conclusion, your Committee cannot sufficiently express their regret that the state of Mr. Wood's health has compelled him to tender his resignation, as both his industry, scientific acquirements, and liberality as a donor, have so materially promoted, during the short period which he has devoted to our service, the value and general usefulness of our Museum.

In regard to the Library, the Committee have only to express their satisfaction at the mode in which the several objects are arranged and catalogued, so as to fulfil, as far as is attainable, the desire which has ever been felt to render all the collections of the Society easy of access, and available to the use of the several members, and the furtherance of Geological Science.

CHARLES LYELL.
RODERICK IMPEY MURCHISON.
GEORGE BELLAS GREENOUGH.

Comparative Statement of the Number of the Society at the close of the years 1837 *and* 1838.

	31st Dec. 1837.	31st Dec. 1838.
Fellows having compounded	103*	106
——— Contributing	252	243
——— Non-resident	376	393
	731	742
Honorary Members	41	37
Foreign Members	53	49
Personages of Royal Blood	3	3
	828	831

Number of Fellows, Compounders, Contributors, and Non-residents, 31st Dec. 1837		731
Add Fellows elected and paid during 1838		31
		762
Deduct, Deceased	16	
Resigned	4	
		20
Total number of Compounders, Contributors and Non-residents, 31st Dec. 1839		742

* The numbers in this column differ from those given in the return for 1838, in consequence of the corrections mentioned in the preceding report.

Number of Fellows liable to Annual Contribution at the close of 1838, *with the alterations during the year.*

Number at the close of 1837		252
Deduct, Deceased	3	
Resigned	4	
Compounded	1	
Residents who became Non-residents.	12	
	—	20
		232
Add, Non-residents who became Residents	2	
Residents, elected, paid, and not compounded	9	
	—	11
		243

The following Donations to the Museum have been received since the last Anniversary :—

British and Irish Specimens.

Fossils from Bognor ; presented by James Laird, M.D. F.G.S.

A Mass of Ostrea Gregarea from near Oxford ; presented by the Rev. William Buckland, D.D. F.G.S.

Specimens from the North Lancashire Coal Field ; presented by Charles Dawes, Esq. F.G.S.

A Tetragonolepis (Agassiz), from Barrow-upon-Soar, Leicestershire ; presented by the Rev. John Pye Smith, D.D. F.G.S.

Remains of Fossil Fishes from Goldworth Hill, near Guildford ; presented by Allan Sibthorpe, Esq.

Fossils from the Chalk of Berkshire ; presented by Richard Grantham, Esq. F.G.S.

Shells from the Crag of Felixstow ; presented by the Rev. Belfield Dennys.

Minerals from Cornwall ; presented by Captain Beaufort, R.N., Hon. Mem. G.S.

The Collection of Minerals, Fossils, and Geological Specimens belonging to the late Nathaniel John Winch, Esq., Hon. Mem. G.S.; bequeathed to the Society by Mr. Winch.

Fossils from the Mountain Limestone of Kirkby Lonsdale and Clitheroe ; presented by the Rev. J. Fisher, F.G.S.

Specimens of Fish Scales in Flint ; presented by the Rev. J. B. Reade.

Fossils from Under Barrow, near Kendal ; presented by Gilpin Gorst, Esq. F.G.S.

Casts of Bones of Reptiles discovered by Dr. Mantell in Tilgate Forest, formerly in the Mantellian Museum at Brighton, and now in the British Museum; and Fossils from the Lower Green Sand; presented by Gideon Mantell, LL.D. F.G.S.

Fossil Pinnas from Honey Pen Hill, near Bristol; presented by George Cumberland, Jun. Esq.

Mass of New Red Sandstone, with impressions of Chirotherium footsteps from Birksbeck, Warwickshire; presented by Roderick Impey Murchison, Esq. V.P.G.S.

Cast of the Jaw of the Chæropotamus; presented by the Rev. W. Darwin Fox.

Fossil Turtle from Harwich; presented by S. R. Heseltine, Esq.

Gryphæa sinuata from the Lower Green Sand; presented by Mr. Binsted.

Casts of Calymene Blumenbachii, Asaphus caudatus, and Encrinites moniliformis; presented by Mr. Isaiah Deck, F.G.S.

Specimens of Chalcedonic Flints from Wiltshire; presented by the Rev. Charles Watkins.

A Series of Fossils from the Crag; presented by Searles Wood, Esq.

Fossils from the Crag near Southwold; presented by Captain Alexander, Royal Staff Corps, F.G.S.

Foreign Specimens.

Specimens of Copper and Malleable Iron Ore from Southern Africa; presented by Captain Sir James Alexander.

Rock Specimens from the Seychelles Islands; presented by J. Harrison, Esq.

Fossils from the Himalayas; presented by Sir Thomas Dyke Acland, Bart. M.P. F.G.S.

Specimens from Upper Assam; presented by Dr. McClelland.

Cast of a rare specimen of Hamites articulatus from the Oolitic formation, Normandy; presented by the Marquis of Northampton, F.G.S.

Cast of the Head of the Mastodon longirostris from Eppelsheim; presented by Sir Philip Grey Egerton, Bart. M.P. F.G.S.

Specimens from Boulogne and Guernsey; presented by Robert Cole, Esq.

Specimen of Plagiostoma from the Gulf of California; presented by — Hodges, Esq.

Specimens from Central France; presented by George Poulett Scrope, Esq. M.P. F.G.S.

Specimens of Obsidian, Manganese containing Silver and Native Quicksilver, from Mexico; presented by John Taylor, Esq., Treas. G.S.

Trilobites and Corals from Hudson's Bay; presented by the Earl of Selkirk, F.G.S.

Specimens from Saint Helena; presented by R. F. Searle, Esq. F.G.S.

Geological Specimens from Columbia River and other parts of North America; presented by the Earl of Selkirk, F.G.S.

Belemnites from Mount Joli; presented by John Vincent, Esq.

Specimens from Christiania; presented by Rev. W. Bilton, F.G.S.

Specimens from Western Africa, between Sierra Leone and Fernando Po; collected by Captain Vidal, R.N.

Specimens from the Island of Ascension, collected by Lieutenant Bedford, R.N., and specimens from Gibralter; presented by Captain Beaufort, R.N., Hon. Mem. G.S.

Specimens from Lisbon; presented by William Edmond Logan, Esq. F.G.S.

Specimens from Southern Africa and the Cape Verde Islands; presented by Lieut. Nelson, Royal Engineers.

Specimen from the Limestone of Bermuda, containing a Cyprea vitellus; presented by Lieut. Symonds, Royal Engineers.

Specimens from the neighbourhood of Lisbon; presented by Daniel Sharpe, Esq. F.G.S.

Miscellaneous.

Statigraphical Model of the Under Cliff, Isle of Wight; presented by Levett L. Boscawen Ibbetson, Esq. F.G.S.

Fossil Infusoria, and Artificial and Natural Silica from recent Infusoria, and Glass manufactured from living Infusoria; presented by Professor Ehrenberg.

Recent Corals; presented by William Richardson, Esq. F.G.S.

The Library has been increased by the Donation of about 130 Books and Pamphlets.

Charts and Maps.

Admiralty Charts, Sailing Directions and Tide Tables, published during the year 1837; presented by Captain Beaufort, R.N., by direction of the Right Hon. the Lords Commissioners of the Admiralty.

Map of the Maritime County of Mayo, in Ireland, in twenty-five sheets; by William Bald, Esq. F.G.S. F.R.S.E. M.R.I.A. &c.; presented by Mr. Bald.

Sheets 49, 50, 66, 67, 68, 72 of the Ordnance Map, in continuation of the Trigonometrical Survey of Great Britain; presented by the Master General and Board of Ordnance.

Sheets 4, 6, and 10 of the Geological Map of Saxony; presented by the Council of Mines of Saxony.

Map of the settled part of New South Wales, showing the situation of the principal rocks; by Major T. L. Mitchell, F.G.S; presented by Major Mitchell.

Ordnance Townland Survey of the County of Westmeath in forty-two sheets, including title page and index; presented by Colonel Colby, by direction of His Excellency the Lord Lieutenant of Ireland.

The following List contains the Names of all the Persons and Public Bodies from whom Donations to the Library and Museums were received during the past year.

Academy of Sciences of Paris.
Acland, Sir Thomas Dyke, Bart. M.P. F.G.S.
Admiralty, The Right. Hon. the Lords Commissioners of the.
Ainsworth, William, M.D.F.G.S.
Alexander, Captain Sir James.
Alexander, Captain, F.G.S.
Allen and Co., Messrs.
American Philosophical Society held at Philadelphia.
Asiatic Society of Calcutta.
Atkins, Henry Martin, Esq.
Athenæum, Editor of.

Bald, William, Esq. F.G.S.
Beaufort, Captain, R.N. Hon. Mem. G.S.
Bedford, Lieutenant, R.N.
Berwickshire Naturalist's Club.
Bilton, Rev. William, F.G.S.
Binsted, Mr.
Bohmen, Gesselchaft des Vaterlandischen, Museums in.
British Association.
Brongniart, M. Adolphe.
Bronn, Herr, H. G.
Bucke, Charles, Esq.
Buckland, Rev. Professor, D.D. F.G.S.

Cambridge Philosophical Society.
Charlesworth, Edward, Esq. F.G.S.
Colby, Colonel, R.E. F.G.S.
Cole, Robert, Esq.
Conrad, — Esq.
Cooper, Daniel, Esq.
Cotta, M. Bernhard.
Cumberland, George, jun. Esq.

Darwin, Charles, Esq. Sec. G.S.
Dawes, Charles, Esq. F.G.S.
De Blainville, M. H. D., For. Mem. G.S.
Deck, Mr. Isaiah, F.G.S.
De Luc, M. J. A.
Dennys, Rev. Belfield.
Depôt Général de la Marine Française.
Desjardins, M. Julien.
Dufrénoy, M., For. Mem. G.S.

Ecole des Mines.
Egerton, Sir Philip Grey, Bart. M.P. F.G.S.
Ehrenberg, Professor, Christian Gottfried.
Elie de Beaumont, M. Léonce, For. Mem. G.S.

Faraday, Michael, Esq. F.G.S.
Fisher, Rev. J. C., F.G.S.
Fox, Rev. W. Darwin.

Geneva, Natural History Society of.
Geological Society of Dublin.
Geological Society of France.
Gorst, Gilpin, Esq. F.G.S.
Grantham, Richard, Esq. F.G.S.
Grateloup, Dr.
Griffith, Richard, Esq. F.G.S.

Hamilton, William R., Esq. Pres. R.G.S.
Harrison, J. Esq.
Hausmann, Professor, For. Mem. G.S.
Heath, J. B., Esq.
Helvetic Natural History Society.

Heseltine, S. R., Esq.
Hisinger, M. W.
Hodges, —, Esq.
Hœninghaus, M. Fred. Wm.

Ibbetson, Levett L. Boscawen, Esq. F.G.S.
Institution of Civil Engineers.

Jackson, Charles T., M.D.
Johnston, James F. W., Esq. F.G.S.

Kenyon, John, Esq. F.G.S.

Laird, James, M.D. F.G.S.
Lea, Isaac, Esq.
Leeds Literary and Philosophical Society.
Liebig, Justin, Ph. D.
Linnean Society of London.
Logan, William Edmond, Esq. F.G.S.
Loudon, John Claudius, Esq.
Lyell, Charles, Esq. V.P.G.S.

Maclaren, Charles, Esq.
Madras Literary Society.
Mammatt, Edward, Esq. F.G.S.
Mantell, Gideon, LL.D. F.G.S.
McClelland, John, M.D.
Michellotti, Sig. Giovanni.
Mining Journal, Editor of.
Mitchell, Major T. L., F.G.S.
Modena, the Scientific Society of.
Murchison, Roderick Impey, Esq. V.P.G.S.
Murray, John, Esq.

Nelson, Lieut., R.E.
Northampton, Marquis of, F.G.S.
Numismatic Society of London.

Ordnance, Master General and Board of.

Paoli, Sig D.

Reade, Rev. J. B.
Redfield, W. C., Esq.
Repertory of Patent Inventions, the Proprietor of.
Richardson, William, Esq. F.G.S.
Royal Academy of Berlin.
Royal Academy of Brussels.
Royal Asiatic Society.
Royal Astronomical Society.
Royal College of Surgeons.
Royal Geographical Society of London.
Royal Geological Society of Cornwall.
Royal Irish Academy.
Royal Lisbon Academy.
Royal Polytechnic Society of Cornwall.
Royal Society of London.

Scarborough Philosophical Society.
Scrope, George Poulett, Esq. M.P. F.G.S.
Seale, R. Francis, Esq. F.G.S.
Selkirk, Earl of, F.G.S.
Sharpe, Daniel, Esq. F.G.S.
Shepard, Charles Upham, Esq.
Sibthorp, Allan, Esq.
Silliman, Prof., M.D. For. Mem. G.S.
Sismonda, Prof. Angelo.
Smith, Rev. John Pye, D.D. F.G.S.
Society of Arts.
Symonds, Lieut., R.E.

Taylor, John, Esq. Treas. G.S.
Taylor, Richard, Esq. F.G.S.
Tenore, Sig.
Thurmann, M. J.
Travers, Benjamin, Esq.
Treasury, Lords Commissioners of.
Turner, Wilton John, Esq.

Van der Maelen, M.
Vanuxem, Professor.
Vidal, Captain, R.N.
Vincent, John, Esq.
Von Meyer, Herr Hermann.

Walker, Francis, Esq. F.G.S.
Warner, J. E., Esq.
Watkins, Rev. Charles.
Wernerian Society of Edinburgh.
Winch, Nathaniel John, Esq. Hon. Mem. G.S.
Whitby Literary and Philosophical Society.
Wood, Searles Valentine, Esq.
Yorkshire Philosophical Society.
Zoölogical Society of London.

The following Persons were elected Fellows during the year 1838.

January 3rd.—David Thomas Ansted, Esq. of Jesus College, Cambridge; James Black, M.D. of Bolton-le-Moor, Lancashire; Alexander Wilson, Esq. of 34 Bryanstone Square; and Major Henry Bullock, of 31 Harley Street, Cavendish Square.

January 31st.—Edward Mammatt, Esq. of Ashby de la Zouch, Leicestershire; John Hawkshaw, Esq. of Salford, Lancashire; and John Carrick Moore, Esq. of Queen's College, Cambridge.

February 21st.—Jose Estavão Cliffe, Esq. of Cuijaba, Brazils; and William Blount, Esq. of 12 Cumberland Place.

March 7.—Charles William Hamilton, Esq. M.R.I.A. of Dominick Street, Dublin.

March 21st.—Richard Henry King, M.D. of Reigate, Surrey; John Warden Robberds, Esq. of Norwich; Edward Lloyd, Esq. of 6 Bloomsbury Square; and Lieutenant George Tremenheere, Bengal Engineers, 33 Somerset Street, Portman Square.

April 4th.—Thomas William Maltby, Esq. M.A. of Turnham Green, Middlesex; William Taylor, Esq. B.A. of 14 New Ormond Street; Mr. Isaiah Deck, of Cambridge; and William Ainsworth, M.D.

April 25th.—Egerton V. Vernon Harcourt, Esq. M.A. Nuneham, Oxfordshire; George Crane, Esq. of Yniscedwyn Iron Works, Swansea; Mr. James Tennant, of 149 Strand; C. W. Grant, Esq. Captain Bombay Engineers, of Bury, near Gosport; and Benjamin Fonseca Outram, M.D. of Hanover Square.

May 9th.—Joseph Skilbeck, Esq. of Highbury Place, London; Rev. John Hymers, Fellow and Tutor of St. John's College, Cambridge; and Rev. Walter Davenport Bromley, of Wootton Hall, Staffordshire.

June 6th.—William Stark, Esq. of Norwich.

November 7th.—John Davies Gilbert, Esq. F.R.S. of Eastbourn, Sussex.

December 5th.—William Long, Esq. of Harts Hall, Saxmundham; George Lloyd, M.D. of Newbold Terrace, Leamington; Edward Wilson, Esq. of Abbot Hall, Kendal; Edward Strutt, Esq. M.P. of St. Helen's, Derby, and of South Street, Grosvenor Square; Mr. Thomas Evans Blackwell, Civil Engineer, of Hungerford, Wiltshire; John M. Herbert, Esq. Fellow of St. John's College, Cambridge; and Charles Collier, Esq, F.R.S. Deputy Inspector-General of Hospitals, of 1 Earl's Terrace, Kensington.

December 19th.—James John Adams, Esq. M.R.C.S., 39 Finsbury Square.

Deceased Fellows :—

Compounders (2): William Henry Booth, Esq.; Michael Shepley, Esq.

Residents (3): Sir Abraham Hume, Bart.; Andrew Martin, Esq.; Sir John Nichol.

Non-residents (11): Lord Ribblesdale; George Harvey, Esq.; Rev. William Carey, D.D.; Lieut.-Col. Montgomery; Rev. Robert Halifax; Edward Ord Warren, Esq.; Major Benjamin Blake; Sir James Edward Colebrooke, Bart.; Sir John Hall, Bart.; Sir Michael B. Clare, M.D.; William Salmond, Esq.

Foreign Members (4): Professor A. Desmarest; Count de Montlosier; Baron E. F. de Schlotheim; Count Sternberg.

Honorary Members (4): Benjamin Bevan, Esq.; Right Hon. Chief Baron Joy; Rev. George V. Sampson; Nathaniel John Winch, Esq.

List of PAPERS *read since the last Annual Meeting, February* 16, 1838.

February 21st.—On part of Asia Minor, between Hassán Dagh and the Salt Lake of Kodj-hissar, and thence to Cæsarea of Cappadocia and Mount Argæus; by W. J. Hamilton, Esq. Sec. G.S.

March 7th.—On some remarkable dikes of Calcareous Grit at Ethie, in Ross-shire; by Hugh Edwin Strickland, Esq. F.G.S.

——— On the connexion of certain Volcanic Phænomena, and on the Formation of Mountain chains and Volcanos, as the effects of Continental Elevations; by Charles Darwin, Esq. Sec. G.S.

March 21st.—Note on the Dislocation of the Tail at a certain point, observable in the Skeletons of many Ichthyosauri; by Richard Owen, Esq. F.G.S., Hunterian Professor in the Royal College of Surgeons.

——— A Synopsis of the English Series of Stratified Rocks, inferior to the Old Red Sandstone, with an attempt to determine the successive natural Groups and Formations; by the Rev. Adam Sedgwick, V.P.G.S., Woodwardian Professor in the University of Cambridge; (commenced, and concluded May 23).

April 4th.—A description of Lord Cole's Plesiosaurus Macrocephalus; by Richard Owen, Esq. F.G.S., Hunterian Professor in the Royal College of Surgeons.

April 25th.—Notes on a small patch of Silurian Rocks to the West of Abergele, on the North Coast of Denbighshire; by J. E. Bowman, Esq., and communicated by R. I. Murchison, Esq. V.P.G.S.

——— A Notice on the occurrence of Wealden Strata at Linksfield near Elgin, on the remains of Fishes in the Old Red Sandstone of that neighbourhood, and on Raised Beaches along the adjacent Coast; by J. G. Malcolmson, Esq. F.G.S.

——— On the Origin of the Limestones of Devonshire; by Robert Alfred Cloyne Austen, Esq. F.G.S.

May 9th.—An Account of a Fossil Stem of a Tree lately discovered in the Coal Measures near Bolton-le-Moor; by James Black, M.D. F.G.S.

May 9th.—On the distribution of Organic Remains in the Strata of the Yorkshire Coast; by W. C. Williamson, Esq., Curator of the Manchester Natural History Society.

————On the State in which Animal Matter is usually found in Fossils; by Mr. Alfred Smee, Student of King's College, London, and communicated by Professor Royle, M.D. F.G.S.

May 23rd.—A Synopsis of the English Series of Stratified Rocks, inferior to the Old Red Sandstone, with an attempt to determine the successive natural Groups and Formations; by the Rev. Adam Sedgwick, V.P.G.S., Woodwardian Professor in the University of Cambridge. (commenced March 21st.)

June 6th.—On Spiriolinites in Chalk and Chalk Flints; by the Marquis of Northampton, F.G.S.

———— A Note to accompany Specimens of Quicksilver Ore, from the Mine San Onofre, near the town of El Doctor, Mexico; by John Taylor, Esq. Treas. G.S.

———— Extract from a letter to John Taylor, Esq., Treas. G.S.; by Mr. Frederick Edmonds, explanatory of some Specimens of Obsidian, from the town of Real del Monte, Mexico.

———— Notice of a Specimen of the Ower's Rock, nine miles south of Little Hampton, Sussex; by Roderick Impey Murchison, Esq. V.P.G.S.

———— On the discovery of Fossil Fishes in the Bagshot Sand at Goldsworth Hill, four miles south of Guildford; by the Rev. Professor Buckland, D.D. F.G.S.

————On the Discovery of a Fossil Wing of a Neuropterous Insect in the Stonesfield Slate; by the Rev. Professor Buckland, D.D. F.G.S.

———— On some Species of Orthocerata; by Charles Stokes, Esq. F.G.S.

November 7th.—A Description of some Fossil Remains of Palæotherium, Anoplotherium, and Chæropotamus, found in the Isle of Wight; by Richard Owen, Esq. F.G.S., Hunterian Professor in the Royal College of Surgeons.

———— On the Drift from the Chalk and the Strata below the Chalk, in the counties of Norfolk, Suffolk, Essex, Cambridge, Huntingdon, Bedford, Hereford and Middlesex; by James Mitchell, Esq. LL.D. F.G.S.

November 21st.—On Two Jaws of the Thylacotherium Prevostii (Valenciennes); by Richard Owen, Esq. F.G.S., Hunterian Professor in the Royal College of Surgeons.

———— A Notice on the Formation of Mineral Veins by Voltaic Agency; by R. W. Fox, Esq.

———— An Extract from a Letter addressed by Captain Alexander, of the Royal Staff Corps, to the Secretary, on the discovery of two Mastodon Teeth, near Southwold.

December 5th.—A Notice on the Trap Rocks of Fifeshire; by the Rev. John Fleming, D.D.

———— An Account of the footsteps of the Chirotherium, and five or six other unknown animals, lately discovered in the

Quarries of Storeton Hill, between the Mersey and the Dee; communicated by the Natural History Society of Liverpool, and illustrated with Drawings; by John Cunningham, Esq.

December 5th.—A Note on four distinct varieties of Impressions, not including those of the Chirotherium; by James Yates, Esq. F.G.S.

———— On the Footsteps of a Chirotherium, from near Tarporly, Cheshire; by Sir Philip Egerton, Bart., M.P. F.G.S.

December 21st.—On the Phascolotherium; by Richard Owen, Esq. F.G.S., Hunterian Professor in the Royal College of Surgeons.

————On the Structure and Relations of the presumed Marsupial Remains from the Oolite of Stonesfield; by William Ogilby, Esq. F.G.S.

January 9th, 1839.—A Letter addressed to the President by Dr. Harlan, on the Basilosaurus and Batrachiosaurus.

———— On the Zeuglodon (Basilosaurus); by Richard Owen, Esq. F.G.S., Hunterian Professor in the Royal College of Surgeons.

January 23rd.—On the Geology of the vicinity of Lisbon; by Daniel Sharpe, Esq. F.G.S.

February 6th.—On a probable cause of certain Earthquakes; by Professor Louis Albert Necker, For. Mem. G.S.

Sums actually Received and Expended

Receipts.

	£.	s.	d.	£.	s.	d.	£.	s.	d.
Balances in hand January 1, 1838:									
Banker (including 49*l.* 19*s.* Wollaston Fund)				130	11	0			
Accountant				40	0	0			
							170	11	0
Arrears:									
Admission Fees				56	14	0			
Annual Contributions				98	3	6			
							154	17	6
Ordinary Income:									
Annual Contributions				659	8	0			
Admission Fees:									
Residents (11)	69	6	0						
Non-Residents (18)	189	0	0						
				258	6	0			
							917	14	0
Compositions:									
Four at 31*l.* 10*s.*				126	0	0			
One at 29*l.* 18*s.* 6*d.*				29	18	6			
							155	18	6
Transactions				273	14	0			
Proceedings				8	7	0			
							282	1	0
Wollaston Donation Fund, Interest on 1084*l.* 1*s.* 1*d.* 3 per cent. Reduced							32	10	4
Dividends, 500*l.* 3 per cent. Consols				15	0	0			
Ditto, 1311*l.* 19*s.* 6*d.* 3 per cent. Red. 6 months				19	13	7			
Ditto, 1412*l.* 12*s.* 9*d.* ditto				21	3	10			
							55	17	5
							£1769	9	9

We have compared the Books and Vouchers presented to us with these Statements, and find them correct.

Signed, WOODBINE PARISH, FRANCIS BAILY, } Auditors.

during the Year ending December 31, 1838.

PAYMENTS.

	£.	s.	d.	£.	s.	d.
Bills outstanding:						
Collector's poundage	2	10	6			
Scientific Expenditure	3	4	6			
Transactions	3	10	0			
Parochial Rates	0	15	0			
Poor's Rates	3	0	0			
House Expenditure	2	19	6			
				15	19	6
General Expenditure:						
Repairs of House	3	2	2			
House Expenses	201	10	5			
Taxes, Parochial	4	17	2			
——, Assessed	23	3	8			
Poor's Rates	28	5	4			
Household Furniture	3	15	0			
———— Linen	4	0	8			
				268	14	5
Insurance				9	0	0
Salaries and Wages:						
Assistant Secretary	125	0	0			
Curator	62	10	0			
Clerks	110	12	6			
Porter and Housekeeper	70	0	0			
Servant	30	12	0			
Collector's Poundage	36	14	0			
				435	8	6
Scientific Expenditure				39	11	3
Stationery and Miscellaneous Printing				34	14	0
Investment in the Funds				294	10	0
Tea for Meetings				46	4	4
Cost of Publications:						
Transactions	42	13	9			
Proceedings	74	19	0			
				117	12	9
Contribution repaid				3	3	0
Award of Wollaston Fund:						
Mr. Owen, Medal	10	10	0			
ditto. Balance of Proceeds	21	0	0			
				31	10	0
Balances in hand Jan. 1, 1839:						
Banker (including *50l.* 19*s.* 4*d.* Wollaston Fund)	433	2	0			
Accountant	40	0	0			
				473	2	0
				£1769	9	9

Valuation *of the Society's Property; 31st December* 1838.

Property.

	£.	s.	d.	£.	s.	d.
Balances in hand, including 50*l.* 19*s.* 4d. Wollaston Fund				473	2	0
Arrears due to the Society:						
Admission Fees	81	18	0			
Annual Contributions	421	1	0			
Transactions	3	15	0			
				506	14	0
Estimated value of unsold Transactions	808	16	0			
——— Proceedings	30	0	0			
				838	16	0
715*l.* 1*s.* 1*d.* Stock, 3 per cent. Consols	657	0	0			
1412*l.* 12*s.* 9*d.* Stock, 3 per cent. Red.	1313	0	0			
				1970	0	0
				£3788	12	0

[*N.B. The value of the Collections, Library and Furniture is not here included: nor is the "Donation Fund," instituted by the late Dr. Wollaston, amounting at present to* 1084*l.* 1*s.* 1*d. in the Reduced* 3 *per cent. Annuities; the dividends thereof being appropriated to the purposes of the Founder.*]

JOHN TAYLOR, Treasurer.

Jan. 29, 1839.

Debts.

	£.	s.	d.	£.	s.	d.
Bills outstanding:						
Household Furniture	20	0	0			
Taxes	5	0	0			
Scientific Expenditure	15	0	0			
				40	0	0
Cash belonging to the "Wollaston Fund"				50	19	4
Arrears not likely to be received				160	0	0
				250	19	4
Balance in favour of the Society				3537	12	8
				£3788	12	0

ESTIMATES *for the ensuing year* 1839.

INCOME EXPECTED.

	£.	s.	d.	£.	s.	d.
Arrears due to the Society, Dec. 31st, 1838. (See valuation sheet)				506	14	0
Ordinary Income of 1838 estimated:						
Annual contributions (200 Fellows)				615	0	0
Admission Fees:						
Residents (15)	94	10	0			
Non-residents (15)	157	10	0			
				252	0	0
Sale of Transactions	300	0	0			
——— Proceedings	10	0	0			
				310	0	0
Dividends on "Wollaston Donation Fund"				32	10	4
Dividends 500*l.* 3 per cent. Consols, 6 months				7	10	0
Ditto 1412*l.* 12*s.* 9*d.* 3 per cent. Red. ditto				21	3	10
Ditto 2100*l.* ditto ditto				31	10	0
				£1776	8	2
Balance against the Society				108	6	2
				£1884	14	4

In the above estimated Receipts no Compositions are included.

EXPENSES ESTIMATED.

	£.	s.	d.	£.	s.	d.
Debts outstanding Dec. 31st, 1838. (See valuation sheet)				40	0	0
General Expenditure:						
Repairs of House	15	0	0			
Taxes	55	0	0			
Insurance	9	0	0			
House Expenses	180	0	0			
Household Furniture	110	0	0			
				369	0	0
Salaries and Wages:						
Assistant Secretary	125	0	0			
Curator	125	0	0			
Clerk	85	0	0			
Porter and Housekeeper	70	0	0			
Servant	33	4	0			
Collector's Poundage	35	0	0			
				473	4	0
Scientific Expenditure				120	0	0
Stationery and Miscellaneous Printing				60	0	0
Tea for Meetings				50	0	0
Cost of Publications:						
Transactions	500	0	0			
Proceedings	80	0	0			
				580	0	0
Arrears not likely to be received				160	0	0
Employment of the "Wollaston Donation Fund"				32	10	4
				£1884	14	4

The Reports having been read, it was resolved :—

That they be received and entered on the Minutes of the Meeting, and that such parts of them as the Council may think fit, be printed and distributed among the Fellows.

The President then announced that the Wollaston Medal and £20 had been awarded by the Council to Professor Ehrenberg of Berlin, for his discoveries respecting Fossil Infusoria; and in delivering the Medal with the accompanying sum of money into the hands of the Chevalier Bunsen, who was present, Mr. Whewell addressed him as follows:

Mr. Bunsen,

I have great pleasure in delivering into your hands the Wollaston Medal, which the Council of this Society have awarded to your countryman Professor Ehrenberg, for his discoveries respecting Fossil Infusoria. These discoveries, eminently striking and curious to all intelligent persons, are full of the most lively interest for Geologists. Such discoveries are a just reward of M. Ehrenberg's merits, since he had prepared himself for this success by a profound study of natural history, by persevering and scrutinizing researches, and by extensive and enterprising travels. We gladly give this medal as a proof that we sympathize in the admiration which these discoveries have excited throughout scientific Europe.

To many others, and to myself in particular, there is an additional source of pleasure at having such a communication to make to M. Ehrenberg, in the circumstance of our having recently become acquainted with him, and having seen personally in our own country the evidences of his talents and genius, his simple and strenuous love of knowledge. We beg you to communicate to him with this medal the expression of our admiration in his labours, our deep interest in their results, and our warm wishes that he may long have granted him the health and energy and opportunity which their successful prosecution demands.

Allow me to say also, that we trust that this token of our respect will be kindly received by M. Ehrenberg's countrymen as well as by himself, and that they will accept it as a testimony how gladly we do honour to the profound knowledge and patient research which distinguish that great branch of the European family. I rejoice to be able to deliver this medal into the hands of a distinguished countryman of Professor Ehrenberg; and I cannot but add, as an additional ground of satisfaction, into the hands of one, who, by his wide acquaintance with men of science and learning, and with their works, is so well prepared to sympathise with their honours and successes, as he is by his nature prompted to rejoice in excellence of every kind.

The Chevalier Bunsen acknowledged the distinction conferred upon Professor Ehrenberg in the following terms :—

Sir,—I feel highly gratified by the honour conferred upon me, of receiving at your hands the valued acknowledgement of the merits of my distinguished countryman, Professor Ehrenberg, and I beg to return thanks, not only in my name, but also in that of Baron Bulow, as the representative of Prussia in this country, who is prevented by official business from being present on this occasion.

Nobody can be more able or inclined to appreciate duly the value of this distinction than Professor Ehrenberg. I know from himself that it was by England in particular that he wished his researches to be examined and approved; and it was especially by this illustrious Society, so worthily presided over by one whose name is also in Germany equally dear to the friends of religion and moral philosophy, and to the followers of the exact sciences: it was to this Society, I say, to whose tribunal he was desirous to submit the judgement of the merits and importance of his discovery. Indeed, the honour you have decreed him to-day is only the public confirmation and solemn badge of that kind and encouraging interest which he met with from the members of this Society, and for which he felt the most sincere gratitude.

But this feeling, Sir, will not be confined to himself: the honour of the prize awarded to him this day amongst so many illustrious competitors of all nations, will be deeply felt by the whole literary public of Germany: it will, I trust, form a new link in that intellectual union between the two great and enlightened nations, which have so many ties of common interest, and so many objects of warm and deep sympathy; an union which must become every day more and more intimate, and prove productive of the most beneficial consequences, not only for the progress of science in the whole range of human intellect, but for the welfare of humanity at large.

The flattering manner in which you have been pleased to allude to myself obliges me to say a few words on my own behalf. I feel only too much how entirely I must attribute those expressions to the kindness that inspired them, knowing how inadequate my own merits are to deserve them. But I rejoice sincerely at having this opportunity offered to me, publicly to express my feelings of gratitude for the kind and generous reception I have constantly met with in this country, which for so many years and for so many and good reasons, has been the object of my love and of my admiration—feelings which will ever remain engraven on my heart, and with a particularly gratifying reference to this day.

It was afterwards resolved:—

1. That the thanks of this Society be given to Professor Whewell, retiring from the office of President.

2. That the thanks of this Society be given to William Henry Fitton, M.D. and Roderick Impey Murchison, Esq., retiring from the office of Vice-Presidents.

3. That the thanks of the Society be given to Henry Boase, M.D., Viscount Cole, M.P., Marquis of Northampton, Professor Royle, M.D., and Thomas Weaver, Esq., retiring from the Council.

After the balloting glasses had been duly closed, and the list examined by the scrutineers, the following gentlemen were declared to have been duly elected the Officers and Council for the ensuing year:

OFFICERS.

PRESIDENT.

Rev. W. Buckland, D.D., Professor of Geology and Mineralogy in the University of Oxford.

VICE-PRESIDENTS.

G. B. Greenough, Esq. F.R.S. & L.S.

Leonard Horner, Esq. F.R.S. L. & E.

Charles Lyell, jun. Esq. F.R.S. & L.S.

Rev. Adam Sedgwick, F.R.S. & L.S., Woodwardian Professor in the University of Cambridge.

SECRETARIES.

Charles Darwin, Esq. F.R.S.

William John Hamilton, Esq.

FOREIGN SECRETARY.

H. T. De la Beche, Esq. F.R.S. & L.S.

TREASURER.

John Taylor, Esq. F.R.S.

COUNCIL.

Professor Daubeny, M.D. F.R.S. & L.S.

Sir P. Grey Egerton, Bart. M.P. F.R.S.

W. H. Fitton, M.D. F.R.S. & L.S.

Prof. Grant, M.D. F.R.S.

Rev. Prof. Henslow, F.L.S.

W. Hopkins, Esq. M.A. F.R.S.

Robert Hutton, Esq. M.P. M.R.I.A.

Sir Charles Lemon, Bart. M.P. F.R.S.

Prof. Miller, M.A.

R. I. Murchison, Esq. F.R.S. & L.S

Richard Owen, Esq. F.R.S.

Sir Woodbine Parish, K.C.H. F.R.S.

George Rennie, Esq. F.R.S.

Rev. Prof. Whewell, F.R.S.

Address to the Geological Society, delivered at the Anniversary, on the 15th of February, 1839, *by the* Rev. William Whewell, B.D. F.R.S. *President of the Society.*

Gentlemen,

The Reports which have been read show that the Society is still in a state of progression as to numbers, although in consequence of some oversights in preceding periods, the comparison of this year's statement with that of last year does not at first sight give an accurate view of our progress.

I venture also to speak of our pecuniary condition as prosperous, although, in the Estimates for the present year the expenses exceed the income. This excess admits of explanation: the estimated expenses include the cost of publishing a Part of our Transactions, and as this occurs only about once in two years, the whole expense ought not to be considered as belonging to one year. Stoves and other articles of furniture, expenses not likely to recur, have also inflamed the debtor side of our account.

There is one considerable article in our estimated expenses, of which payment may not be required, but from which I confess I should be sorry to see the Society liberated. I speak of the salary of our Curator. In my address last year I stated that the Council had it in contemplation to make some arrangement by which Mr. Lonsdale's labours, then far too heavy, should be lightened. This was done, I believe to the satisfaction of every one, by separating the office of Curator from that of Assistant Secretary, and to the former office Mr. Wood was appointed, with a salary of 125*l.* The Council found in Mr. Wood's zeal and knowledge every reason to congratulate themselves on the possession of such an officer; and have heard with regret that the state of his health compels him to resign his office. I trust, however, that the Council will be able to provide some means of rendering the Society's Collection useful, without allowing Mr. Lonsdale to be again burthened with a complication of duties injurious to him and inconvenient to the Society.

Although, as I have said, I look without any inquietude upon the state of our funds, it is impossible not to allow that such an aspect of them makes it necessary to attend to economy wherever it is possible. There is one part of our establishment to which I am compelled, most reluctantly, to apply this remark; I mean, our Library and Museum. I fear that we must consider ourselves as under the necessity of confining within very narrow limits any assistance which can be rendered to those departments from our general funds. And yet we cannot look at these parts of our establishment, and especially at the Library, without seeing that they do in fact require very material additions. Our Library, which ought to possess all the best books and maps which bear upon our science, is destitute of many of them, especially of the more modern works, to an extent which we should hardly any of us find tolerable in our private libraries. This deficiency interferes materially with the utility of the Society, and is indeed inconsistent with its character. We shall, I trust, all agree that it is a state of things we ought to remedy. At no period of the history of this body has there been found wanting, when the occasion demanded it, a liberal and generous spirit among its members; and I am fully persuaded that at the present day the love of the Society has not waxed cold among the Fellows, nor have their purse-strings become rigid. It has appeared to me, that when a definite list of our deficiencies is laid before you, it will not be found difficult for each person to find in such a list some article, book or map, which it will gratify him that the Society should possess as his gift. In this or in some other way I do not doubt that we shall be able to bring up the condition of our Library to that which the time and our position require.

The Council have adjudged the Wollaston medal for the present year to Professor Ehrenberg, for his discoveries respecting fossil Infusoria and other microscopic objects contained in the materials of the earth's strata. We all recollect the astonishment with which, nearly three years ago, we received the assertion, that large masses of rock, and even whole strata, are composed of the remains of microscopic animals. This assertion, made at that time by Professor Ehrenberg, has now not only been fully confirmed and very greatly extended by him, but it has assumed the character of one of the most important and striking geological truths which have been brought to light in our time: for the connection of the present state of the earth with its condition at former periods of its history, a problem now always present to the mind of the philosophical geologist, receives new and unexpected illustration from these researches. Of about eighty species of fossil Infusoria which have been discovered in various strata, almost the half are species which still exist in the waters: and thus these forms of life, so long overlooked as invisible specks of brute matter, have a constancy and durability through the revolutions of the earth's surface which is denied to animals of a more conspicuous size and organization. Again, we are so accustomed to receive new confirmations of our well-established geological doctrines, that the occurrence of such an event produces in us little surprise; but if this were not so, we could not avoid being struck with one feature of Prof. Ehrenberg's discoveries;—that while the microscopic contents of the more recent strata are all freshwater Infusoria, those of the chalk are bodies (*Peridinium*, *Xanthidium*, *Fucoides*,) which must, or at least can, live in the waters of the ocean. Nor has Prof. Ehrenberg been content with examining the rocks in which these objects occur. During the last two years he has been pursuing a highly interesting series of researches with the view of ascertaining in what manner these vast masses of minute animals can have been accumulated. And the result of his inquiries is*, that these creatures exist at present in such abundance, under favourable circumstances, that the difficulty disappears. In the Public Garden at Berlin he found that workmen were employed for several days in removing in wheelbarrows masses which consisted entirely of fossil Infusoria. He produced from the living animals, in masses so large as to be expressed in pounds, tripoli and polishing slate similar to the rocks from which he had originally obtained the remains of such animals; and he declares that a small rise in the price of tripoli would make it worth while to manufacture it from the living animals as an article of commerce. These results are only curious; but his speculations, founded upon these and similar facts, with respect to the formation of such rocks for example, polishing slate, the siliceous paste called *keiselguhr*, and the layers of flint in chalk, are replete with geological instruction.

As the discoveries of Prof. Ehrenberg are thus full of interest for the geological speculator, so have they been the result, not of any fortunate chance, but of great attainments, knowledge, and labour. The author of them had made that most obscure and difficult portion

* Abhandl. Kön. Ak. Wissensch. Berlin, 1838.

of natural history, the infusorial animals, his study for many years; had travelled to the shores of the Mediterranean and the Red Sea in order to observe them; and had published (in conjunction with Prof. Müller) a work far eclipsing anything which had previously appeared upon the subject. It was in consequence of his being thus prepared, that when his attention was called to the subject of fossil Infusoria, (which was done in June, 1836, by M. Fischer) he was able to produce, not loose analogies and insecure conjectures, but a clear determination of many species, many of them already familiar to him, although hardly ever seen perhaps by any other eye. The animals (for he has proved them to be animals, and not, as others had deemed them, plants) consist, in the greater number of examples, of a staff-like siliceous case, with a number of transverse markings; and these cases appear in many instances to make up vast masses by mere accumulation without any change. Whole rocks are composed of these minute cuirasses of crystal heaped together. Prof. Ehrenberg himself has examined the microscopic products of fifteen localities, and is still employed in extending his researches; and we already see researches of the same kind undertaken by others, to such an extent, as to show us that this new path of investigation will exercise a powerful influence upon the pursuits of geologists. We are sure therefore that we have acted in a manner suitable to the wishes of the honoured Donor of the medal, and to the interests of the science which we all in common seek to promote, in assigning the Wollaston medal to Prof. Ehrenberg for these discoveries.

Although it is not necessary as a ground for this adjudication, it is only justice to Prof. Ehrenberg to remark, that his services to geology are not confined to the researches which I have mentioned. His observations, made in the Red Sea, upon the growth of corals, are of great value and interest; and he was one of the distinguished band of scientific explorers who accompanied Baron von Humboldt in his expedition to the Ural Mountains. And I may further add, that even since the Council adjudged this medal, Prof. Ehrenberg has announced to the Royal Academy of Sciences of Berlin new discoveries; particularly his observations on the organic structure of chalk; on the freshwater Infusoria found near Newcastle and Edinburgh, and on the marine animalcules observed near Dublin and Gravesend; and, what cannot but give rise to curious reflections, an account of *meteoric paper* which fell from the sky in Courland in 1686, and was found to be composed of Confervæ and Infusoria.

I now proceed to notice some of the most conspicuous names, both among our own countrymen and foreigners, which have been removed by death from our lists since last year.

In Sir Abraham Hume the Society has lost a member who was at all times one of its most strenuous friends and most liberal supporters, and especially in its earliest periods, when such aid was of most value. Indeed he may in a peculiar manner be considered as one of the Founders of the Society. English geology, as is well known, evolved itself out of the cultivation of mineralogy,—a study which was in no small degree promoted, at one time, by the fame of the mineralogical collections of Sir Abraham Hume and others. The Count de Bournon, exiled by the French revolution in 1790, brought to England new and striking views of crystallography, resembling those which Haüy was unfolding in France; and was employed to arrange and describe the mineralogical collections of Sir John St. Aubyn and Mr. Greville, and especially the collection of diamonds of Sir Abraham Hume, of which a description, illustrated with plates, was published in 1816. Some years before this period a few lovers of mineralogy met at stated times at the house of Dr. Babington, whose influence in preparing the way for the formation of this Society was mentioned with just acknowledgement in the President's Address, in 1834, by Mr. Greenough; and certainly he, more fitly perhaps than any other person, could speak of the merits and services of his fellow-labourers. Of the number of these Sir Abraham Hume was one; although not, I believe, one of those who showed their zeal for the pursuits which associated them by holding their meetings at the hour of seven in the morning, the only time of the day which Dr. Babington's professional engagements allowed him to devote to social enjoyments of this nature.

Out of the meetings to which I refer this Society more immediately sprung. The connection of mineralogy with geology is somewhat of the nature of that of the nurse with the healthy child born to rank and fortune. The foster-mother, without being even connected by any close natural relationship with her charge, supplies it nutriment in its earliest years, and supports it in its first infantine steps; but is destined, it may be, to be afterwards left in comparative obscurity by the growth and progress of her vigorous nursling. Yet though geology now seeks more various and savoury food from other quarters, she can never cease to look back with regard and gratitude to the lap in which she first sat, and the hands that supplied her early wants. And our warm acknowledgments must on all due occasions be paid to those who zealously cultivated mineralogy, when geology, as we now understand the term, hardly existed; and who, when the nobler and more expansive science came before them, freely and gladly transferred to that their zeal and their munificence.

The spirit which prevailed in the infancy of this Society, and to which the Society owed its permanent existence, was one which did not shrink from difficulties and sacrifices; and among the persons who were animated by this spirit Sir Abraham Hume was eminent; his purse and his exertions being always at the service of the body. He gave his labours also to the Society by taking the office of Vice-President, which he discharged with diligence from 1809 to 1813. He died in March last at the great age of ninety, being then the oldest person both in this and in the Royal Society.

Mr. Benjamin Bevan was a civil engineer, and throughout his life showed a great love of science, and considerable power of promoting its purposes. He instituted various researches, theoretical and practical, on the strength of materials; and it was he who first proved by experiment the curious proposition, that the Modulus of Elasticity of water and of ice is the same. In 1821 he wrote a letter to the secretary of this Society, recommending that the form of the surface of this country should be determined by barometrical measurements of the heights of a great number of points in it,—the barometer which was to be used as a standard being kept in London. Mr. Bevan and Mr. Webster were commissioned to procure a barometer, and Dr. Wollaston recommended one of Carey's barometers, but it does not appear that any further steps were taken. I may remark that recent researches have further confirmed the wisdom of Mr. Bevan's suggestion, that heights should be measured, as all other measurements are made, from some fixed *conventional* standard, instead of incurring the vagueness and inconsistency which result from assuming the existence of a natural standard, such as the level of the sea.

Nathaniel John Winch was born at Hampton Court in the year 1769, and after a voyage into the Mediterranean, and travels in various countries in Europe, settled at Newcastle-upon-Tyne as a merchant. He had early paid great attention to botany, which he continued to cultivate during a long life, and kept up a correspondence with all the leading botanists in Europe. He was one of the earliest, and always one of the most active members of the Literary and Philosophical Society of Newcastle; and, in conjunction with a few of his friends, gave to that town a scientific and cultured character, which still distinguishes it. He was one of the honorary members of this Society; and contributed to its meetings, in 1814, "Observations on the Geology of Northumberland and Durham," and in 1816, "Observations on the Eastern Part of Yorkshire,"* which were printed in the fourth and fifth volumes of our Transactions. In these he stated his object to be to combine with his own observations much interesting information on the subjects of the quarries, and coal and lead mines, of those districts, which had long been accumulating, and was widely diffused among the professional conductors of the mines. And these memoirs, though not containing much of originality in their views and researches, were, at the time, of considerable utility. He died May 5th, 1838, and, by his will, left to this Society a very considerable and valuable mineralogical collection, now in our Museum.

Mr. William Salmond, of York, was one of the persons who was most zealously and actively engaged in the examination of the celebrated Kirkdale Cavern. He measured and explored new branches of the cave in addition to those first opened, and made large collections of the teeth and bones, from which he sent specimens to the Royal Institution of London, and to Cuvier at Paris. The bulk of

* Besides these papers, Mr. Winch published: "The Botanist's Guide through the Counties of Northumberland and Durham. By N. J. Winch, J. Thornhill, and R. Waugh." 2 vols. 1805.—"Flora of Northumberland and Durham." In the Transactions of the Newcastle Natural History Society, vol. 2.—"An Essay on the Geographical Distribution of Plants through the Counties of Northumberland, Durham, and Cumberland." First edition, 1820; second edition, 1825.—"Contributions to the Flora of Cumberland." 1833.—"Addenda to the Flora of Northumberland and Durham." 1836.

his collection was deposited in the Philosophical Society at York, then newly established.

I now proceed to notice our deceased Foreign Members.

François-Dominique de Reynaud, Comte de Montlosier, was born at Clermont in Auvergne, April the 16th, 1755, the year of the celebrated earthquake of Lisbon. He was the youngest of twelve children of a family of the smaller nobility of that province, and was remarkable at an early age for the zeal with which he pursued various branches of science and literature.

Count Montlosier must ever be considered as one of the most striking writers in that great controversy respecting the origin of basaltic rocks, which occupied the attention of mineralogists during the latter half of the last century; and to which, in so large a degree, the progress and present state of geology are to be ascribed. The theory of the extinct volcanos of Auvergne, the subject of his researches, was the speculation which gave the main impulse to scientific curiosity on this point. It is true that he was not the originator of the opinions which he so ably expounded. Guettard, in 1751, had seen, vaguely and imperfectly, that which it now appears so impossible not to see, the evidences of igneous origin in the rocks of that district: and the elder Desmarest, whose examination of them began in 1763, had made that classification of them, which is the basis, and indeed the main substance, of the views still entertained with regard to the structure of that most instructive region. His map of the district, published in 1774 (in the Transactions of the Academy of Paris *for* 1771, according to a bad habit of that body still prevailing), exhibits the distinction of modern currents of lava, ancient currents, and rocks fused in the places where they now are, which distinction supplies a key to the most extraordinary phænomena, while it reveals to us a history more wonderful still. But striking and persuasive as this view was, and fitted, apparently, to carry with it universal conviction, the theory which it implied, collected, as it seemed at the time, from one or two obscure spots in Europe, was for a while resisted and almost borne down by the opposite doctrine of the aqueous origin of basalt; which came from the school of Freyberg, recommended by the power of a connected and comprehensive system,—a power in science so mighty for good and for evil. Montlosier's Essay on the Volcanos of Auvergne, which appeared first in 1788, was, however, not written with any direct reference to this controversy, but was rather the exposition of the clear and lively views of an acute and sagacious man, writing from the fullness of a perfect acquaintance with the country which he described, in which, indeed, his own estate and abode lay. In its main scheme, although Desmarest's is mentioned with just praise*, the object of this Essay is to criticise and correct a work of M. Le Grand d'Aussy, entitled *Voyage en Auvergne*. But as the main additions to sound theory which this work contains, (a point which here concerns us far more than its occasion and temporary effect), we may, I think, note the mode in which he traces in detail the effects which the more recent currents of lava (those which follow the causes of the existing valleys) must have produced upon the courses of rivers and the position of lakes; and the idea, at that time a very bold and, I believe, a novel one, that lofty insulated ridges and pinnacles of basalt, which tower over the valleys, have been cut into their present form by the long-continued action of fluviatile waters, aided by a configuration of the surface very different from the present. The striking and vivid pictures which Montlosier draws of such occurrences, are to the present day singularly instructing and convincing to those who look at that region with the geologist's eye. After publishing this essay, M. Montlosier, a man of varied and commanding talents, became involved in the political struggles of his time, and was an active member of the National Assembly, to which he was sent as Deputy of the Noblesse of Auvergne. In his place there he resisted in vain the proposals for the spoliation of the clergy; and one speech of his on this subject was very celebrated. After witnessing some of the changes which his unhappy country had then to suffer, he became an exile, and resided in London, where for some years he was the editor of the *Courier Français*, a royalist journal. Under the empire, he returned to France, and was employed in the Foreign Office of the Ministry, but recovered little of his property except a portion of a mountain, which was too ungrateful a soil to find another purchaser. The situation however could not but be congenial to his geological feelings; for

* After mentioning Guettard, he says, "Les mémoires de M. Desmarest, publiés quelques années après, entrainèrent tout-à-fait l'opinion publique." (p. 20.)

his habitation was in the extinct crater of the Puys de Vaches. The traveller, in approaching the door of the philosopher of Randane, had to wade through scoriæ and ashes; and from the deep basin in which his house stood, a torrent of lava, still rugged and covered with cinders, has poured down the valley, and at the distance of a league, has formed a dike and barred up the waters which form the lake of Aidat;—a spot celebrated by Sidonius Apollinaris, Bishop of Clermont in the fifth century, as the seat of his own beautiful residence, under the name of Avitacus. It is curious to remark that Sidonius does not overlook the resemblance between his own mountain and Vesuvius:

"Æmula Baiano tolluntur culmina cono,
Parque cothurnato vertice fulget apex."

In this most appropriate abode M. de Montlosier was, in his old age, visited at different times by several distinguished English geologists, some of whom are now present; and invariably delighted them with his unfading interest in the geology of his own region, his hospitable reception, and I may add, his lofty and vigorous presence, according well with his frank and chivalrous demeanour. His ardour of character had shown itself in early age: "From my first youth," thus his Essay opens, "I occupied myself with the natural history of my province, in spite of repulse and ridicule." The same spirit involved him in other struggles to the end of his life; and, indeed, we may almost say, beyond it. He took a prominent part in the political controversies of his day; and few works on such subjects, which appeared in France in modern times, produced a greater fermentation than his "Mémoire à consulter" on the subject of the Jesuits. In this work he maintained that the position of the Jesuits in France was dangerous and illegal; and he must be considered as the originator of that movement in consequence of which their body was, a few years later, suppressed by the government. The expression of his opinions respecting the conduct and influence of the clergy of his country was condemned by the ecclesiastical authorities, and was deemed by them of a nature to exclude him from that recognition of his being a son of the Catholic church, which is implied by the performance of the funeral rite according to its ordinances. This, however, did not prevent the inhabitants of the neighbourhood and the military stationed at Clermont from showing the regard which his intercourse with them had inspired, by attending his sepulture in great numbers. He was buried in a spot previously selected by himself, in the crater of the extinct volcano in which his abode was, in the middle of the scenes which he had from his earliest years loved and studied, and taught others to feel a deep interest in. He died at the age of 83, on his way to Paris in order to take his seat in the Chamber of Peers, of which he was a member*.

Anselme-Gaëtan Desmarest, honorary member of the Royal Academy of Medicine, and Professor of Zoology at the Royal Veterinary College of Alfort, was the son of Nicolas Desmarest, who has just been mentioned as the predecessor of Montlosier in his theory of the volcanic origin of Auvergne. The son also employed himself upon the same district; and published an enlarged and improved edition of his father's map of Auvergne;—a work which is still spoken of with admiration, for its fidelity and skilful construction, by all who explore that country. But the labours of the younger Desmarest were principally bestowed upon the other parts of natural history. We possess in our Library, extracted from various journals, and presented us by the author, his "Notes on the impressions of marine bodies in the strata of Montmartre," published in 1809; his "Memoir on the Gyrogonite," published in 1810; to which he added, in 1812, the recognition of the analogy of this fossil with the fruit of the Chara, pointed out by his brother-in-law M. Léman; his review of a work by M. Daudebard de Ferrussac, on the Fossils of Freshwater Formations, in 1813; his memoir on Two Genera of Fossil Chambered Shells, in 1817; and his "Natural History of the Proper Fossil Crustaceans," published in 1822 along with M. Brongniart's "Natural History of Fossil Trilobites." In the "Dictionaire d'Histoire Naturelle," the article Ma-

* Besides his "Essay on the Extinct Volcanoes of Auvergne," M. de Montlosier was the author of the following works: "Memoire à consulter sur un Système Religieux et Politique tendant à renverser la Religion, la Société et le Trône" (1826). "Dénonciation aux Cours Royales rélativement au Système Religieux et Politique signalé dans le Mémoire à consulter," (1826). "Mémoires de M. le Comte de Montlosier sur la Révolution Française, le Consulat, l'Empire, et les principaux Evènements qui ont suivis 1755-1830." Of this work two volumes have appeared, which bring the narrative down to the author's quitting the National Assembly in 1790.

locostracés, which contains a complete account and classification of Crustaceans, is by M. Desmarest, with others on the same subject. In this work all the articles on Crustaceans had originally been assigned to Dr. Leach; but when the lamented illness of that distinguished naturalist prevented his finishing this task, it was committed to Desmarest, who carefully studied the labours of his predecessor; and, with most laudable industry and self-denial, made it his business to follow his method as closely as possible. He also published a separate work on Crustaceans in 1825.

Count Kaspar Sternberg was one of those persons, so valuable in every country, who employ the advantages of wealth and rank in the cultivation and encouragement of science. He belonged to a younger branch of one of the best and oldest families in Bohemia; and was closely connected with the persons of most elevated station in that country. He was born the 6th of January, 1761, and received a distinguished education at Prague; not only, as was then common among the Bohemian nobility, through private tutors, but by following the public course of the university. He was created Canon of the Chapter of the metropolitan church at Ratisbon, which, obliging him to receive the lower degree of holy orders, bound him to celibacy. At Ratisbon, then a considerable place, and the seat of the Diet of the German empire, he formed friendships with several eminent persons, and especially with Count Bray (afterwards Bavarian minister at various courts), a man of letters, and a distinguished botanist. Count Sternberg also cultivated botany, and became an active member of the Botanical Society of Ratisbon. During the time that Germany was a prey to the miseries of war, he retired to his hereditary country seat Brzezina, in the circle of Pilsen, in the north-western part of Bohemia. Here his attention was early drawn to the coal formation, of which mineral he possessed an extensive estate at Radnitz. He soon formed the intention of publishing representations of the fossil vegetables belonging to the coal strata. These had already begun to excite the attention of geologists. Some of these works, containing notices on such subjects, preceded the existence of sound geology, as the *Herbarium Diluvianum* of Scheuchzer, the *Sylva Subterranea* of Beutinger, and the *Lapis Diluvii Testis* of Knorr*. At the beginning of the present

* To the earlier works on this subject we may add Martin's *Petrificata*

century, Faujas de St. Fond had published in the Annales du Muséum some impressions of leaves, not indeed belonging to the coal, but to a later formation. These impressions were examined and determined by Count Sternberg, in the Botanical Journal of Ratisbon, in 1803. In the following year appeared the first truly scientific work on this subject, the "*Flora der Vorwelt*" of Schlotheim, in which the great problem which was supposed to demand a solution was, Whether the vegetables of which the traces are thus exhibited belong to existing or to extinct kinds? Count Sternberg was in Paris when he received the work of Schlotheim, and he studied it carefully by the aid of the collections which exist in that metropolis. He published in the Annales du Muséum a notice on the analogies of these plants, but concluded with observing, that a greater mass of facts was requisite; and that, these once collected, the general views which belong to the subject would come out of themselves.

Bearing in mind this remark of his own, when fortune, after the storming of Ratisbon in 1809, set him down in the midst of the great coal formations of Bohemia, he proceeded forthwith to manage the working of his mines, so as to preserve as much as possible the most remarkable impressions of fossils. Combining his own specimens with those found in other places, he began to publish, in 1820, his "Essay towards a Geognostic-botanical Representation of the Flora of the Pre-existing World." In this work he not only gave a great number of very beautiful coloured engravings of vegetable fossils, but also attempted a systematic classification of them. But he stated, in the first portion of his work*, that the problems, important alike for botany and geology, which offered themselves, could only be solved by combined labours on a common plan; and after mentioning the various European Societies to which he looked for assistance (among which he includes this Society), he adds, "Bohemia and the hereditary states of the Austrian empire, I am ready, with some friends of science, to make the subject of continued investigation." The specimens of which he published representations, with many more, formed the Count's collection at his castle of Brzezina; but he declared in the outset, that as soon as the National Bo-

Derbiensia, published 1809; and Parkinson's Organic Remains (1804), which contains many plates of vegetables.

* *Erster Heft*, p. 16.

hemian Museum at Prague was provided with the means of receiving and displaying this collection, the whole should be transferred from Brzezina to the capital. This was afterwards done; and in this and other ways he was one of the principal founders of the Museum at Prague. He also gave notice, that while the collection continued in his own residence, it was open to the inspection of every lover of science, even in the absence of the Count himself.

The publication of Sternberg's *Flora der Vorwelt* went on till 1825, after which it was discontinued till 1838, when two parts appeared, terminating the work. In this last publication he states that he is compelled to give up this undertaking, having been in a great measure deprived of sight for two years, so that he was obliged to devolve the greater part of such labours upon MM. Corda and Presl. His hearing also failed him. He adds, however, that though thus no longer able to pursue the path which he has trodden for twenty years, he shall not fail to render to the science, of which he was one of the founders, any service which may be in his power. This publication was the crowning labour of his life, for he did not long survive it; he retained, however, to the last the elasticity and activity of his mind. He died very suddenly at his country seat already mentioned, on the 20th of December, 1838, being carried off by apoplexy in his 78th year.

In his own country his influence was highly salutary: he directed his attention especially to the improvement of the national education; and we cannot be surprised at finding such a person very soon at the head of nearly all the institutions for literary and public purposes. He founded the National Museum of Bohemia, of which he was the President; gave to it his library and his various collections, and further enriched it at various periods of his life. He was, indeed, zealous in all that concerned Bohemian nationality, and was an accomplished master of the language and literature of his country: since his death I am assured that there is hardly one Bohemian of any class who does not mourn for him as for a most respected benefactor. Throughout Germany, he was looked to by all who felt an interest in science with a respect and regard which he well merited. The emperor Francis held him in the highest esteem; he gave him the title of Privy Councillor, and the Grand Cross of St. Leopold, held in that monarchy as a distinguished honour.

In the preceding sketch I have mentioned Schlotheim as one of the predecessors of Count Sternberg in fossil botany. Although this writer died in 1832, and was an honorary member of this Society, he has never been noticed in the annual address; I may therefore here add a few words with reference to him. Baron E. F. von Schlotheim was Privy Councillor and President of the Chamber at the court of Gotha, and his collection of Petrifactions has long been celebrated throughout Germany. Besides his Flora of a Former World, or Descriptions of remarkable Impressions of Plants, which appeared in 1804, he published, in 1820, 'Petrifactenkunde, or the Science of Petrifactions according to its present condition, illustrated by the Description of a Collection of petrified and fossil remains of the animal and vegetable kingdom of a former world.' And in 1822 and 1823 he published Appendixes to this work. His collection was also further made known by articles in Leonhard's Mineralogical Pocket Book and in the Isis. After his death a new description of this collection was announced, but whether it appeared I am not able to say. Schlotheim's introduction to his account of his collection contains some extensive geological views.

It is only justice to M. de Schlotheim to add here what is said of him by M. Adolphe Brogniart, whose own labours on fossil vegetables have been of such inestimable value to the geologist, and are every year increasing in interest. "Almost half a century," he says, "elapsed, during which no important work appeared on this subject. It was not till 1804 that the 'Flora of the Ancient World,' by M. de Schlotheim, again turned the attention of naturalists to this branch of science. More perfect figures, descriptions given in detail and constructed with the precision of style which belongs to botany, and moreover some attempts at comparison with living vegetables, showed that this part of natural history was susceptible of being treated like the other branches of science: and we may say, that if the author had established a nomenclature for the vegetables which he described, his work would have become the basis of all the succeeding labours on the same subject."

In attempting a sketch of the subjects which have occupied the attention of the Society during the year, I should wish to retain that distribution of the science of geology according to which I arranged my remarks in the Address which I had last year the honour of reading to the Society; I mean the primary division into *Descriptive Geology* and *Geological Dynamics*; the former implying a description of the rocks of the earth's surface according to an established classification of strata and formations; and the latter dealing with the study of those general laws and causes of change by which we hope to understand and account for the facts which Descriptive Geology brings before us;—in short, the present condition and the past history of the earth's crust. But as the laws of permanence and change, with regard to organized beings, differ very widely from the dynamics of brute matter, we may conveniently make a separate study of the relations of organic life to which geology conducts us, and may mark it by the name *Palæontology*, by which it is commonly known. I will add that it still appears to me convenient, for the present, to divide Descriptive Geology into two portions,—the Home circuit, in which the order of superposition has already been established with great continuity and detail; and the Foreign region, in which we are only just beginning to trace such an order. I shall also, as before, take the ascending order of strata. According to this arrangement of the science, I shall venture to bring to your recollection a few of the points to which our attention has mainly been called during the past year.

DESCRIPTIVE GEOLOGY.

1. *Home (North European) Geology.*—When I stated that Descriptive Geology has for its task the reference of the rocks of some portion of the earth's surface to an established classification into strata and formations, it was implied, that the more common employment of the descriptive geologist must be to refer the rocks which he examines to some classes *already fixed and recognized*; but it could hardly fail to occur to you, that from time to time the leaders in this study will be called upon to execute a more weighty and elevated office, in framing the classifications which other observers are to apply; in drawing the great lines of division and subdivision which fix the form of the subject; in setting up the type with which examples are to be compared; in constructing the language in which

others are to narrate their facts. Steps of this kind have formed, and must form, the great epochs in the progress of all sciences of classification, and especially in ours; and I need not remind you how great the importance and the influence of such steps amongst you have been. To pronounce at once upon the success of such steps must always be in some degree hazardous; since their success is in fact this, that they influence permanently and powerfully the researches, descriptions, and speculations of future writers; and there are few of us who can pretend to the foresight which might enable us to say, in any special case, how far this will be so. Yet the great works of Messrs. Murchison and Sedgwick, tending to the establishment of a classification of the strata below the old red sandstone (works which, on all accounts, we must consider as a joint undertaking), appear already to offer an augury which can hardly be doubtful, of this influence and permanence. Mr. Murchison's appellation of the "Silurian System" has already been adopted by MM. Elie de Beaumont and Dufresnoy, who have given it currency on the continent: M. Boué and M. de Verneuil announce the diffusion of "Silurian" rocks in Servia and the adjacent parts of Turkey in Europe; our own members, Mr. Hamilton and Mr. Strickland, have extended their range to the Thracian Bosphorus; M. Forchhammer, of Copenhagen, visited the "Silurian region" to endeavour to recognize the rocks of Scandinavia; and MM. Omalius D'Halloy and Dumont have just explored it, to establish a parallel between its deposits and those of Belgium. It will be observed that some of the districts thus mentioned are out of the limits of our geological Home circuit; and if the identification be really and permanently established in these cases, will extend the limits within which the parallelism of geological series can be asserted: and this is, in effect, what we have a right to look for, sooner or later, in the progress of geological science. As we must be careful not to apply our domestic types without modification to other regions, so must we take care not to despair of modifying our scheme, so that it shall be far more extensively applicable than it at first appeared to be. Of this progress of things examples are too obvious and too recent to require to be pointed out.

The labours of Professor Sedgwick refer to the "Cambrian System," which lies beneath the Silurian System, occupying much of North

Wales, Cumberland, and a great part of Scotland; while the Silurian System spreads over a great part of South Wales and the adjoining English counties. The classification of the rocks of this portion of our island to which Professor Sedgwick has been led, though laid before you only at a recent meeting, is the fruit of the vigorous and obstinate struggles of many years, to mould into system a portion of geology which appeared almost too refractory for the philosopher's hands; and which Professor Sedgwick grappled with the more resolutely, in proportion as others shrank away from the task perplexed and wearied. I need not attempt any detailed view of his system: his First Class of Primary Stratified Rocks occupies the Highlands of Scotland and the Hebrides, and appears in Anglesea and Caernarvonshire; the crystalline slates of Skiddaw Forest, and the Upper Skiddaw slate series come next. Above these is his Second Class, or Cambrian and Silurian System. The Cambrian is divided into Lower and Upper Cambrian, of which the former includes all the Welsh series under the Bala limestone; the two great groups of green roofing slate and porphyry on the north and south sides of the mineral axis of the Cumbrian mountains (of which groups the position had previously been misunderstood), and parts of Cornwall and South Devon. The Upper Cambrian System contains a large part of the Lammermuir chain; a part of the Cumbrian hills, commencing with the calcareous slates of Coniston and Windermere; the system of the Berwyns and South Wales; all the North Devon, and a part of the South Devon and Cornish series. Ascending thus through a series of formations distinguished and reduced to order by the indefatigable exertions and wide views of Professor Sedgwick, we arrive at the Silurian system; and here we must seek our subdivisions from the rich results of the labours of Mr. Murchison. These subdivisions were published in the summer of 1833. Like the Cambrian, the Silurian is divided into a Lower and an Upper System, the former including the Llandeilo flags and the Caradoc sandstones; the Upper Silurian Rocks being the Wenlock shale and limestone, the Lower Ludlow, the Aymestry limestone, and the Upper Ludlow, which finally conducts us to the Tilestones or bottom beds of the Old Red Sandstone.

That these various series of Cambrian and Silurian rocks are really superposed on one another; that they are justly separated into these groups; and that the smaller groups are truly of a subordinate nature, divided by lines less broad than those which bound the great series of formations;—these are points, of which the evidence must be sought in the works to which I refer. The evidence adduced by Prof. Sedgwick is mainly to be found in the great fact of superposition, supported by the circumstances of dip, strike, cleavage, mineral character, and all the great incidents of mountain masses. To proofs of this kind Mr. Murchison is able to add the testimony of organic fossils, of which a vast and most instructive collection is figured in his work. These fossils of the Silurian system, amounting in all to about 350 species, are essentially distinct from those of the Carboniferous System and Old Red Sandstone. This being so, the establishment of these great divisions is supported by that geological evidence which properly belongs to the subject.

In detecting order and system among the monuments of the most obscure and remote periods of the earth's history, it may easily be supposed that it has been necessary to employ and to improve all the best methods of geological investigation. Prof. Sedgwick's classification of the oldest rocks which form the surface of this island has of course been obtained by a careful attention to the position and superposition of the mineral masses, and by tracing the geographical continuity of the strata, almost mile by mile, from Cape Wrath to the Land's End. In this manner he has connected the rocks of Scotland with those of Cumberland; these again with those of Wales; and the Welsh series, though more obscurely, with that of Devonshire and Cornwall. In this survey he has constantly kept before his eyes a distinction, known indeed before, but never before so carefully and systematically employed, between the slaty cleavage of rocks and their stratification; for the directions of these two planes, though each wonderfully persistent over large tracts, never, except by accident, coincide. He has taken for his main guide the direction of the strata, or, as it is called, the *strike* of the beds; and in such a course, the theory of Elie de Beaumont respecting the parallelism of contemporaneous elevations, whether true or false, could not fail to give an additional interest to geological researches, conducted on so large a scale as those of Prof. Sedgwick. Mr. Murchison's mode of investigation may be described thus: that he has applied, for the first time, to the rocks below the Old Red Sandstone, the method of classification previously employed with so much success for the Oolites. It is truly remarkable, that Nature has placed in this our corner of the world, series, probably the most complete which exist, of both these groups of strata; and as the Oolites of England have long been the type of that portion of European geology, the Silurians of Wales may perhaps soon be recognized as the standard members of a still more extensive range of deposits. As if Nature wished to imitate our geological maps, she has placed in the corner of Europe our island, containing an *Index Series* of European formations in full detail.

The Carboniferous, Old Red, Silurian and Cambrian systems have, by many writers, up to the present time, been all comprehended in the term "transition rocks", so far as that term has been used with any definite application at all. The analysis of this vague group into these distinct portions removes the confusion and perplexity which have hitherto prevailed in this province of geology. Prof. Sedgwick has further proposed to apply the term *Palæozoic*, and Mr. Murchison that of *Protozoic*, to the rocks which constitute the Cambrian and Silurian systems.

How far these appellations are useful, we shall see when we have had speculations presented to us in which they are familiarly used; for necessity is the best apology, and convenience the best rule, of innovations in scientific language. In the names applied to the members of the Silurian system, Mr. Murchison, following those examples of geological nomenclature which have been most clearly understood and most generally adopted, has borrowed his terms from localities in which standard types of each stratum occur. If the Silurian system be as exclusively diffused as some indications seem to imply, we may find the Ludlow Rocks in Scandinavia, and the Caradoc Sandstone even in Patagonia. Whether a like identification of the more ancient rocks of the Cambrian series with the lowest formations of other countries be possible, may perhaps be (for the present) more doubtful.

I have spoken of Mr. Murchison's work as if it had formed part of our Proceedings, as indeed almost every part of it has done, although it now appears in a separate form. And I will add, that it is impossible not to look with pleasure upon the form in which the work appears, enriched as it is in the most liberal manner, with every illustration, map and section, picturesque view and well-marked fossil, which can aid in bringing vividly before the reader all the instructive and interesting features of the formations there described. The book must be looked upon as an admirable example of the sober and useful splendour which may grace a geological monograph.

Having been tempted to dwell so long on this subject from my conviction of its importance, I must the more rapidly proceed with the remainder of my survey. Mr. Bowman sent us, "Notes on a small patch of Silurian Rocks to the west of Abergele." In this investigation, which is interesting to us as the first application of Mr. Murchison's Silurian System, the author found strata of which some could be, by means of fossils, identified with the Ludlow rocks. Mr. Malcolmson has, by the remains of fossil fishes, shown that the calciferous conglomerate of Elgin represents the old red sandstone of Clashbinnie, as the Rev. G. Gordon had already supposed. Finally, proceeding to higher strata, we have to notice a trait of the fossil history of the coal strata near Bolton-le-Moors, contributed by Dr. Black. A stem of a tree thirty feet long, and inclined at an angle of 18° in a direction opposite to the strata, was discovered, having upon it a Sternbergia, about an inch in diameter, extending the whole length of the stem, which had been, while living, a parasite plant, like the mighty existing creepers of the tropical regions.

The most curious addition to our fossil characters of strata, are the footsteps discovered on the surface of beds of the new red sandstone. It is well known that several years ago such marks were discovered at Corncockle Muir, in Dumfries-shire. Since that time similar discoveries have been made at various places, and especially in 1834, in the quarries of Hesseberg near Hilbergshausen; and to the animal which had produced the impressions then discovered, the name of Chirotherium was provisionally applied by Professor Kaup. In the quarries of Storeton Hill, in the peninsula of Worrall, between the Mersey and the Dee, marks were discovered strongly resembling the footsteps of the Chirotherium of Kaup: these were described by a committee of the Natural History Society of Liverpool, and drawn by J. Cunningham, Esq. Mr. James Yates has also described footsteps of four other animals from the same quarries; and Sir Philip Egerton has given us a description of truly gigantic footsteps of the same kind, which he terms the *Chirotherium Herculis*.

Mr. Strickland gave us a notice of some remarkable dikes of calcareous grit which occur in the lias schist at Ethie in Ross-shire, and which had already been remarked by Mr. Murchison, in his examination of the coast of Scotland, in 1826. They appear not to have been injected from below, but filled in from above.

Mr. Williamson's "View of the Distribution of Organic Remains in part of the Oolitic Series on the Coast of Yorkshire," was the welcome continuation of a labour of the same kind already executed for the lower portions of the series, and promised to be continued for the upper. Among the contributions to the fossil history of the oolites, we must also place Dr. Buckland's "Discovery of the fossil wing of an unknown Neuropterous Insect in the Stonesfield slate." This stratum, the Stonesfield slate, has, during the past years, occupied the Society in the consideration of its fossils in no small degree; but the speculations thus suggested belong to Palæontology rather than Descriptive Geology. Mr. Murchison's notice of a specimen of the Oar's rock, which stands in the sea off the coast of Sussex, nine miles south of Little Hampton, shows it to agree with some of the rocks in the greensand or Portland beds; and its thus belonging to the strata below the chalk falls in with the remark of its occurring between the parallels of disturbance which traverse the Wealden of Sussex on the north, and the Isle of Wight on the south; for these disturbances and other facts agree well with the notion of protruded strata between. The wealden strata themselves have been observed by Mr. Malcolmson, at Linksfield, near Elgin. It is remarkable, that these strata had already, very unexpectedly, been found by Messrs. Murchison and Sedgwick in the Isle of Skye.

I have also to notice Dr. Buckland's account of the discovery of fossil fishes in the Bagshot Sands at Goldworth Hill, near Guilford. As these fossils resemble those of the London clay, Mr. Lyell's opinion that the Bagshot Sands were deposited during the eocene period is strongly confirmed.

The freshwater beds of the Isle of Wight, which had already supplied specimens of some of the Pachydermata of the Paris basin, have furnished an additional supply of rich fossils, which have been examined by Mr. Owen. He has found them to contain bones of four species of Palæotherium, and two species of Amplotherium; also a jaw of the Chæropotamus, a fossil genus established by Cuvier; and another jaw closely resembling that of a Musk Deer, which Mr. Owen refers to the genus Dicobune, a genus also established by Cuvier upon the fossils of the Paris basin. Such discoveries, falling in with the conclusions obtained by the researches of previous philosophers respecting the tertiary period of the earth's history, and supplying what they left imperfect, cannot fail to give us great confidence in the results of those investigations, and to enhance our admiration of the sagacity which opened to us this path of discovery.

Dr. Mitchell gave an account of his attempts to trace the drift from the chalk and strata below the chalk, as it exists in the counties of Norfolk, Suffolk, Essex, Cambridge, Huntingdon, Bedford, Hertford, and Middlesex. This drift I had occasion to notice in my Address last year, in reference to Mr. Clarke's elaborate geological survey of Suffolk; and I then stated that this diluvial deposit is known in the neighbourhood of Cambridge by the name of *brown clay*. Dr. Mitchell has shown that this deposit is of greater extent than we were before aware. But still to determine with precision its principal masses, total extent, and local modifications, would be a valuable service to the geology of the eastern part of our island.

As my order requires me to take the igneous after the sedimentary rocks, I must here notice Dr. Fleming's "Remarks on the Trap Rocks of Fife," which he distinguishes into three epochs;—those of the eastern extremity of the oolites, which are variously associated with the old red sandstone;—those which run from St. Andrew's to Stirling, which were produced after the coal-measures;—and those which occur along the shores of the Forth, which occur in the higher coal-measures.

2. *Foreign* (*South European and Trans-European*) *Geology.*—

In the survey of the progress of our labours which I offered to your notice last year, I stated, that in proceeding beyond the Alps, and I might have added the Pyrenees, we no longer find that multiplied series of strata, so remarkably continuous and similar, when their identity is properly traced, with which we have been familiar in our home circuit. Yet the investigations of Mr. Hamilton and Mr. Strickland appear to show, that we may recognise, even in Asia Minor, the great formations, occupying the lowest and highest positions of the series, which are well marked by fossils, namely the Silurian and Tertiary formations; and also an intermediate formation corresponding in general with the Secondary rocks of the north, but not as yet reduced to any parallelism with them in the order of its members. Besides these sedimentary rocks, in this as in most other countries, there are found vast collections of igneous rocks of various kinds, which interrupt and modify, and may mask and overwhelm, the fossiliferous strata. A paper has been communicated to us by Mr. Hamilton, "On a part of Asia Minor," namely, the country extending from the foot of Hassan Dagh to the great salt lake of Toozla, and thence eastwards to Cæsarea and Mount Argæus, and thus occupying a part of the ancient Cappadocia.

It appears that in this district the igneous rocks occupy a large portion of the surface, and the sedimentary strata which are associated with these are not easily identified with those which occur in countries already examined. The district examined by Mr. Hamilton contains a limestone belonging to the vast calcareous lacustrine formation of the central part of Asia Minor, and beneath this, a system of highly inclined beds of red sandstone, conglomerates and marls, which are perhaps connected with the saliferous deposits of Pontus and Galatia; but which could not be satisfactorily compared with the beds of the south of Europe, for want of the occurrence of organic remains. In only one instance did Mr. Hamilton observe the trace of organic bodies in the sandstone: these were impressions resembling fucoids, and similar to those found in the Alpine limestone near Trieste. Mr. Hamilton ascended to the summit of Mount Argæus, which had not previously been reached by any traveller, which rises abruptly from the alluvial plain of Cæsarea to the height of 13,000 feet.

We have another contribution to the geology of the countries exterior to the Alps and Pyrenees in Mr. Sharpe's memoir on the geology of Portugal. He has examined with great care the neighbourhood of Lisbon, and has traced the superposition of the strata, naming the most conspicuous of them from the places in which they are well exhibited. His series (exclusive of igneous rocks) consists of San Pedro limestone (which rests upon the granite), slate clay and shale, Espichel limestone, red sandstone, hippurite limestone, a lower tertiary conglomerate, the Almada beds, and the upper tertiary sand. In the Memoirs of the Royal Academy of Sciences of Lisbon, for 1831, Baron Eschwege had examined a geological section taken across the mouth of the Tagus, and passing from the granite of the Serra of Cintra, to that of the Serra of Arrabida. But his identifications of the Portuguese beds do not agree with those of Mr. Sharpe, and have indeed the air of proceeding on the arbitrary assumption of a correspondence between this and other parts of Europe. Thus Baron Eschwege has referred both the San Pedro and the Espichel limestones to the magnesian limestone; the red sandstone formation he considers as Bunter Sandstein, while Mr. Sharpe refers it to the age of our Oolites: the hippurite limestone (now acknowledged to be the equivalent of our chalk and greensand) M. Eschwege makes to be Jura limestone; and the Almada beds he would have to be Plastic Clay and Calcaire Grossier. Mr. Sharpe is very properly attempting, by a further study of the organic fossils which he has procured, to confirm or correct the identifications to which he has been led. It is only by thus starting from different points, and tracing strata by their continuity, that we can hope to cover the map of Europe, and finally the world, with geological symbols of a meaning fully understood.

PALÆONTOLOGY.

The portion of our subject which we term Palæontology, might at first sight seem to form a part of zoology rather than of geology; since it is concerned about the forms and anatomy of animals, and differs from the usual studies of the zoologist only in seeking its materials in the strata of the earth's crust instead of upon its surface. Yet a moment's thought shows us how essential a part of our science the zoology of extinct animals is; for in order to learn the history of the revolutions which the earth has undergone, we must seek for general laws of succession in the remains of organic life which it presents, as well as in the position and structure of its brute masses. And since such general laws must necessarily be expressed in terms of zoology, it becomes our business to define those terms, so that they shall be capable of expressing truths which include in their circuit the past as well as the present animal and vegetable population of the world.

An example of this process has occupied a large portion of our attention during the past year. It appeared to be a proposition universally true, that the oldest strata of the earth's surface contained cold-blooded animals only; and that creatures of the class mammalia only began to exist on the surface after the chalk strata had been deposited and elevated. And when, to a rule of this tempting generality, a seeming exception was brought under our notice, it became proper to examine, whether the anatomical line, which enables us to separate hot-blooded from cold-blooded animals, had really been rightly drawn; and whether, by rectifying the supposed characteristic distinction, the exception might not be eliminated. The exception on which this very instructive point was tried, consisted in a few jaw-bones of a fossil animal, which, though occurring in the Stonesfield slate near Oxford, a bed belonging to the oolite formation, had been referred by Cuvier to the genus Didelphys, and thus placed among marsupial mammals. In August last M. de Blainville stated to the Academy of Sciences of Paris his reasons for doubting the justice of the place thus assigned to the fossil animal. Founding his views principally upon the number and nature of the teeth of the fossil, he asserted that the animal, if a mammal, must come nearest the phocæ; but he rather inclined to believe it a saurian reptile; following, as he conceived, the analogies offered by a supposed fossil saurian described by Dr. Harlan of Philadelphia, and termed by him Basilosaurus. M. Valenciennes, on the other hand, asserted the propriety of the place assigned by Cuvier to the fossil animal, although he made it a new genus; and gave to the species the name *Thylacotherium Prevostii.* The controversy at Paris had its interest augmented when Dr. Buckland in September carried thither the specimens in question. From Paris the controversy was transferred hither in November, and principally occupied our attention at our meetings till the middle of January.

One advantage resulting from the ample discussion to which the question has thus been subjected, has been, that even those of us who were previously ignorant of the marks by which zoologists recognise such distinctions as were in this case in question, have been put fully in possession of the rules and the leading examples which apply to such cases. And hence it will not I trust be deemed presumptuous, if, without pretending to any power of deciding a question of zoology, I venture to state the result of these discussions. It appears, then, that some of the marks by which the under jaws of Mammals are distinguished from those of Saurians are the following: (1) a convex condyle; (2) a broad and generally elevated coronoid process, (3) rising near the condyle; (4) the jaw in one piece; (5) the teeth multicuspid, and (6) of varied forms, (7) with double fangs, (8) inserted in distinct sockets, but (9) loose and not anchylosed with the jaw. In all these respects the Saurians differ; having, for instance, instead of a simple jaw, one composed of six bones with peculiar forms and relations, and marked by Cuvier with distinct names; having the teeth with an expanded and simple fang, or anchylosed in a groove, and so on. Of course, it will be supposed, by any one acquainted with the usual character of natural groups, that this line of distinction will not be quite sharp and unbroken, but that there will be apparent transgressions of the rule, while yet the unity of the group is indubitable. Thus the Indian Monitor and the Iguana, though Saurians, violate the *second* character, having an elevated coronoid process; but then it is narrow, and this seeming defect in our second character is further remedied by the third; for in those Saurians there is a depressed space between the condyle and the coronoid process quite different from that which a mammal jaw exhibits. Again, the teeth of Crocodiles, Plesiosaurs, and the like, are inserted in distinct sockets; but then they have not double fangs. The Basilosaurus was supposed to be a saurian with double-fanged teeth, but that exception was disposed of afterwards. And as there are thus saurians which trench upon the characters of mammals, there are mammals in which some of the above characters are wanting: thus the condyle is slightly or not at all convex in the Ruminantia; there is no elevated coronoid process in the Edentata; the Dolphin and Porpoise have not multicuspid teeth; the Armadillo has not varied forms of teeth, nor has it double fangs to its teeth, which also the fossil Megatherium has not. Still, upon the whole, the above appears to be the general line of distinction. Even if one or two of the above nine marks were wanting to prove the animal a mammal, still if the great majority of them were present, our judgment could not but be decided by the preponderance of characters. But if all the above characters of mammals are present, and all those of saurians absent, it seems to be a wanton scepticism to doubt that the animal was really warm-blooded.

Now it was asserted by Mr Owen, who brought this subject before us, that this is the case; that all the characters which I have enumerated above exist in the Stonesfield jaws. If we satisfy ourselves that this is the case, I do not see how we can avoid assenting to his opinion,—that the animal belonged to the class Mammalia.

Every such question of classification must resolve itself into two; that of the *value*, and that of the *existence* of the characters. If we assent to Mr. Owen in his view of the former, we are then led to consider the latter.

M. de Blainville, at least in his first examination, had laboured under the disadvantage of forming his judgments from casts and drawings only of the Stonesfield bones. Under these circumstances, he had denied several of the above characters; he had held that the teeth in the Thylacotherium are uniform; and that they are confluent with the jaw; and that the jaw is compound. These statements Mr. Owen, resting upon a careful examination of the specimens, contradicts. The assertion of the compound nature of the jaw is occasioned by a groove near the lower margin of the jaw, which however is not so situated as to represent the saurian sutures but is completely explained by supposing it to be a vascular canal, such as exists in the Wombat, Didelphys, Opossum, and similar animals.

Another specimen, at that time the property of Mr. Broderip, but now very properly placed in the British Museum, exhibits a jaw similar indeed to the Thylacothere, but belonging to a different genus; and to this species Mr. Owen has given the name *Phascolotherium Bucklandi.* Both these generic names imply that the animals are pouched animals; and in addition to the reasons which led Cuvier to this opinion, Mr. Owen has noticed in the fossils an inflection of the lower edge of the jaw, which, so far as has been hitherto observed, occurs in Marsupials, and in them alone.

As if this question had been destined to be settled at this time, the only remaining doubt with regard to the possible existence of double fangs in the teeth of a saurian was removed by the arrival in London of Dr. Harlan with his "Basilosaurus." That gentleman, with great liberality and candour, allowed sections of the fossil to be made in such a manner as to expose the structure of the teeth. And these being examined by Mr. Owen, and compared with the general laws of dental structure which he has lately discovered, it appeared that Dr. Harlan's fossil was by no means a saurian, but an animal nearly allied to the Dugong, to which Mr. Owen proposes to apply the generic name of Zeuglodon, expressing the conjoined form of its teeth.

I have not hesitated to lay before you the view of this subject to which I have been led by the discussions in which we have been engaged, notwithstanding the very great authorities which incline to the other side of the balance. Among these I hardly know whether I am to reckon Mr. Ogilby, who laid before us a very instructive communication, in which, without deciding the point, he pointed out the difficulties which appear to him to embarrass both views, and especially to contradict the opinion of the marsupial nature of the animal.

I have dwelt the longer on this controversy, since it involves considerations of the most comprehensive interest to geologists, and, we may add, of the most vital importance. For—*de summâ reipublicæ agitur*,—the battle was concerning the foundations of our philosophical constitution; concerning the validity of the great Cuvierian maxim,—that from the fragment of a bone we can reconstruct the skeleton of the animal. This doctrine of final causes in animal structures, as it is the guiding principle of the zoologist's reasonings, is the basis of the geologist's views of the organic history of the world; and, that destroyed, one half of his edifice crumbles into dust. If we cannot reason from the analogies of the existing, to the events of the past world, we have no foundation for our science; and you, Gentlemen, have all along been applying your vigorous talents, your persevering toil, your ardent aspirations, idly and in vain.

Besides the important investigations thus referred to, we owe to Mr. Owen other palæontological contributions. The genus *Chæropotamus*, established by Cuvier from an imperfect fragment of the bone of a skull, was asserted by him to be a Pachyderm most nearly allied to the Peccari. A fragment of a lower jaw of the same genus, found by Mr. Darwin Fox in the Isle of Wight, confirms this view, but indicates in some points an approach to the carnivorous type. And it was remarked as interesting, that the living genus of the hog tribe which most resembles the Chæropotamus, the Peccari, exists in South America, where the Tapir, the nearest living analogue of the Anoplothere and Palæothere, the associates of the Chæropotamus, also occur. Another jaw, found by Mr. Pratt in the Binstead quarries in 1830, and resembling that of the Musk Deer, Mr. Owen refers to a new species of Cuvier's genus Dicobune, under the name *Dichobune cervinum.* Mr. Owen has also given us a description of Lord Cole's specimen of *Plesiosaurus macrocephalus*, which he compares with Mr. Conybeare's *Plesiosaurus Dolichodeirus*, by establishing an intermediate species, founded upon a specimen existing in the British Museum, and termed by him *Plesiosaurus Hawkinsii.* Besides tracing the analogies which connect these with each other, and comparing them with the two great modifications of the saurian tribe, the crocodiles and the lizards, Mr. Owen presented his remarks on the form of the Plesiosaurian vertebræ, founding them upon a general view of the elements of which all vertebræ are constituted.

To the communications thus made to us, we may add Mr. Owen's determination of another animal, of which the remains brought from the neighbourhood of Buenos Ayres, are among the many treasures of this kind which we owe to Sir Woodbine Parish. This animal, of gigantic dimensions, appears to have been allied to the Megatherium, but with closer affinities to the Armadillos; and it probably possessed the characteristic armour, of which, in the Megatherium, the existence is perhaps problematical. Mr. Owen has termed it *Glyptodon*, from the furrowed shape of its teeth.

In another communication Mr. Owen endeavoured to account for the dislocation of the tail of the Ichthyosaurus at a certain point, which is observable in many of the fossil skeletons of that animal. This circumstance, so remarkable from its general occurrence, and which Mr. Owen was the first to observe, he is disposed to account for by supposing a broad tegumentary fin to have been attached to the tail for a portion of its length, the position of which fin must, he conceives, have been vertical.

I cannot close my enumeration of the valuable contributions for which we are indebted to Mr. Owen, without remarking how well our anticipations have been verified, when, in awarding him the Wollaston medal last year, we considered the labours which we thus distinguished as only the beginning of an enlarged series of scientific successes; and how well also Mr. Owen's own declaration, that he should lose no available time or opportunity which could be applied to palæontological research, has been borne out by the services he has rendered that branch of our science.

In the remainder of my review of what has been done among us in Palæontology I must necessarily be very brief. I have already mentioned the discovery of fossil fishes in the Bagshot sand. These fishes have supplied three new genera, which Dr. Buckland has distinguished and has named *Edaphodon*, *Passalodon*, and *Ameibodon*; of which the two first offer combinations of the characters of bony and cartilaginous fishes. Mr. Stokes has given us his views of the structure of the animal to which belonged those fossils with which we are so familiar under the name of Orthoceratites. He is of opinion, that these fossils, in their living condition, existed as a shell, enveloped within the body of the animal to which they belonged. He has distinguished three genera of these shells, to which he assigns the names *Actinoceras*, *Ormoceras*, and *Huronia*. The Marquis of Northampton also has examined those minute spiral shells which occur in the chalk and chalk flints, and have been termed Spirolinites. And, finally, under this head I must mention Mr. Alfred Smee's paper on the state in which animal matter is usually found in fossils.

Mr. Austen's hypothesis of the origin of the limestone of Devon, though belonging in some measure to Geological Dynamics, may perhaps be mentioned here, since he explains the position of those beds by reference to the habits of the coral animal. Mr. Austen has already shown himself to us as an excellent observer; and in constructing geological maps, a task requiring no ordinary talents and temper, he has earned our admiration. We shall therefore not be thought, I trust, to depreciate his labours if we receive with less confidence speculations in their nature more doubtful. As we can hardly suppose the calcareous beds of Devon to have had an origin different from those of other countries, we cannot help receiving with some suspicion a doctrine which would subvert almost the whole of our existing knowledge of the relations of fossiliferous beds of limestone.

GEOLOGICAL DYNAMICS.

In that part of geology which I have termed Geological Dynamics, and which investigates and applies those causes of change by which we may hope to explain geological phenomena, we may still observe that fundamental antithesis of opinion which has long existed on the subject;—the division of our geological speculators into *Catastrophists* and *Uniformitarians*;—into those who read in the rocks of the globe the evidence of vast revolutions, of an order different from any which those of man has survived;—and those who see in the condition of the earth the result of a series of changes which are still going on without decay, the same powers which produced the existing vallies and mountains being yet at work about us. Both these opinions have received their contributions during the preceding year: Mr. Darwin having laid before us his views of the formation of mountain chains and volcanos, which he conceives to be the effect of a gradual, small, and occasional elevation of continental masses of the earth's crust; while Mr. Murchison gathers from the researches in which he has been engaged, the belief of a former state of paroxysmal turbulence, of much deeper rooted intensity and wider range than any that are to be found in our own period; and M. de Beaumont, in France, has endeavoured to prove that Etna and many other mountains must have been produced by some gigantic and extraordinary convulsion of the earth. Both Mr. Darwin and M. de Beaumont refer to the same examples; and while M. de Beaumont conceives that the cones of the Andes must have been formed by an abrupt elevation, caused by subterranean force, Mr. Darwin has maintained the opinion, that these lofty summits have been gradually thrust into the place which they occupy by a series of successive injections of molten matter from below, each intruded portion of fluid having time to harden into rock before it was burst and again injected by the next molten mass. For how otherwise, he asks, can we conceive the strata to be thrust into a vertical position by a liquid from below, without the very bowels of the earth gushing out? Without attempting to answer this question, we may observe, that when we suppose, as Mr. Darwin supposes, a vast portion of the earth's crust, the whole territory of Chili for example, to rest on a lake of molten stone, there is considerable force in M. de Beaumont's argument:—that when such a fluid is raised to the top of a mountain ten or twenty thousand feet high, the pressure upon the crust which is in contact with the fluid must be more than a thousand atmospheres; and who, *he* too asks, flatters himself that he knows enough of the interior machinery of volcanos, to be certain that this vast pressure, acting upon a large surface, may not, by some derangement of its safety-valve, the volcanic vent, produce effects to which we cannot assign any limit?

In speaking of Mr. Darwin's researches I cannot refrain from expressing for myself, and I am sure I may add for you, our disappointment and regret that the publication of Mr. Darwin's journal has not yet taken place. Knowing, as we do, that this journal contains many valuable contributions to science, we cannot help lamenting, that the customs of the Service by which the survey was conducted have not yet allowed this portion of the account of its results to be given to the world.

Although not communicated to us, but to our Alma Mater the Royal Society, I may notice Mr. Hopkins's endeavours to throw light upon such subjects as this by the aid of mathematical reasoning. The researches of Mr. Hopkins respecting the effects which a force from below would produce upon a portion of the earth's crust, have already interested you, and would be of still greater value if the directions of faults and fissures which result from his theory did not depend very much upon that which in most cases we cannot expect to know, the form of the area subjected to such strain. Mr. Hopkins has since been employing himself in tracing the consequences of another idea, truly ingenious and philosophical, and which a person in full possession of the resources of mathematics could alone deal with. Some of the effects which the sun and moon produce upon the earth (as the precession and nutation,) include the attraction of those bodies upon the interior portion of the earth, and have hitherto been deduced from the theory by mathematicians, upon the supposition that the earth is solid. But what if the central portion of the earth were fluid? What if it appeared, by calculation, that the fluid internal condition would make the amount of the precession of the equinoxes, or of the nutation of the axis, different from that which the solid spheroid would give? What if it appeared that the precession and nutation thus calculated for a fluid interior agreed better with observation than the result hitherto obtained by supposing the earth solid? If this were so, we should have evidence of the earth's interior fluidity, evidence, too, of a perfectly novel and most striking nature. But to answer these questions is far from an easy task; the precession of the solid earth is a problem in which Newton erred, and in which the greatest mathematicians of modern times have not found their greatest strength superfluous. Yet how incomparably more difficult in all cases is the mechanics of fluid than of solid bodies! It may, therefore, require more than one trial before any satisfactory solution of the problem can be obtained. Mr. Hopkins has attacked it by the aid of certain hypotheses, and the result is, so far, not favourable to the decisiveness of this test of the interior condition of the earth; but notwithstanding this state of things, I venture to say on your behalf, Gentlemen, that an idea so full of promise of that which we so much desire, and which seems to be so utterly out of our reach, the knowledge of the condition of the centre of the earth,—that such an idea is not to be lightly abandoned*.

* The following are the results at which Mr. Hopkins has arrived, supposing the earth to consist of a homogeneous spheroidal shell filled with a fluid mass of the same density as the shell:—

1. The precession will be the same, whatever be the thickness of the shell, as if the whole earth were solid.

2. The lunar nutation will be the same as for the solid spheroid, to such a degree of approximation, that the difference would be inappreciable to observation.

3. The solar nutation will be sensibly the same as for the solid spheroid; unless the thickness of the shell be very nearly of a certain value, something less than one fourth the earth's radius, in which case this nutation might become much greater than for the solid spheroid.

4. In addition to the above motions of precession and nutation, the pole of the earth would have a small circular motion, depending entirely on the internal fluidity. The radius of the circle thus described would be the greatest when the thickness of the shell should be least; but the inequality thus produced would not, for the smallest thickness of the shell, exceed a quantity of the same order as the solar nutation; and for any but the most inconsiderable thickness of the shell, would be entirely inappreciable to observation.

Mr. Hopkins intends hereafter to consider the case of variable density.

M. Necker, of Geneva, offered an addition to the causes of convulsions of the earth, which are contemplated by our Geological Dynamics, in a paper in which he ascribed the earthquakes which took place in the southern provinces of Spain, in 1829, to the falling in of strata, the subjacent gypseous and saliferous masses being washed out by subterraneous currents. Without denying all influence to such a cause, we may observe that it does not appear likely that there would be thus produced, simultaneously, any greater effects than those which are known to have occurred from the falling in of unsupported mines; and these have never approached in their scale to any except the smallest earthquakes.

While geologists are thus looking in all directions for causes which may produce the phenomena which they study, it is natural that the powerful, but as yet mysterious influences of electricity should draw their attention. Mr. Robert Were Fox has endeavoured to show, that by voltaic agency, a laminated structure, and deposits of metal in cracks, resembling metallic veins, may be produced in masses of clay. The experiments are of an interesting kind, and it can hardly be doubted that voltaic agency had some influence in such cases as those described by Mr. Fox; although Mr. Henwood and Mr. Sturgeon have failed in attempting to reproduce his results, and although results much resembling these occur in cases where no electrical action is suspected. But we may remark that the conditions under which such voltaic effects are produced have not yet been attempted to be defined with any accuracy; and that till this is done, the reality of such agency can neither be verified nor applied to geological speculations.

A reflection which naturally offers itself upon this review of our recent career, is this:—that different portions of the science of geology advance with very different rapidity. Descriptive Geology is constantly and actively progressive: facts are accumulated by observers in every land; and though facts are, in truth, of no value, at least for any purpose of science, except so far as they are reduced to some classification, yet on the other hand, sound classifications are perpetually, almost necessarily, suggested, when observation is vigilant and persevering. Even if we at first express our facts in terms of a false classification, we find afterwards the means of translating them into the language of a true one. And the spirit of geological observation is so widely diffused, and so thoroughly roused, that I trust we need not anticipate any pause or retardation in the career of Descriptive Geology. I confess, indeed, for my own part, I do not look to see the exertions of the present race of geologists surpassed by any who may succeed them. The great geological theorizers of the past belong to the *Fabulous Period* of the science ; but I consider the eminent men by whom I am surrounded as the *Heroic Age* of geology. They have slain its monsters, and cleared its wildernesses, and founded here and there a great metropolis, the queen of future empires. They have exerted combinations of talents which we cannot hope to see often again exhibited, especially when the condition of the science which produced them is changed. I consider that it is now the destiny of geology to pass from the heroic to the *Historical Period.* She can no longer look for supernatural successes, but she is entering upon a career, I trust a long and prosperous one, in which she must carry her vigilance into every province of her territory, and extend her dominion over the earth, till it becomes, far more truly than any before, an universal empire.

Such are the prospects of Descriptive Geology ;—of the geology of facts and classifications. To our knowledge of causes we can look with no such certainty of its progress being steady and rapid; or rather, we are certain that the advance must be slow, and may be often and long interrupted. For it is not an advance, to suggest one or another hypothetical cause of change, without assigning the laws and amount of the change: it is hardly an advance even to calculate the results of our hypotheses on assumed conditions. To obtain by induction, from adequate facts, the laws of change of the organic and inorganic creation,—this alone can lead us to those discoveries which must form the epochs of Geological Dynamics. And we have yet to learn, whether man's past duration upon the earth, whether even that which is still destined to him, is such as to allow him to philosophize with success in such matters ;—whether, not individuals only, not a generation alone, but whether the whole species be not too ephemeral, to penetrate, by the unassisted powers of its reason, into the mystery of its origin :—whether man, placed for a few centuries on the earth as in a school-room, have time to strip the wall of its coating, and count its stones, before his Parent removes him to some other destination.

And now, Gentlemen, I approach the close of my task, and of the office which has imposed it upon me; an office which has been to me a source of unmingled gratification. The good opinion implied by your selection of me, the good opinion of such a body of men, was an occasion of sincere and earnest self-congratulation,—a self-congratulation hardly damped by my consciousness of an imperfect acquaintance with your science;—since I trusted that you, though not unaware of my defects, had judged that good will, and a disposition to look at the subject in its largest aspect, might in some measure compensate for them. And if I needed other grounds of satisfaction in the employment which I am thus bringing to its close, I might find them in the reflections I have just been led to make in the progress and prospects of the science with which you are concerned. For it has ever been one of my most cherished occupations, and will, I trust, long be so, to trace the principles and laws by which the progress of human knowledge is regulated from age to age in each of its provinces. To have had brought familiarly under my notice, in a living form, the daily advance of a science so large and varied as yours, has been, as it could not but be, a permanent and most instructive lesson;—perpetually correcting lurking mistakes, and suggesting new thoughts. And if, while I have looked at your science in this spirit, you have thought me worthy to be called to preside over your body for two years; and if, during that time, you have not repented of your choice, as I have not found my views inapplicable to the subjects which have come before you; I may, I would believe, find in this some ground for confiding in the trains of thought which have thus led me to such a position; and may hope that, however arduous be the task of framing a philosophy of science suitable to its present condition, and of using such a philosophy as a means of furthering knowledge in general, still, that in this task, to which our age is so manifestly called, I too may be a helper.

I trust that you will excuse these few words uttered with reference to my own peculiar pursuits, since these include yours also, and are my only claim to your indulgence. And now, Gentlemen, that I may trespass upon that indulgence no longer, I once more thank you in all earnestness and sincerity for your good opinion which placed me in this chair, and for the kindness and support which I have on all occasions received from you; and with my best wishes for your prosperity, and that of your science, I resign my office into abler hands.

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PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

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Feb. 27.—Lewis Llewelyn Dillwyn, Esq., F.L.S., of Burrows Lodge, Swansea, was elected a Fellow of this Society.

A paper was first read, entitled "An Account of Impressions and Casts of Drops of Rain, discovered in the Quarries at Storeton Hill, Cheshire," by John Cunningham, Esq., F.G.S.

The author commences by stating, that no person acquainted with Geology, can doubt of rain having fallen during remote ages of the world, because to its destructive and transporting powers many of the sedimentary strata must have owed their origin. He also observes, that the vast forests which flourished anterior to the era of the new red sandstone, and are now treasured up in beds of coal, could not have existed without abundant supplies of atmospheric waters. Mr. Cunningham refers likewise to Mr. Scrope's account of the permanent preservation of the effects of a shower, which fell on extremely fine ashes, thrown out by Vesuvius during the eruption of 1822. The drops of rain formed globules which resembled in shape and motion those produced by sprinkling water on a dusty floor; and the globules afterwards hardened into pellets, which accumulated, at the bottom of a slope in some places, into beds a foot or more thick; and they afterwards became so firmly agglutinated, that it required a smart blow from a hammer to break the mass.

The effects of rain described by Mr. Cunningham, are, however, of a kind entirely different from those produced on the ashes of Vesuvius. They were discovered by him in the sandstone quarries in which the footsteps of the Chirotherium were found*; and he was the first to assign their origin to the effects of rain. The under surface of two strata, at the depth of 32 and 35 feet from the top of the quarry, present a remarkably blistered or warty appearance, being densely covered by minute hemispheres of the same substance as the sandstone. These projections are casts in relief of indentations in the upper surface of a thin subjacent bed of clay, and due, in the author's opinion, to drops of rain. On one of the layers of clay, they are small and circular, as if produced by a gentle shower; on the other, they are larger, deeper and less regular in form, indicating a more violent operation,

* See the Memoir by the Committee of the Natural History Society of Liverpool, p. 12.

possibly accompanied by hail. On the surface of these layers of clay there are also impressions of the feet of small animals, which appear to have passed over the clay either during the showers or not long before, as the footsteps are indented by the drops of rain, but to a less degree than the untrodden parts, in consequence, the author conceives, of the pressure which the clay had undergone beneath the feet of the animals. Ripple marks are exhibited also on the surface of many sandstone strata in the same quarries; and the rain marks as well as the sharpness of many of the footsteps prove, that the clay was not covered by water during the shower, or while traversed by the animals; and Mr. Cunningham, therefore, is of opinion that the conditions necessary to the preservation of such impressions, particularly of the rain drops, would be a return of water over surfaces which had been left uncovered during an interval too short for the desiccation of the laminæ of clay before the shower fell; and which were sufficiently soft to receive the impressions, as well as tenacious enough to retain them, until the return of the water which filled the prints with sand. Another condition is, that the velocity of the water charged with the sand was not sufficient to overcome the tenacity of the clay, or disturb the impressions of the rain drops. The author adds, that Dr. Buckland has suggested to him, that the interval between the rise and fall of tides over extensive sandbanks, the surface of which was between the level of high and low water, might have afforded daily occasions for the fulfilment of all the conditions; and that it is not easy to explain the alternate exposure to air and submersion under water without appealing to the flux and reflux of tides.

An extract was then read from a letter addressed to Dr. Buckland, by John Taylor, jun., Esq., F.G.S., on a slab of sandstone, exhibiting footmarks, and supposed to be from the Kelsall quarry, at the foot of Delamere Forest, but now in a pavement in the house of Mr. Potts, of Chester.

A letter was next read, addressed to Dr. Buckland by Sir Philip Grey Egerton, Bart., M.P., F.G.S., respecting the same slab; and accompanied by a tracing of the foot-marks, by Miss Potts.

When the slab was first laid down, there were no indications of the footsteps, and Sir Philip Egerton explains, in the following manner, their origin in a homogeneous stone and subsequent development. The weight of the animal on the soft sand compressed the yielding materials in the vicinity of the foot, and the print having been filled with sand, the stone, on becoming indurated, would present a nearly uniform texture. The action of the weather, on the flag being exposed, would remove the softer portions of the surface, and the denser parts surrounding the impressions of the feet, would resist the same operation, and present in relief the outline of the foot.

The flag contains the prints of three hind and two fore feet, the latter bearing nearly the same proportions to the former as in the other species, but Sir Philip Egerton could not make accurate measurements, because the markings are not all on one plane; the length of the stride he was also unable to determine, in consequence of the impressions in the same line being all of the right foot. There are distinct marks of claws on several of the toes.

A paper was next read, "On the occurrence of numerous Swallow Holes, near Farnham; with some observations on the drainage of the country at the western extremity of the Hog's Back," by George Long, Esq., and communicated by C. Lyell, Esq., V.P.G.S.

Farnham stands at the foot of the chalk hills, upon a deep bed of loam, which appears to overlie the gault. Upon the chalk, immediately to the north of the town, is the castle, beyond which the tertiary strata commence and rise to a considerable height, forming the great mass of hill known by the name of Farnham Beacon, Tunbury, or the Lawday House. On the north side, this hill presents, for the greater part, an abrupt precipice, under which several streams are thrown out; but on the south there are landsprings only, which occupy the gullies for the greater portion of the year, and occasionally become formidable torrents. These rivulets pour down the tertiary clays until they arrive at the chalk, where they plunge into the ground and disappear, except during very heavy rains, when the surplus waters are carried off by gravely channels in the chalk.

The principal object of the paper is to describe the seven swallow holes between Clear Park and Farnham Park, and a minute account is given of each. They occur in Clear Park—Lower Old Park Gully—Clay-pit Gully—near the Potter's Clay-pit—in the Hop-grounds, above the turnpike a little west of the Odiham-road—near the entrance of the pleasure ground in Farnham Park—and near the end of the avenue at the east of Farnham Park. The water absorbed by the holes in Farnham Park is supposed to reappear at the Bourne-Mill-stream; and though soft where it sinks into the chalk, it is hard and unfit for use, where it again breaks forth. The existence of underground currents was further proved by a well sunk at Hale Farm, which gave the following section:

Sand and gravel	6 feet.
Clay (potters')	15 or 16.
Sand and gravel	20.
Clay (potters')	14 or 15.
Clay, blue (London?) lowest 2 feet a green sand	24.
Hard chalk	20 or 30.

At that depth a spring was reached, which was supposed to be the Bourne-Mill-stream, and the instrument went down rapidly many fathoms, through a chalk mud. The well-sinkers afterwards came upon chalk with many flints, and finally breaking their instrument, left 80 feet of it in the earth, having bored altogether to a depth of 176 feet.

The green-sand tract, described in the second part of the memoir, and drained by a stream which flows northward through a gap in the chalk at Runfold into the London basin, is bounded on the north by the straight line of the Hog's Back, and on the south by a semi-circular range of the low hills extending from Seale on the east by Crooksbury Hill to Moor Park on the west. The surface of the tract being sandy and naturally bibulous, the proprietor of the farm has rendered it more retentive by a system of marling, and the rain water being consequently less absorbed than formerly, it is collected in an excavation called White-ways End Pond, at the western end of the Hog's Back. From this pond a small stream flows towards Runfold, and passing thence across the depressed chalk, continues its course to the county stream, or Blackwater river, receiving apparently a small augmentation from a spring at Andrew's hop-kiln. This gap in the chalk at Runfold, not having been hitherto noticed by geologists, Mr. Long conceives, that it deserves to be recorded among the apertures of the North Downs.

An extract was last read from a letter addressed to Mr. Lyell by Capt. Charters, F.G.S., and dated Cape Town, Nov. 12, 1838.

During an extensive tour through the colony, Capt. Charters's attention was drawn to a vast deposit of greenstone, overlying the horizontally stratified sandstone which occupies so large a portion of Southern Africa. The following localities are mentioned in the letter. A hill close to Fort Beaufort, on the Kaffir frontier. The banks of the Great Fish River, near the small town of Cradock, in the neighbourhood of which quantities of spherical masses of trap are heaped together, the surrounding sandstone mountains being of considerable elevation, and having their flanks and sometimes their tops very frequently covered with loose fragments of trap. On the right bank of the river and about a mile from the town, is exhibited a section, consisting in the lowest part of inclined strata of clay slate, in the middle of horizontal beds of sandstone, and in the uppermost of masses of trap. The same geological structure prevails in passing through the Tanka district, behind the Winterberg range to Shiloh, and thence to Colesberg, near the Orange river. From Colesberg, Captain Charters proceeded to Graf Keynet by the Schneeberg, and he found that the only variation in the nature of the country, consisted in a considerable diminution of the quantity of greenstone. The left of a narrow gorge through which the Sunday river passes, presents an abrupt precipice 300 feet high and as many yards long, composed of columnar greenstone resting at its foot on horizontal strata of sandstone.

March 13.—Major George Walker Prosser, Cambridge Terrace, Regent's Park; William Sanders, Esq., Park Street, Bristol; William Marshall, Esq., M.P.; and Robert Blagdon Hale, Esq., M.P., Alderly Park, Gloucestershire; were elected Fellows of this Society.

A paper on the geology of the North Western part of Asia Minor, from the peninsula of Cyzicus, on the coast of the sea of Marmara, to Koola, with a description of the Katakekaumene, by William John Hamilton, Esq., Sec. G.S., was read.

The memoir is divided into two parts, the first containing an account of the country between Cyzicus and Koola, the second a description of the Katakekaumene.

The line of route taken by Mr. Hamilton from Cyzicus, ascends the valley of the Macestus to the sources of that river near Simaul, then crosses the Demirji chain, and afterwards passes through Kars-kieui and Selendi to Koola, in the Katakekaumene, the whole distance being about 170 miles. The principal leading feature of the district is the Demirji chain reaching from Pergamum on the west, to the lofty mountain of the Ak Dàgh or Shapkhana Dàgh on the east, and it is prolonged in that direction by a lofty range which extends E.S.E. to Morad Dàgh, south of Kutàhiyah, and thence by Aiom Karahissar to Sultan Dàgh, an extension of one of the chains of Mount Taurus, so that the Demirji range forms a portion of the central axis of Asia Minor. The country traversed by Mr. Hamilton is also intersected by numerous hills, some of which exceed 1200 feet in height. The lake of Maniyas is another marked feature in the district. The formations of which the country is composed, are,—1, schistose rocks with saccharine marble; 2, compact limestone resembling the scaglia of Italy and Greece; 3, tertiary sandstones; 4, tertiary limestones; 5, granite; 6, peperite; 7, trachyte; 8, basalt. Between Kespit and the Demirji chain is a deposit of white marl, which Mr. Hamilton is of opinion, was accumulated in an ancient lake drained by some of the igneous operations which dislocated the horizontal tertiary limestone, and formed the traverses in the high hills between Kespit and Susugerli.

1. The schists are composed of gneiss, mica slate, and clay slate, and they are associated with crystalline limestone. Argillaceous schists and marble occur between Cyzicus and Erdek; and thickly wooded hills, 1000 feet in height, which rise abruptly from the shore of the sea of Marmara, are capped by a fine marble. A little further eastward are extensive quarries of the same stone, to which Cyzicus was partly indebted for having been ranked among the most splendid cities of antiquity. The limestone is interstratified with indurated marls and shales of various colours; the whole dipping from 70° to 80° S.E. by S.: and near Erdek S.W., or in each instance from the granitic nucleus of Cyzicus. Similar schists occur in the Demirji range, and in the Katakekaumene, associated with limestone.

Between the 33rd and 34th miles from Simaul towards Koola, is a low ridge of hills of saccharine limestone, rising above the plateau of horizontal limestone, and belonging to the same formation as the hills about Koola. In the Katakekaumene, the older system of volcanic cones is situated on these schists, and the newer in the adjacent alluvial plains, an important distinction accounted for in the description of that district.

2. *Compact Limestone* resembling the scaglia of Italy and Greece occurs only south of the lake of Maniyas, and at the foot of the range of hills near the town of the same name. It is associated with beds of shale. A micaceous sandstone, which forms a range of broken and

water-worn hills between Mülverkieui and the valley of the Susugerli or Macestus, is considered by Mr. Hamilton, to be perhaps of the age of this limestone, as well as the high and broken range of hills between Ildij and Kespit.

3. *Tertiary Sandstones.*—This formation is very extensively developed, and consists of micaceous sandstones, sands, marls, and shales. No organic remains were noticed in it by the author. It ranges southward from the village of Susugerli for about two miles. At the eastern extremity of the Demirji chain, where it was traversed by Mr. Hamilton, thinly laminated micaceous sandstone rests against the granitic nucleus, and extends thence to the South for nine miles. This formation is also exhibited about 16 miles from Simaul, underlying irregularly and conformably the peperite, and at the 18th mile the junction between the peperite and the sandstone is well exhibited. The lower volcanic beds are contorted, and consist of large masses and boulders of primary, igneous, and scoriaceous rocks; the beds, however, gradually become finer in the ascending order, and nearly horizontal in their position. In the sandstone the author noticed no fragments of volcanic matter. At the 19th mile, however, there appears to be a gradual passage or interstratification between the upper beds of the sandstone and the lower beds of the peperite. The sandstone and peperite extend along the valley of the Selendichai, and the former constitutes the hills between the valleys of the Selendi and the Hermus, and is capped by the white limestone. The beds throughout the country are nearly horizontal, except where they have been disturbed by igneous rocks.

4. *Tertiary Limestone.* This deposit Mr. Hamilton considers as belonging to the great lacustrine formation which occupies so large a portion of Asia Minor, but within the range of country described in this paper, it appears to be destitute of organic remains. It presents table lands composed of beds of white, compact, or thinly laminated limestone resembling chalk, and sometimes containing nodules of opaque white flints, and sometimes extensive beds of tabular flint. Near Kespit it is chalky, as well as 8 miles further south. It forms the hill on which stands the castle of Bogaditza, at the south-eastern extremity of the plain of the same name. South of the Demirji chain, and about eleven miles from Simaul, a white limestone overlies peperite, and a few miles further, rests upon trachyte. About the 19th mile, trachytic conglomerate overlies horizontal beds of white marl irregularly associated with beds of quartz pebbles. Between the valleys of the Selendi and the Hermus white limestone rests upon the micaceous sandstone, the volcanic products having thinned out. About the 35th mile, in the bottom of a ravine, Mr. Hamilton noticed the following section:

Lowest part, gravel and loose beds of sand	30 feet.
Alternations of marls and sands, the former predominating in the upper part	20 do.
White marl	5 to 6.

Mr. Hamilton believes that the last bed passes into the white limestone. The hill above the ravine is capped by basalt in some places 100 feet thick, but a stratum of sand is occasionally interspersed between the limestone and the basalt. South of the Hermus an insulated patch of limestone is also overlaid by basalt, and around its base are lava streams which have flowed from the volcanic cones near Koola. The lower part of this patch of limestone is converted into a yellow jasper-looking substance, with a bright conchoidal fracture.

5. *Granite* occurs near Cyzicus, where it is a finely grained, gray rock, which decomposes rapidly; but it contains large masses of hornblende, and is sometimes traversed by veins of felspar. It throws off the adjacent schistose rocks, which dip from it in opposite directions. Granite apparently forms also the axis of the Demirji range.

6. *Peperite.*—This deposit is extensively developed in many parts of Asia Minor. It is distinctly stratified, but it has sometimes a crystalline or vitreous aspect, and contains crystals of hornblende as well as much glassy felspar. Within the range of Mr. Hamilton's route it occurs about $2\frac{1}{2}$ miles south of the village of Susugerli; also 9 miles south of Simaul: and a little further the author obtained the following descending section:

1. Hard volcanic tuff, slightly crystalline, but containing many boulders and pebbles of trap, with numerous concretions of green marl, 12 feet.
2. Soft whitish volcanic earthy tuff, containing small fragments of pumice, 10 feet.
3. Hard crystalline but stratified rock.

About the 11th and 12th miles from Simaul, peperite is overlaid by a white limestone; between the 15th and 16th it rests upon protruded masses of decomposing trap or syenite; and half a mile further a mass of trachytic or trap conglomerate, forming the point of separation of two valleys, has been raised up subsequent to its deposition by a protrusion of trap, as the conglomerate, which is much contorted, adheres to the side of the trap; and near the 16th mile, it is underlaid by the micaceous sandstone.

The beds are occasionally horizontal, but where the peperite has been affected by the trachyte, they are variously inclined.

7. *Trachyte and Trachytic Conglomerate.*—Several varieties of this rock occur within Mr. Hamilton's district. The points more particularly mentioned are, one mile south of Kespit, where it forms a ridge of hills; the village of Kalburja, 7 miles S.W. of Kespit; also near the town of Bogaditza, whence a high trachytic range extends for a considerable distance east and west, succeeded by a less elevated district of the same rock, which continues beyond Singerli to the foot of the Dimirji mountains. In this district the trachyte varies greatly in colour, is generally soft, decomposes easily, and the author was often unable to decide whether it was an aqueous deposit of volcanic sand, or a subaqueous igneous rock. To the east of Singerli is a large mass of red porphyritic trachyte, considered by Mr. Hamilton to be a coulée which has flowed from the high rugged hills to the south-east. The trachytic rocks continue up the valley of Macestus for several miles. It is also extensively developed south of

the Demirji chain between Simaul and Koola, particularly about the 13th or 14th mile from the former, and is overlaid by white limestone. About the 19th mile, in some places, cliffs of trachytic conglomerate rest upon the peperite, and in others the trachytic conglomerate overlies horizontal beds of white marl belonging to the white limestone, and interstratified as before stated, with irregular beds of quartz pebbles.

8. *Basalt* is exposed south of the Demirji chain at several places, but more particularly near and in the Katakekaumene.

A spur of porphyritic trap occurs about two miles south of Susugerli.

Hot Springs burst forth in great force about $7\frac{1}{2}$ miles east of Singerli. Their temperature is supposed by Mr. Hamilton to be equal to that of boiling water. Extensive depositions, in one part 8 or 10 feet thick, occur around the mouths of the springs; and a strong sulphureous smell accompanies the emission of the water; but where the temperature had become sufficiently low to permit the water to be tasted, no peculiar flavour was perceived. After flowing a mile and a half and turning several mills, the water is used for a warm bath. The rock from which the springs rise, is a greenish brown porphyritic trap. Some copious hot springs issue near the lower beds of the tertiary white limestone, a little north of Koola, the temperature varying from 123° to 137° Fahr. Two of them are situated in the centre of the ruins of an unknown ancient city. Mr. Hamilton perceived a slight development of sulphuretted hydrogen gas.

The Katakekaumene.—The extent of this interesting tract is much less than is assigned to it in published maps, being not more than 7 miles from north to south, and 18 or 19 from east to west. After alluding to his first visit to it in company with Mr. H. E. Strickland, and refering to that gentleman's account of a portion of the district*, Mr. Hamilton describes minutely the two systems of volcanos, distinguished by the state of preservation of the craters and of the coulées: he defines also the course of each lava-current, and points out its attendant phenomena—but these details admit of only partial abridgement.

The volcanic products are basalt, lava, and ashes, the first being confined to the more ancient craters, and the last to the more modern. The numerous older cones are further distinguished by being situated on parallel ridges of gneiss and mica slate, and the newer, only three in number, by being confined to the intervening alluvial valleys. This important distinction Mr. Hamilton explains on the supposition, that the elevation of the schistose ridges produced cracks, through which, as points of least resistance, the first eruptions of lava found vent; and that these openings becoming subsequently plugged up, by the cooling of injected molten matter, the schists were rendered so solid, that when the volcanic forces again became active, the lines of least resistance were transferred to the valleys.

* Proceedings, vol. ii., p. 425.

The coulées from the ancient craters appear to have been partly under water, as their surface is, in some places, covered with sediment and turf; but the lava streams from the modern are bare, rugged, and barren, and the craters are surrounded by mounds of loose scoriæ and ashes. In addition to the comparative view given by Mr. Strickland of the phenomena of the Katakekaumene and Central France, Mr. Hamilton enters into a more extended investigation of points of resemblance, including other portions of Asia Minor. The great volcanic groups of Mont Dore, the Cantal, and Mont Mezen, Mr. Hamilton conceives are represented by Ak Dàgh, Morad Dàgh, the trachytic hills east of Takmak, Hassan Dàgh, and Mount Argæus. The modern volcanic period of Central France he compares with the Katakekaumene, as respects the composition of the lavas, their arrangement at different levels, and the cones being scattered, not collected in great mountain masses. The Katakekaumene, in Mr. Hamilton's opinion, exhibits also additional evidence, that the disposition of comparatively recent volcanos is coincident with the strike of the granitic axis, from the interior of which the volcanos have burst forth. The author also alluded to other comparative phenomena noticed in Mr. Strickland's paper. Lastly, he pointed out two distinctions :—in Central France streams of igneous products may be traced from the most ancient volcanic masses of Mont Dore, but in Asia Minor none have been detected which could have flowed from Ak Dàgh, or Morad Dàgh. In France, also, trachytic eruptions occurred during the deposition of the lacustrine limestone; but in the Katakekaumene, they appear to have preceded that of the white limestone, or are associated with only its lowest beds.

In conclusion, the paper gives a general summary of the geological phenomena of the country south of the Demirji range.

The relative antiquity of the vast lake or sea in which the strata were deposited, cannot be determined, as the micaceous sandstone forming the lowest series of beds is apparently destitute of organic remains, and Mr. Hamilton, therefore, does not attempt to compare that deposit with any European formation. The sandstone, he conceives, was accumulated upon an irregular surface of schistose rocks and crystalline limestone, and before the elevation of the Demirji chain. Upon the sandstone were deposited in the north of the district the beds of peperite, derived probably from subaqueous volcanos; and upon the peperite and the micaceous sandstone, the white limestone, which is the highest sedimentary rock. The drainage of the lake, he is of opinion, took place during the earliest volcanic eruptions of the Katakekaumene.

Three well-defined periods of igneous operations may be traced. The first is marked by the masses of basalt which cap some of the plateaux of white limestone, and were ejected previously to the country assuming its present configuration, and to the formation of the valleys. Mr. Hamilton considers that the basalt flowed under water, and probably but a short time before the drainage of the lake.

The second period is characterized by the currents of basalt and lava from the ancient system of volcanos in the Katakekaumene, and was subsequent to the formation of the present valleys, as many of the lava streams may be traced into them. The coulées which flowed towards the Hermus from the crater or Karadevit near Koola, present an inclined plane, the surface of which is not more than 150 or 200 feet above the present bed of the river; but they must, at one period, have been under water, as the lava is covered with a sediment which fills its crevices and smooths its asperities.

The third period belongs to the more modern system of cones, the lava of which is as rugged and barren as the recent coulées of Etna and Vesuvius. Of the date of these eruptions, Mr. Hamilton offers no opinion, merely remarking that the craters are mentioned by Strabo, and that there is no tradition of their activity.

March 27.—William Harris, Esq., of Charing, Kent; Rev. Robert Norgrave Pemberton, of Church Stretton, Shropshire; Rev. Alexander Thurtell, A.M., Fellow of Caius College, Cambridge; and Searles Valentine Wood, Esq., of Bernard-street; were elected Fellows of this Society.

A paper was read by Prof. Owen, F.G.S., entitled a "Description of a Tooth and part of the Skeleton of the Glyptodon, a large quadruped of the Edentate order, to which belongs the tessellated bony armour figured by Mr. Clift in his memoir on the remains of the Megatherium, brought to England by Sir Woodbine Parish, F.G.S."

The first notice of the remains of a fossil large edentate Mammal associated with a tessellated bony armour, is an extract from a letter addressed by Don Damario Larrañaga, Curé of Monte Video, to M. Auguste St. Hilaire, and appended to Cuvier's account of the Megatherium in the Ossemens Fossiles, t. v. p. 179. (1823). The bones were discovered near the surface in alluvium, in the Rio del Sauce, a branch of the Saulis grande, and consisted of a femur 6 to 8 inches in width, but short, and in every respect like the femur of an Armadillo; also a portion of a tessellated bony armour. The tail is described as very short and very stout, and to have had a bony armour, which was not verticellate or disposed in rings. Similar fossils are said to occur in analogous strata near the lake Mirine, on the frontier of the Portuguese colonies. The notion that the remains found in the Rio del Sauce belonged to the Megatherium, rests solely on the circumstance of Don Damario Larrañaga having inserted the word Megatherium as the synonym of his gigantic fossil "Dasypus." Je ne vous écris point sur mon Dasypus, (*Megatherium*, Cuvier.)

The next observations bearing upon the present subject are contained in Weiss's Geological Memoir on the provinces of San Pedro do Sul, and the Banda Oriental, (Berlin Trans., 1827). These remains consisted of part of a femur of a Megatherium, without any associated armour, found at a deserted Indian camp near the Queguay, a tributary of the Uruguay; of portions of osseous tessellated armour, apparently unaccompanied by bones, discovered on the Arapey chico, in the province of Monte Video; and of bones of the extremities and fragments of armour found near the Rio Janeiro. The whole of these remains were collected by Sellow, the Prussian traveller, and after his death the last-named collection of bones and armour were submitted to Prof. D'Alton, by whom they have been described, (Berlin Trans., 1833,) and who states, that they are not the remains of the Megatherium, but of a large edentate animal more nearly allied to Dasypus.

In 1832, Mr. Clift laid before the Geological Society a memoir on the remains of the Megatherium brought to England from Buenos Ayres by Sir Woodbine Parish. In the collection of which they formed a part, were fragments of bony tessellated armour, one of which was figured but not described by Mr. Clift, because the fragments were not associated with the remains of the Megatherium; there were also a portion of a jaw and several other bones, which were found in connexion with portions of a bony armour in the bed of a rivulet at Villaneuva, about 95 miles south of Buenos Ayres. On the examination of the last-mentioned remains when they first arrived in England, it was evident both to Mr. Clift and Mr. Owen, particularly from the conformation of the alveoli in the jaw, that the bones did not belong to the Megatherium; and that the dentition of the extinct species differed more widely from that of the existing subgenera of Armadillos than the respective dental characters of the latter differ from each other. As the portions of the skeleton were not sufficient to enable Mr. Clift to determine satisfactorily the characters of the animal, no account of them was given in his memoir on the Megatherium, but they form the subject of Mr. Owen's paper, of which this is a notice. Soon after the arrival of Sir Woodbine Parish's collection, the College of Surgeons had casts made of the bones, and presented them to different museums, including the Jardin du Roi, where they were examined by M. Laurillard and Mr. Pentland. These naturalists also concluded, especially from the bones of the foot, that the remains were not portions of the Megatherium, but of a gigantic Armadillo.

More recently, Sir Woodbine Parish received an account of the discovery, in the bank of a rivulet near the Rio Matanza, 20 miles south of the city of Buenos Ayres, of a perfect skeleton and bony covering, and with the description, he also received a fragment of a tooth and a drawing of the animal. On examining the tooth, Mr. Owen found, that it belonged to an animal referable to the Edentata of Cuvier, but indicative of a new sub-genus of the Armadillo family; and for which he proposed the name of *Glyptodon*, in reference to the sculptured character of the tooth. Subsequently, he compared the tooth with the alveoli in the fragment of the jaw in Sir Woodbine Parish's collection; and he found that the peculiar longitudinal ridges in the sockets precisely corresponded with the flutings in the tooth itself, whereby he was enabled to prove, that the bones discovered with the tessellated coat of mail at Villaneuva appertained to the same species as the more perfect skeleton and cuirass found near the Rio Matanza.

Judging from the drawing transmitted to Sir W. Parish, the Glyptodon differs from the Megatherium not only in the form and structure of the teeth, but in the number, which appears to be eight on each side of each jaw; and from all known Armadillos in the form of the lower jaw, as well as in the presence of a long process descending from the zygoma, in both which respects it resembles the Megatherium. According to the same figure, the tail was protected by a narrow bony covering on the upper surface only, and was not encompassed by it as in the Armadillos.

Mr. Owen then proceeds to describe the remains of the Glyptodon which have arrived in England. The molar tooth is only a fragment, but the grinding surface and upwards of an inch of the crown are perfect, the whole length being about two inches. There is no indication of a diminution in any of its diameters from the grinding surface to the opposite end, and the alveoli in the fragment of the jaw terminate abruptly without any contraction. The teeth are more compressed than those of the Megatherium, and differ from them in intimate structure, resembling in this respect the teeth of the Armadillos. From all known Armadillos, the Glyptodon, however, is distinguished by the tooth having on both the outer and inner surfaces two deep grooves, each extending from the opposite sides about one third of the transverse diameter of the tooth and through its whole length, dividing the grinding surface into three portions, joined together by the contracted isthmus interposed between the opposite grooves. The teeth thus exhibit a more complicated form than those of any known Edentate, and seem to indicate a transition from that family to the Pachydermal Toxodon.

The fragment of the jaw discovered at Villaneuva consists of a portion near the extremity of the left ramus, and includes three alveoli, which slightly increase in size as they are placed further back.

The humerus, of which the distal half has been received, agrees most nearly with that portion of the humerus of the Dasypus, but the internal condyle is not perforated; the depressions also above the trochlea, both in front and behind, are relatively deeper, and in the side opposite the deltoid trochanter there is a rugged raised surface for a muscular insertion, of which Mr. Owen has not perceived anything analogous in the Armadillos. From the humerus of the Megatherium it differs in not presenting the extraordinary expansion of the distal extremity exhibited in that animal; but the internal condyle in the Megatherium is also imperforate.

The radius of the Glyptodon corresponds very nearly with that of the Armadillo, but it differs from the radius of the Megathere in being three times less in every dimension, and by well-marked differences in all the details of structure.

The ungueal phalanges of the Glyptodon approach most nearly those of the species of Dasypus; but in their shortness, as compared with their breadth and depth, they resemble still more the ungueal phalanges of the Pachyderms. Mr. Owen is of opinion that they were encased in strong, short, hoof-like claws; and that they exhibit rather the base of an anterior column of support to an animal clad in a ponderous cuirass than instruments especially designed for scratching or digging. There cannot be a greater contrast than is presented between the short, broad, and flat phalange of the Glyptodon, and the long and compressed claw-bone of the Megatherium.

Of the posterior extremity of the Glyptodon, the tibia, which is anchylosed to the fibula, presents the structure characteristic of the tibia of the Armadillos; while in the Megathere the corresponding bones deviate widely in their proportions, and in the conformation of the distal articular surface from those of the Glyptodon. The conformation of the astragalus, calcaneum, the cuboid, scaphoid, and internal cuneiform bones, also of the metatarsals of the three middle and largest toes, the three phalanges of the second and middle, and the distal phalanges of the third and fourth toes, were described in great minuteness, but it is not possible to abridge the details.

Mr. Owen, however, stated that when the bones of the hinder extremity are arranged in their natural juxta-position, they present a foot of such singular proportions as to be without a parallel in the animal kingdom. The nearest approach to its broad, thick, short, and massive proportions is made by the skeleton of the fossorial extremity of the Mole; but it is the fore foot only of this animal that can be compared in the compressed figure of the metacarpals and proximal and middle phalanges with the singular hind-foot of the Glyptodon. The hind foot of the Mole resembles in the lengthened metatarsal and phalangeal bones that of the existing Armadillos, and the generality of quadrupeds. The true structure of the hind foot of the Megatherium is not known, but in the terminal phalanges it differs most widely from those of the Glyptodon. In the former, the compressed lengthened shape is as extreme in the claw-bones as, in the latter, is the depressed, shortened figure. In the Glyptodon, the hind foot, like the fore, appears to be expressly modified to form a base to a column destined to support an enormous superincumbent weight; while in the Megatherium the toes were free to be developed into long and compressed claws, such as form the compensating weapons of defence of the hair-clad Sloths and Ant-eaters. The ungueal phalanges of the Armadillos, in their shorter, broader, and flatter form, make a much nearer approach to those of the Glyptodon; and it may be readily admitted that the hind foot of the Glyptodon is an extreme modification of the same general plan of structure as that on which the foot of the Armadillo is constructed; but if the differences in the tarsal bones (described in the paper) exceed those which are traceable between one species of Armadillo and another, *a fortiori*, the antero-posterior compression of the metatarsals and phalanges, and the total suppression in those of the ginglymoid trochlear articulations are indicative of a difference of general habits, as great as is usually observed in animals of distinct but nearly-allied genera. Thus both the dental modifications and the locomotive organs prove that the Glyptodon cannot be called an Armadillo without making use of an exaggerated expression; still less can it be considered a species of Megatherium; but it offers the type of a distinct genus, which is much more nearly allied to the Dasypodoid than to the Megatherioid families of Edentata. For this genus Mr. Owen had proposed a name indicative of its dental peculiarities, and, as the present species agreed with the Armadillos in its dermal armour, he preferred the name of *Glyptodon clavipes*, in relation to the peculiar modification of the foot.

Mr. Owen then showed that the portions of tessellated armour described and figured by Weiss are identical in structure with those brought to England by Sir Woodbine Parish, and that the bones which were found with the armour in both cases belonged to animals specifically identical. He next entered upon the inquiry, Had the Megatherium a bony armour? and he concluded from a comparison of its skeleton with that of the Armadillos, that it had not. In the pelvis of the Armadillo there are twelve sacral vertebræ anchylosed together, and the spines of the vertebræ are greatly developed antero-posteriorly, forming a continuous vertical ridge of bone, bearing immediately the superincumbent weight. In the Megathere the sacral vertebræ are only four in number, and are not anchylosed, and the spinous processes are comparatively small, not locked together, as in the Armadillos, but separated by intervals as in the Sloths. In the Armadillos, the weight of the cuirass is transferred from the sacrum to the thigh-bones by two points on each side. One of them, the ischium, is anchylosed to the posterior part of the sacrum, the other point is formed by the conversion of the iliac bone into a stout three-sided beam passing straight from the thigh-joint to abut against the anterior part of the sacrum, where the weight of the shell is greatest,—a structure which is wanting in the Megathere. In no species of Armadillo is the ilium expanded, while in the Megathere it is greatly developed, resembling that of the Elephant in size, form, and position; and among the Edentata the nearest approach in this portion of the skeleton is to be found among the Sloths and Ant-eaters. The most striking point however, in the structure of the Armadillos, with reference to the support of a bony covering, is the remarkable production of a part of the vertebra from above the anterior articular process on each side, in a straight direction upwards, outwards, and forwards, to nearly the height of the true spinous processes. Now, these oblique processes, which are developed only in the loricated Edentata, beautifully correspond in form and use with the tie-bearers in the architecture of a roof, and are entirely wanting in the Megathere, the structure of this part of the vertebral column of that animal corresponding with the character of the vertebræ of the hair-clad Sloths and Ant-eaters. Mr. Owen noticed other supposed adaptations in the skeleton of the Megathere to sustain a bony covering, as the breadth of the ribs, but the ribs of the Sloths and Ant-eaters are broader than those of the Armadillos.

The paper contained a tabular account of the discovery of twelve skeletons of the Megathere, and in no instance did any portion of bony armour occur with or near the bones. A notice was also given of the remains of a Glyptodon, found in the left bank of the Pedernal before its junction with the Sala, an affluent of the Rio Sante, near Monte Video, and preserved in the museum of that town. From the accounts which have been given of these remains they appear to have belonged to the same species as that described in the paper. An allusion was also made to some portions of bony armour obtained in the Rio Seco, in the Banda Oriental, and similar in structure to the specimen of the Pedernal. One of the portions was the covering for the tail. It was hollow to its extremity, and presented in its concavity, vestiges of caudal vertebræ very distant from each other.

In conclusion, Mr. Owen observes, that having brought together evidence of the remains of five specimens (found in the Rio Seco, Rio Janeiro, Villaneuva, Pedernal, and the Banda Oriental) of a large Edentate species undoubtedly covered with armour, and more or less corresponding with the characters of the Glyptodon, and having established the characters of that genus on both dentary and locomotive organs; he trusts that he has at the same time vindicated the opinion of Cuvier with reference to the Megathere, by proving it to be, by its tegumentary covering as well as its osseous system, more nearly allied to the Ant-eaters and Sloths than to the Armadillos.

PROCEEDINGS

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April 10.—John Manning Needham, Esq., Chiswell Street; Samuel Wright Fearn, Esq., St. Peter's, Derby; Barratt Edward Lampet, Esq., B.A., of Corpus Christi College, Cambridge, Haverstock Hill, Hampstead; and John Laurence, Esq., High Street, Leicester; were elected Fellows of this Society.

A paper was read, "On as much of the Transition or Grauwacke system as is exposed in the counties of Somerset, Devon, and Cornwall," by the Rev. David Williams, F.G.S.

The author commences by stating, that his views of the general structure and arrangement of the country are original and independent, but that he does not in the least impugn the originality of the observations and inferences of other geologists. He mentions, that in a communication read before the British Association at Dublin (1835), he used the following expression in remarking on the broad outline of the structure of Devonshire with respect to the relative position of the strata containing plants and culm: "the clay slate (without the intervention of gneiss or mica-slate) dips away from the granite of Lundy on the one hand, and from the granite of Dartmoor towards it on the other;" and that in a paper sent to the Meeting of the British Association at Bristol (1836), but received too late to be read, was inserted this passage: "the same beds being brought up to the surface at either extremity" (Exmoor and the north of Cornwall) "contain in their great intermediate trough all the strangely contorted rocks and carbonaceous shales we there witness."

Mr. Williams then alludes to an error which he made in the paper read at Dublin, by considering the mineral axis of Dartmoor to be composed of the strata he calls the "Morte Slates," but which he corrected in a paper read at Liverpool (1837); he notices also another error which he had made in supposing that the same beds (the Morte slates) were brought up among the granite of Dartmoor, and which he did not discover till the spring and summer of 1838, when he perceived that "the two superior members of the North Devon group, Nos. 7. and 8. are brought up in the south in precisely the same order and relation in which they descend on the north," having previously overlooked this natural simplicity of arrangement.

The chief objects of the paper are to show, that the strata can be divided into certain groups, distinguished by well-marked lithological characters; and that there is a gradual passage from the lowest part of the uppermost or culm deposit into the series next below it, and that similar passages are presented in each of the other underlying groups. To the intermediate strata the term neutral is applied.

The whole of the beds are assigned to the transition or graywacke class, and are arranged in descending order under the following nine heads, the topographical names being derived from the localities where the strata are best exposed:—9. Floriferous slates; 8. Coddon Hill grits; 7. Trilobite slates; 6. Wollacomb sandstones; 5. Morte slates; 4. Trentishoe slates; 3. Calcareous slates of Linton; 2. Foreland and Dunkerry sandstone; 1. Cannington Park limestone. Only 9. 8. and 7. are described in the paper; the other six, confined, the author believes, to the north of Devonshire and the south of Somersetshire, being reserved for future consideration.

9. *Floriferous slates and sandstones.*—This term is proposed for the series of beds containing culm, to avoid the ambiguity of the word "carbonaceous," and as preferable, in the author's opinion, to "culmiferous," plants being very generally distributed, and culm confined to a small area. The sandstones are finely micaceous, tough, externally of a rusty or dull purple colour, and internally of a dull olive, and they are stated to be totally distinct from any others in the country. The shales or slates are commonly dark-coloured and friable, but at Forrabury and Bos Castle they constitute roofing slates, resembling those of the inferior groups, though much deteriorated by a combination of pyritous anthracite. One variety, called Adder Limestone, is a fine hone slate. The culm forms great insulated elliptical "bunches," sometimes gradually thinning out, and sometimes being suddenly nipped off. The strata are strangely contorted, and these disturbances have entailed on the country its physical features of rapidly succeeding hills and valleys; but Mr. Williams conceives, that the curvatures are confined to No. 9. and the two upper divisions of No. 8. and that they are due to lateral pressure produced by the upheaval of the granite of Dartmoor. The area occupied by the "floriferous deposit" is stated to be 50 miles in a west and east direction, and 25 in a north and south.

8. *Coddon Hill Grits.*—On the confines of this formation the floriferous sandstones become thin-bedded and coarsely laminated, and after a series of alternations and gradual transitions, are finally succeeded by the well-characterized Coddon Hill grits. This series is divided by the author into grits, limestones, and dark slates, connecting the floriferous sandstones (9.) with the trilobite slates (7.); and Mr. Williams asserts, that more regular passages from one system of beds to another cannot exist, there being no want of conformity, and that as the constituents of one deposit gradually decrease those of the other gradually increase. The grits are stated to be lithologically distinct from any other in the country. They

are slightly calcareous, fine-grained, flinty, thin-bedded, and dark-coloured, but often striped of different tints; and from containing a varying proportion of felspar, occasionally assume, on decomposition, a resemblance to some of the harder chalks. The wavelite of Devonshire occurs in these grits. The following localities are mentioned where the passage from the floriferous strata into the Coddon grits, and thence into the trilobite slates, may be advantageously examined: the neighbourhood of Bampton, Morebath, where the turnpike road to Hatchet intersects the grits—the back of Swimbridge, four miles east of Barnstaple—Rumson Lane, a mile south of Barnstaple, and Fremington Pill, below Pen-hill, on the west of Barnstaple. Organic remains are very rare in the grits, Mr. Williams having found only a few fragments of Crinoidea and a chambered univalve.

The grits are associated, about the middle of the series, with large insulated lenticular masses composed of beds of dark limestones alternating with strata of black shale, containing plants and flakes of anthracite; also Goniatites and Posidonia. These lenticular masses may be traced, in the north of Devon, from Barnstaple to Bampton, and in the south from Launceston to Drewsteignton. To the east of Bampton and Drewsteignton the shales not only thin out, and the whole mass becomes calcareous, but the author says, that there is an upper suite of thick-bedded coral limestones. These changes are stated to take place at Hockworthy, Holcomb Rogus, Westleigh, Chudleigh, and Ashburton, emerging at each locality except the last, from below the floriferous slates, and accompanied by the Coddon Hill grits. At Ashburton, however, he states, that a fault brings the limestone abruptly in contact with the trilobite slates, the passage beds not being exhibited.

The Coddon Hill limestones are succeeded by the lowest division of No. 8, consisting of the series of slaty beds which forms the passage into the trilobite slates (No. 7.).

7. *Trilobite Slates.*—This group is characterized, in some localities, by an abundance of trilobites, particularly in the north of Devon, and at Landlake in the south. It constitutes the low southern flank of Exmoor, ranging from Baggy and Diamond Points on the British Channel eastward to Shawley; and Mr. Williams conceives that it constitutes the south of Devonshire and the whole of Cornwall, with the exception of the granitic and other igneous masses. The limestones of Trenalt, Petherwin, Landlake, Plymouth, Newton Bushell, Denbury, and Torbay, are placed in it by the author; but in the north of Devon he knows only two localities at which limestone has been observed in this division. Organic remains are abundant in the calcareous beds, and are well preserved. The author estimates the thickness of the group to be $8\frac{1}{2}$ miles.

The strata in the north of Devon and south of Somerset inferior to No. 7, Mr. Williams proposes to describe in another paper.

April 24.—James William Farrer, Esq., F.S.A., John-street, Berkley-square; C. B. Rose, Esq., of Swaffham, Norfolk; and

William Haughton Stokes, Esq., M.A., Fellow of Caius College, Cambridge, were elected Fellows of this Society.

A paper was first read "On the Climate of the newer pliocene tertiary period," by James Smith, Esq., F.G.S.

During an examination of the fossils contained in the marine beds which indicate the latest changes in the relative level of sea and land in the west of Scotland, Mr. Smith observed, that many of the most common shells in the raised beds of the basin of the Clyde are identical with species found by Mr. Lyell at Uddevalla in Sweden*; and he has been induced to conclude from the arctic character of the testacea, that the climate of Scotland during the accumulation of these beds was colder than it is at present.

On showing some of the fossils, which are apparently extinct, to Mr. Gray, that naturalist noticed their great resemblance to arctic species. The shells still living, though not known on the coasts of Great Britain, but found in the raised deposits of the Clyde, M. Deshayes has determined to be inhabitants of the northern seas, viz. *Natica clausa,* which occurs as far north as Spitzbergen; *Fusus Peruvianus,* erroneously considered by Lamarck to exist on the coasts of Peru, but which is an inhabitant of the seas at the North Cape; *Tellina proxima, Astarte multicostata, Turbo expansus, Velutina undata,* (also on the coast of Newfoundland); and *Pecten Islandicus,* erroneously considered by some conchologists, according to M. Deshayes and Mr. G. Sowerby, to occur in a living state on the coast of Scotland.

The *Cyprina Islandica,* which is abundant in the raised deposits, Mr. Smith has not found alive in the waters of the Firth of the Clyde.

The following summary is given in the paper of shells found in the newer pliocene deposits in the British Isles.

Marine		190 species.
Land and fresh water		57
		247
Of these there are recent British		
Marine species	166	
Land and fresh water	54	
		220
		27
Recent in Arctic seas	7	
European and Indian seas	1	
Extinct or unknown	19	
		27

Mr. Smith also mentions the occurrence in the newer pliocene of Sicily, of several species now found living only in more northern European seas; and he infers from them, that the climate of Sicily was at one period colder than it is at present. Four species are

* Phil. Trans., 1835, Pl. 1.

mentioned in the paper, *Panopæa Bivonæ, Bulla ampulla, Arca papillosa,* and *Bulbus Smithii.*

A paper was then read, entitled, " Remarks on some fossil and recent shells, collected by Capt. Bayfield, R.N., in Canada," by Charles Lyell, Esq,, V.P.G.S.

Several eminent conchologists having observed that the English crag contains shells, which seem to indicate a somewhat colder climate than that which now prevails in our latitude ; and it having been supposed that a similar inference may be deduced, with still greater certainty, from the abundant occurrence of many arctic species in the marine newer pliocene strata of Scotland and Ireland, Mr. Lyell was induced to examine carefully a collection of shells procured by Capt. Bayfield, and consisting partly of fossils from the most modern tertiary deposits bordering the Gulf of Saint Lawrence, and partly of recent testacea from the gulf itself.

The shells were obtained principally at Beauport (lat. 47°) 2 miles below Quebec and 100 feet above the St. Lawrence, but similar species are met with on the north side of the St. Charles, 3 miles from Beauport, and at Port Neuf, 40 miles above Quebec, in the latter instance at heights varying from 50 to 200 feet above the level of the river.

The deposits near Quebec fill a valley formed in a horizontal limestone, containing Trilobites and Orthocera, and they resemble those forming in the bed of the St. Lawrence. They consist of strata of sand, gravel, and stiff blue clay, the last composing the bottom of the series, and the first the uppermost part. Numerous boulders occur at different levels, not resting upon each other, but dropped apparently at widely distant intervals of time, from masses of ice on which it is supposed they had been floated. Some of the shells are broken, but many are perfect, and have both their valves together; and it is impossible to imagine that the clay, sand, gravel, and boulders could have been drifted together, into their present position, by a violent rush of water, as the fragile *Terebratula psittacea* is found perfect, and with its interior appendages complete.

On first examining the shells, which are found principally in the upper sandy bed, Mr. Lyell was struck with their great resemblance to those which he had collected at Uddevalla in Sweden. The *Saxicava rugosa,* so predominant there, is particularly mentioned by Capt. Bayfield as the most abundant shell in the tertiary strata of the St. Lawrence ; and the *Natica clausa* and *Pecten Islandicus* are very common at each locality. The fossils of Beauport, however, considered as a whole, by no means agree with the marine shells inhabiting the Gulf of St. Lawrence, but, as far as they have been examined, possess a decidedly arctic character, the species ranging from the Gulf to the border of the north polar circle, or being found in the newer pliocene of Scotland and Sweden ; and on the contrary many of the most conspicuous of the living testacea of the St. Lawrence are wanting in the tertiary deposits.

The following list of some of the fossil species is given by Mr.

Lyell on the authority of Dr. Beck: *Mya truncata* (var.), found fossil in Bute, and living in the St. Lawrence; *Mya arenaria* and *Saxicava rugosa*, recent in the Gulf of St. Lawrence; *Tellina calcarea*, fossil at Bute; *Tellina Grœnlandica*, which exists in the Gulf of St. Lawrence and at Icy Cape; *Mytilus edulis*; *Pecten Islandicus*, found living in the North Sea, and fossil in Scotland; *Terebratula psittacea*, which occurs on the coasts of Greenland and the Feroe Islands; also at places intermediate between them and the entrance of the Baltic; *Natica clausa*, recent in Greenland and fossil at Uddevalla; *Scalaria Grœnlandica*, *S. borealis*, *Tritonium fornicatum*, *T. Anglicanum*, all now existing in the Greenland seas, the last being considered by some authors as a variety of *Buccinum undatum*, and the *T. fornicatum* being also found living on the Irish coast, and fossil at Dalmuir and in Scotland. On the other hand, many of the shells living in the Gulf of St. Lawrence and most conspicuous for their size, are wanting in the collections of fossils hitherto obtained, as the *Mactra solidissima*, *Erycina Labradorica*, *Purpura*, allied to *P. Lapillus*, *Natica Heros*, and *Rostellaria occidentalis*.

The torrents and rivers which flow into the St. Lawrence wash down annually into that estuary great numbers of tertiary fossil shells, so that they become mingled with the living testacea. The latter, however, may be generally distinguished by retaining their colour, animal matter, or ligaments; but it is more difficult to distinguish those shells which have been derived exclusively from the tertiary beds. Nevertheless, Mr. Lyell has little doubt in assigning to them the specimens of *Balanus Uddevallensis* and the Fusus allied to *F. lamellosus*, which have been dredged up off Cape Bic, as they are all in the same condition as the Beauport fossils.

The climate of Canada being now excessive, it is natural to find in the Gulf of St. Lawrence many northern and arctic species, without any mixture of tropical forms, for the latter cannot resist severe cold, though they range far towards the southern polar latitudes, where a low mean annual temperature prevails. Mr. Lyell, therefore, conceives that during the period immediately antecedent to the present, the climate of Canada was even more excessive than it is now; and that the shells resembled still more closely the small assemblage now living in high northern latitudes. He is also of opinion, that this extreme cold may have coincided with the era of the principal transportation of erratic blocks, an inference supported by the masses of rock irregularly dispersed among the clay. He further believes, that a more equable though cold climate may have preceded immediately that condition; and that there may have been more than one oscillation of climate at the modern period, the last having been connected with the geographical changes which upheaved the shelly deposits of Canada 200 feet above the level of the St. Lawrence, and converted them from submarine deposits to dry land.

An extract was next read from a letter addressed to Dr. Fitton by Herr Roemer, of Hildesheim, on the Wealden of the North of Germany.

The Wealden formation, including the Purbeck stone, is extensively developed in the north of Germany, and is overlaid a great argillaceous deposit containing marine shells, similar bo to the oolitic and cretaceous systems. Of the fossils found in the Wealden of England, almost every species occurs in Germany, including even the minute *Cypris tuberculata*, *C. granulosa*, and *C. Valdensis*. Last autumn, Herr Roemer discovered the Wealden with its characteristic shells, near Bottingen, in the High Alps. He possesses also the *Lepidotus Mantelli* of the English Wealden, from Saxony. The Portland sand occurs in the north of Germany, but the Portland stone and the Kimmeridge clay are so intimately connected by their fossils, that the intermediate sandy beds cannot be considered as a separate deposit. The chalk with flints occurs possibly in the Hartz. The greensand series is extensively developed, the Flammenmergel of Hausmann being the upper greensand of England, and the quader-sandstein the lower. Herr Roemer believes that the gault also exists in Northern Germany.

A paper was then read on the classification of the older rocks of Devonshire and Cornwall, by the Rev. Professor Sedgwick, F.G.S., and Roderick Impey Murchison, Esq., F.G.S.

In a communication read in 1837, the authors explained their general views respecting the older rocks of Devon and Cornwall, but having recently changed one part of their classification, they have hastened to place their reasons for doing so upon record, before the Geological Society. On three out of four of the essential points in their former communication, the authors' views remain unchanged; they adhere to the belief, which they were the first to put forth, that the greater portion of Devonshire belongs to the true carboniferous system, and that the succession and lithological characters of the different mineral masses in North and South Devon, which they then pointed out, remain unaltered. In proof of this there were suspended, during the reading of the paper, the same sections as were exhibited at Bristol in 1836. The change, therefore, which they propose, is to remove the lowest rocks from the Cambrian and Silurian systems to the old red; and their reason for making this alteration is founded on zoological evidence recently obtained, which shows that the organic remains of these deposits are of a peculiar character, approaching in the upper division, the fossils of the carboniferous strata, and in the lower, those of the Silurian system; as well as upon the previously ascertained regular sequence or passage from the carboniferous strata, through all the subjacent series of deposits.

The fossil plants of the culm basin having been formerly determined to be, as far as recognizable, true coal measures remains, and the deposit having been therefore assigned to the era of the carboniferous system, the order of superposition being also clear, the strata underlying the coal basin might naturally be referred to the old red sandstone, if the organic remains found in them, belonged to a natural group, intermediate between the fossils of the carboni-

.s and Silurian systems. Subsequent examination has proved ; such is the case; but this distinction could not have been ascer-.ıned had not Mr. Murchison published his work on the Silurian system.

In the order of sequence there is now no difference of opinion between the authors and Mr. De la Beche and Mr. Williams, the only point on which the agreement is not common, being the class to which the formations should be assigned.

The authors then explained that their sections both in S. Devon and N. Cornwall indicate, with some limited exceptions, a passage downwards, the transition being stratigraphically true, whether the beds be examined along the banks of the Taw, near Barnstaple, on the north, or to the west of Launceston, on the south of the great trough.

The authors next gave an approximate list of the fossils, collected by themselves or placed at their disposal by the Rev. R. Hennah, Major Harding, and the Rev. D. Williams, referring them to the great mineral groups to which they belong, both in North and South Devon.

Descending order in North Devon.—The shells in the uppermost group, beneath the culm, as at Barnstaple, in the North of Devon, and South Petherwin, near Launceston in the south, approach generally forms of the carboniferous system, consisting of Goniatites of new species, and of spined Producti and Spirifers, entirely unlike the species found in the Silurian system, but resembling those obtained in the mountain limestone. The same group contains also new species of Trilobites and Crinoidea.

In the next underlying formation in the north, or the sandstone group, ranging from Baggy Point by Marwood and Sloly, occur new species of *Cucullæa, Avicula? Cypricardia,* and *Orthocera;* one cast also has been obtained, undistinguishable from *Bellerophon globatus* of the Silurian system. In the same series are found casts of plants of considerable size, but in Professor Henslow's opinion, quite distinct from any known coal measures remains.

In the third descending group, but few fossils have yet been found, yet it has been ascertained to contain one of the varieties of Producta common in the overlying groups, and similar to the spinous species of the mountain limestone; also a coral (*Favosites polymorpha,*) previously found in England only in the Upper Silurian rocks.

The next descending series of beds, or the arenaceous deposits of Linton, contains few fossils, except towards its lower part, where calcareous matter re-appears, and in that portion a Spirifer has been obtained resembling the *S. attenuatus* of the mountain limestone, and a new species of Orthis, a genus characteristic of the Silurian system.

In the Quantocks, which the authors consider as formed of the oldest strata in North Devon, organic remains appear to be rare, the principal hitherto procured consisting of *Favosites polymorpha.*

South Devon.—Having thus shown that in North Devon there is a regular succession of strata characterized by distinct fossils differing more and more in descending order from the organic remains of the mountain limestone, and approaching those of the Silurian system; the authors proceed to enumerate the order of the groups and the imbedded fossils in South Devon and the North of Cornwall. They show a similarity of succession of deposits and of organic remains in the upper groups, but they state that in consequence of the protrusion of the granite, there is in the lower a considerable difference in mineral type, especially south of Dartmoor. They refer, however, to their former memoir for ample details respecting these counties, and for proofs that they were correct in placing the great calcareous masses of Plymouth and Chudleigh on the same parallel as the lowest calcareous strata of North Devon.

In conclusion, the authors show, that the variation in Devonshire and Cornwall from the ordinary type of the old red sandstone in Herefordshire and adjoining counties, cannot be admitted as a valid argument against assigning the slates and sandstones of these counties to that system, because the variations in composition of other formations within limited areas is equally great. They show also that the absence of the true carboniferous limestone in Devonshire cannot disprove their present classification, because in Western Pembrokeshire that limestone is wanting, and the coal measures rest on older formations.

In consequence of mineral character being no longer indicative of age, and the term greywacke being lithologically applicable to beds of every class of rocks, and as Devonshire affords the best type of the fossils of this intermediate system, the authors propose to substitute the term *Devonian* for old red sandstone; and they hope that the organic remains, discovered in that county, will enable continental geologists to detect in their own country, a system of strata hitherto supposed to be almost peculiar to the British Isles.

The authors acknowledge the assistance they have received from Mr. J. Sowerby; and that Mr. Lonsdale first suggested, from their fossil contents, that the limestones of S. Devonshire might prove to be the representatives of the old red sandstone.

A paper was afterwards read on the structure of South Devon, by Robert A. C. Austen, Esq., F.G.S.

This communication is supplementary to a memoir read in 1837 *, and its object is to show the general relations of the various bands of slates, limestones, and sandstones in South Devon.

Commencing with the older deposits east of the Teign, there appear—

1st. Slates, but of which little is seen.

2nd. A band of black stratified limestone of variable thickness and slaty structure. It contains much carbonaceous matter, thin seams of anthracite, also corals and Brachiopoda. It is associated with irregular beds of contemporaneous trap. The band is stated to range from Staple Hill on the east, through Bickington, Ashburton,

* Proceedings, vol. ii., p. 584.

Buckfastleigh, and Dean, near which the limestone ends; but the calcareous slate and limestone of the south of Cornwall, Mr. Austen considers to be of the same age. These beds dip south.

3rd. Fine-grained schists and roofing slates.

4th. The Plymouth limestones, which cannot be traced westward further than Whitesand Bay, but to the eastward they are considered by Mr. Austen to be represented by the limestones of Dunwell, Shilstone, Ugborough, Fowley-cumber, North Huish, Stoverton, Great and Little Hampston, &c.

5th. An arenaceous deposit, often coarse and resembling old red sandstone; but sometimes conglomeratic, and then not distinguishable from the new red of Devonshire. Its upper conglomeratic portion ranges from Plymouth Sound and Bigbury Bay, to Modbury and Blackdown; its lower portion cuts the Dart a little below Totness, and rises into lofty hills, east of a line passing through Berry Pomeroy, Marldon, Cockington, and Barton. It contains limestone south of Yealmpton, and at Sequers Bridge; also several thin bands on the Dart, and beds at Berry, Marldon, Collaton, and Yalberton. Organic remains are not uncommon in this arenaceous division. Only the fine-grained beds show a slaty cleavage. The limestone is confined to its northern limit, and has a southwardly dip; but all the lines of roofing slate are to the southern with either vertical or northern cleavage dips. As the intermediate country about Modbury presents many undulations, Mr. Austen suggests that the slate beds of the south may be the equivalents of the limestone on the north; in which case the passage downwards into the mica slate and gneiss of the Prawle Point may be the equivalents of No. 4, in a metamorphic condition.

6th. The limestones of Torbay, &c., which are said to constitute the newest deposits of the series, not being covered by any formation into which they pass.

The carbonaceous rocks of central Devon are stated by Mr. Austen to form no part of the above system, but to rest upon it unconformably.

May 8.—Thomas Griffin, Esq., of Cheltenham; John Griffith, Esq., Finsbury-place, South; and Robert Fitch, Esq., of Norwich; were elected Fellows of this Society.

An extract from a letter addressed to Mr. Murchison by Mr. Miller of Cromartie, was first read.

The fish beds in the old red sandstone of the neighbourhood of Cromartie, are very extensive. They are overlaid, where not denudated, by a thick stratum of soft yellow sandstone; and are underlaid by a deposit consisting of red sandstone, containing in the middle a chocolate-coloured conglomerate, similar to that of the Findhorn. The bold cliffs of the Moray Frith present fine sections of the old red, including the fish beds. The letter is accompanied by illustrative drawings exhibiting the succession, range, and dip of the strata. Mr. Miller gives also an account of a series of faults in the Burn of Ethie, one of which, he conceives, may be traced nearly north to the town of Cromartie.

A paper was first read, On the London and Plastic Clay formations of the Isle of Wight, by Mr. Bowerbank, F.G.S.

The object of this communication is to show that there are no zoological distinctions between the London and Plastic Clays. Mr. Bowerbank first examined closely the strata of White Cliff Bay, and found the ascending order of the beds to be as follows:—

Chalk.

1.	Variegated clay, principally red, corresponding with *b* and *c* in the Alum Bay section*	45 paces.
2.	Dark greenish grey sand, like that of the lowest part of *d*, Alum Bay....................	25 —
3.	Red and yellow sands	27 —
4.	Dark greenish grey sand and clay, similar to *d*, Alum Bay.........................	65 —
5.	Red and yellow sands like those of Alum Bay	30 —
6.	Dark greenish gray sand and clay, in which were found *Venericardia planicosta*, Cerithia, and other London clay fossils............	30 —
7.	Variegated sands	6 —
8.	Dark greenish gray sand and clay.......... At different points in this interval the author found small Nummulites, with London clay species of Venus, Voluta, Cerithia, &c., and in one place large Nummulites like those obtained at Bricklesome Bay, Sussex, associated with *Venericardia planicosta*, and other London clay shells.	186 —
9.	Variegated sands	10 —
10.	Dark greenish gray sand and clay like No. 8.	54 —
11.	Variegated sands like those of Alum Bay....	38 —
12.	Greenish gray, brown, and greenish brown clays.............................. This bed contains lignite, sharks' teeth, *Voluta luctator*, Ostrea, and numerous other shells characteristic of the London Clay.	13 —
13.	Yellowish sandy clay, without fossils	26 —
14.	Greenish sand similar to that of the upper marine in Colwell Bay, and containing apparently the same Venus.................	12 —
15.	Yellowish sand without fossils	14 —

Beyond this point, freshwater beds, enclosing abundance of Potamides, are displayed.

The above section proves, in Mr. Bowerbank's opinion, that in White Cliff Bay there is an alternation of London and plastic clays throughout 525 paces, and that London clay fossils not only occur abundantly in the part which corresponds with the great mass of

* See Mr. Webster's section in Sir Henry Englefield's Isle of Wight, Geol. Trans., 1st series, vol. ii., Pl. 11.

that formation in Alum Bay, but are likewise found in the beds, Nos. 8. and 6, which occur below it.

Mr. Bowerbank then described the strata in Alum Bay, taking Mr. Webster's section as the base of his observations; and he pointed out, that in the beds of greenish gray sand and clay marked *d* in that section, and below the variegated sand and clays which underlie the London clay, he found the following shells, characteristic of that formation:—*Venericardia planicosta, Cardita margaritacea, Mya intermedia, Cardium semigranulatum, Nucula similis, N. amygdaloides, Turritella conoidea, T. elongata, T. edita, Murex innexus,* (Brander) *Buccinum desertum,* and *Cancer Leachii.* In the variegated sands and clays no fossils were found.

An extract from a letter, dated Newcastle, 14th February, 1839, and addressed to Dr. Buckland, by Mr. Atkinson, was then read.

This letter accompanied a series of slabs of fissile or slaty micaceous sandstone, presenting the tortuous casts of vermiform bodies, either impressed in the stone or in relief. The more perfect casts are marked by a longitudinal line, and closely-set transverse fine striæ. The bed from which the slabs were procured, belongs to the carboniferous formation near Haltwhistle in Northumberland.

The following is the succession of strata presented by the quarry:

Compact sandstone..................	
Red marly sandstone, with shells	10 miles.
Micaceous blue and white sandstone, containing the casts, the largest of which are found near the centre of the bed. The stone splits into thin flags, and is used for roofing	18 feet.
Compact sandstone............................	30 —
Limestone containing in one part a few encrinital remains	30 —

The strata dip 15¼° to the S.S.W.

Mr. Atkinson is of opinion that the impressions are principally due to worm-tracks.

A paper was afterwards read, "On the relative ages of the tertiary deposits commonly called Crag, in Norfolk and Suffolk," by Charles Lyell, Esq., V.P.G.S.

This paper contains the results of Mr. Lyell's examination of the crag, with reference to the three following points:—First, The direct superposition of the red to the coralline crag, as originally pointed out by Mr. Charlesworth in 1835: Secondly, Whether the remains of mammalia are really imbedded in regular and undisturbed marine strata in the Norwich crag: Thirdly, Whether the proportion of recent shells, as compared to the extinct, is decidedly larger in the crag of Norwich, so as to indicate a posteriority in age relatively to the Suffolk crag.

1. Of the superposition of the red on the coralline crag, the author found distinct proofs in the sections at Ramsholt and Tattingstone, as previously indicated by Mr. Charlesworth, and in

quarries near Sudburne pointed out to him by Mr. Bunbury. At Tattingstone the coralline crag consists chiefly of greenish marl, with discontinuous layers of stone, and the number of corals is very small; but both at that locality and Ramsholt, the red crag rests on denuded beds of the coralline. At Sutton, near Woodbridge, Mr. Lyell was enabled to ascertain, by the assistance of Mr. W. Colchester, that the red crag in some places abuts against a vertical face of the coralline, as well as overlies it; and that in consequence of the irregularities in the outline of the face, the two deposits have a deceptive appearance of alternating. He also ascertained, in addition to the above evidence, that the older or lower strata must have acquired a certain consistency before the newer were accumulated, because the calcareous sand or comminuted shells and zoophytes, of which the former are composed, is perforated to the depth of 6 or 8 feet from the surface by the tortuous borings of pholades, the shells of which are frequently found at the bottom of the tubes, the remainder of the perforations being filled with the sand of the superjacent red crag. The most northern point to which the coralline crag has been traced, is Sizewell Gap, several miles north of Thorpe.

2. With respect to remains of mammalia being imbedded in undisturbed marine beds in the Norwich crag, Mr. Lyell stated, that an examination of this crag in the neighbourhood of Southwold and Norwich had convinced him, that instead of the deposit being purely marine, it is fluvio-marine, containing every where an intermixture of land, freshwater, and sea-shells, with the bones of mammalia and fishes. The formation is exposed along the coast, at Thorpe, near Aldborough, where it may be seen at low-water resting on the coralline crag; but it is most largely developed in the neighbourhood of Southwold, where the author examined it accompanied by Capt. Alexander. In that district, it varies greatly in character, consisting of irregular beds of sand, shingle, loam, and laminated clay; but it appears to have been in some places tranquilly accumulated, as specimens of *Nucula Cobboldiæ*, *Tellina obliqua*, and *Mya arenaria*, occur with the valves united, and not worn by attrition. In the same beds, however, are procured rolled fish-bones, and remains of the elephant, rhinoceros, horse, and deer. Capt. Alexander found at the base of the cliff, in a bed about 6 inches thick and rich in marine shells, the tooth of a horse within a large *Fusus striatus*. That gentleman also possesses a tooth of a mastodon, washed out of the cliffs between Dunwich and Sizewell.

In tracing the Norwich crag from Easter Bavant northward towards Kessingland, Mr. Lyell found in it layers of flinty shingle; and he consequently refers to this formation, those strata of sand and shingle, on the coast, which resemble the sandy portions of the plastic clay of the London and Hampshire basins.

In some of the inland pits of Norwich crag near Southwold, the author found mammiferous remains associated with a variety of *Cyrena trigonalis*, a shell common in the freshwater deposit of Grays, and elsewhere.

In the neighbourhood of Norwich the deposit forms patches of very variable thickness, resting upon chalk, and covered by a dense bed of gravel. It is best displayed at Bramerton, Whitlingham, Thorpe, and Postwick, and consists of sand, loam, and gravel, enclosing marine, land, and freshwater shells, with ichthyolites and bones of mammalia; and Mr. Lyell says, it was evidently accumulated near the mouth of a river. The late Mr. Woodward describes the chalk of Postwick as having been drilled by marine animals before the deposition of the crag; and the Rev. Mr. Clowes found in a perforation in the chalk at Whitlingham the shell of a *Pholas crispatus*, the remainder of the perforation being filled with crag. Among other proofs that the strata were gradually deposited, the author mentioned Capt. Alexander's discovery of an elephant's tusk, with many serpulæ attached to it; and he infers from this fossil, that the remains of the mammalia were really washed into the sea of the Norwich crag, and were not subsequently introduced by diluvial action, as some observers have suspected. The freshwater shells, although most diligently searched for, are less abundant than marine, and the terrestrial are still more rare; but Mr. Wigham has found in one bed at Thorpe, a great predominance of fluviatile testacea. In the same pits he obtained a mastodon's tooth at the bottom of the deposit, near the chalk, associated with pectens and other marine shells. In the beds at Postwick, he also discovered, in 1835, part of the left side of the upper jaw of a mastodon, containing the second true molar. This fragment Mr. Owen has been able to identify with the *Mastodon longirostris* of Eppelsheim. In the same bed, Mr. Wigham also obtained the teeth and jaw of a field-mouse, larger than those of the common species; likewise remains of birds, and several species of fishes. The horns of stags, bones and teeth of the horse, pig, elephant, and other quadrupeds, have been obtained at Postwick, Thorpe, Bramerton, &c., near Norwich; and this association of remains of the mastodon and horse, both in Norfolk and on the continents of Europe and America, Mr. Owen considers as a subject not without interest.

Mr. Lyell examined also the crag north of Norwich at several pits between that city and Horstead, and ascertained that it was of the same kind, resting upon chalk, and overlaid by gravel. He found in it *Fusus striatus*, *Turritella terebra*, *Cerithium punctatum*, *Pectunculus variabilis*, *Tellina obliqua*, *T. calcarea*, *Cardium edule*, and *Cyprina vulgaris*.

3. On the third point, the relative antiquity of the Norwich to the Suffolk crag, and the degree of resemblance of its shells to those of existing series, the memoir contains much very valuable information. The author acknowledges his obligations for assistance during his researches, to Mr. J. B. Wigham, who has nearly doubled the number of Norwich species of testacea; to Mr. Searles Wood, who gave Mr. Lyell free access to his fine collection of crag fossils; and to Mr. G. Sowerby, for the careful comparison and determination of the recent species; he also acknowledges the aid afforded him by Mr. Fitch of Norwich, and Capt. Alexander of Southwold.

The total number of species in the Norwich crag, rejecting those varieties formerly considered to be distinct species, is 111, of which 19 belong to land or freshwater genera. This comparatively small number of species, whether compared with the testacea of the British seas or the Fauna of the Suffolk crag, and not due to want of activity on the part of collectors, or a paucity of specimens, Mr. Lyell explained by showing, that in seas, the water of which is only brackish, as that of the Baltic, or any great estuary, species are far less numerous than in the salt sea, latitude, climate, and other conditions being the same. A similar scarcity of species exists also in the fluvio-marine deposits alone the Rhine, between Basle and Mayence.

Of the 92 marine shells of the Norwich crag, Mr. Wood has recognised 73 species found in the red crag, and therefore it might be inferred that the two formations are nearly of the same age; but on applying the test of the proportions of recent species, Mr. Lyell ascertained that the Norwich crag, both with respect to the marine and the freshwater shells, contains between 50 and 60 per cent., whereas in the red crag there are only 30 per cent., and in the coralline but 19.

Mr. Charlesworth had previously implied that the Norwich beds were the most recent, by stating his belief that shells had been washed out of the red crag into the Norwich; and both he and Mr. S. Wood had recognised in the Norwich beds a nearer approach to the existing British Fauna.

The only known freshwater testacea of the red crag of Suffolk were collected by Mr. S. Wood at Sutton, and consist of three specimens of *Auricula myosetis* and one of the variety of *Planorbis marginatus*, with a slightly prominent keel: both of these shells occur in the Norwich crag. Among the other freshwater species of the Norwich crag is the *Cyrena trigonalis,* found also at Southwold and Crostwick. The land shells consist of *Helix hispida, H. plebium,* and a species found at Southwold by Capt. Alexander, bearing a strong resemblance to *Helix Touronensis,* so common in the faluns of Touraine. All the 92 marine species, except two or three, are found either in the red crag or living, so that a very small number were peculiar to this period. It is important to notice, that a large proportion of the recent shells in the coralline crag have not been met with in red or Norwich; but this absence Mr. Lyell attributes to the fragile nature of many of these shells, and in some cases to their having been peculiar to deep or tranquil seas.

In determining the above results, the utmost care was taken to exclude all those shells which might have been washed out of the red crag into the Norfolk, or did not live in the waters by which the latter was deposited.

Should these numerical conclusions hereafter require some modification, still the Norwich crag will be referable to the older Pliocene period, and the red and coralline to different parts of the Miocene.

From an equally careful examination by the author, Mr. Wood, and Mr. G. Sowerby, of the testacea obtained in the superficial lacustrine or fluviatile deposits at Cromer and Mundesley in Norfolk, Stutton, Grays, Ilford, and other places near London, it appears, that the proportion of recent shells in those accumulations is still greater than in the Norwich crag, exceeding 90 per cent., and, consequently, that they must be placed among the newer Pliocene strata.

In a paper communicated to the British Association at Bristol in 1835, Mr. Charlesworth adopted a similar chronological arrangement of the formations above the London Clay in the eastern counties, placing the coralline crag at the bottom of the series, the red crag next in ascending order, then the Norwich (mammaliferous) crag, and, highest, the lacustrine strata. In that paper Mr. Charlesworth states, that the proportion of recent to extinct species had not then been determined; and Mr. Lyell remarks, it is satisfactory to find, that the palæontological test of age, derived from the relative approach to the recent Fauna, is perfectly in accordance with the independent evidence drawn from superposition and the included fragments of older beds.

The memoir contains also a general comparison of the fossils of the crag with those of the faluns of Touraine. When M. Desnoyers, in 1825, assigned a contemporaneous origin to both these formations, Mr. Lyell dissented from the conclusion, 1st. because the per-centage of recent species then ascribed to the crag, and determined chiefly from fossils of the Norwich beds, was greater than that of the Touraine deposit; and, 2ndly, because the fossils are not only almost entirely of distinct species, though only 300 miles distant from each other, but that the Fauna of the crag has a northern aspect, and that of Touraine an almost tropical character. A recent examination, by Mr. S. Wood, of a series of Touraine shells procured from M. Desjardin by Mr. Lyell, has proved, that there are not 10 per cent. of species identical with shells of the crag; but an examination of the same series by Mr. G. Sowerby and the author has led to the conclusion, that the recent species are in the proportion of 26 per cent. Mr. Lyell, therefore, now accedes to the opinion of M. Desnoyers, that the red and coralline crag may correspond in age, generally, with the faluns of Touraine; and he is of opinion that the difference in the character of the two Faunas may be explained by there having existed at that epoch, a more equable climate, similar to the one experienced at present on the east coast of South America, where, in lat. 39°, occur, in a living state, a large Oliva, a Voluta, and a Terebra; and that a geographical barrier, like that of the Isthmus of Suez, which separates the widely different Faunas of the Mediterranean and the Red Sea, may have intervened between the region of the crag and the faluns of Touraine.

The paper concludes with a list of the testacea of the Norwich crag, determined by the author, Mr. S. Wood, and Mr. G. Sowerby*.

* The memoir is printed in the Magazine of Natural History for July, 1839.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. III. 1839. No. 64.

May 22.—William Fane De Salis, Esq., M.A., Carlton Gardens, and George Fleming Richardson, Esq., of the British Museum, were elected Fellows of this Society, and Professor Ehrenberg of Berlin was elected an Honorary Member.

A paper was first read, "On the Wells found by digging and boring in the gravel and London clay in Essex, and on the geological phenomena disclosed by them," by Dr. Mitchell, F.G.S.

Essex consists chiefly of London clay, but that portion of the county which lies to the north-west of a line drawn from Harlow to Ballingdon Hill, near Sudbury, and the long ridge extending from Purfleet to East Tilbury, are composed of chalk. Extensive districts, however, are covered by thick deposits of gravel, sand, and other detritus, varying in depth from 10 to 300 feet. In Wakering Marshes and Foulness Island, there are 300 feet of sand between the vegetable soil and the London clay.

The wells formed in the gravel are supplied by land springs, the water, when enough, being collected in a reservoir excavated in the London clay. They are often not more than 12 feet in depth; but it is impossible to estimate the number of feet to which they must be sunk in any district, on account of the great inequalities of the outline of the chalk. At Stanway, near Colchester, the clay was found to be 45 feet from the surface; but at the Union workhouse, less than a quarter of a mile distant, and on the same level, it was necessary to sink 60 feet before it was reached. When the London clay forms the surface there are no land-springs, as the clay is generally impervious to water; but in some places it is sandy, and permits the percolation of water. That much of the rain which falls in Essex penetrates downwards, is evident from the smallness of the number and size of the brooks and rivers. Very little water enters the Lea on the west side; and into the Thames only four streams flow between the Lea and Purfleet. There are three rivers, the Crouch, the Blackwater, and the Coln, but they are small, and can carry off only an inconsiderable portion of the water, which falls on about a million of statute acres.

The London clay in Essex is of great but variable thickness. It is seldom, however, that its actual dimensions can be ascertained, for though the depth of the wells is known, accurate details of that at which the clay commenced and terminated have not often been preserved. Dr. Mitchell gives the following list of the total depth of wells, selected from a very large number:

Stratford	247	feet.
Ilford	301	—
Dagnam Hall	$404\frac{1}{2}$	—
Brook-street	340	—
Upminster	192	—
Parsonage, Warley	390	—
Grange Hill, near Fairlop	398	—
Dunton	344	—
Battle Bridge	350	—
Ferry-house on the Crouch	360	—
Rochford Union workhouse	330	—
Wakering Marshes	400	—
Foulness Island { sand 300; clay, 100 to 160 }	460	—
Clay-street, Walthamstow	190	—
Loughton, in Epping Forest	324	—
Epping	270	—
Horsley Park, near Ongar	340	—
Bocking	370	—
Braintree	420	—

This variation the author conceives, is partly due to the unevenness in the surface of the chalk; but in some instances to the undulatory nature of the country, the difference in the depth of the wells agreeing with the increase in the rise of the ground. When this is the case, the bed in which the water is found is the same in the adjacent wells, and consequently the variation in the outline of the surface is due to denudation, and not to unequal elevation. Thus, in the two wells close to the turnpike at Romford, water was found at the depth of 100 feet, but half-way up the hill between Hare-street and Havering Ate Bower at the depth of 250 feet; at Bocking it was obtained at 370, but at higher ground, at Braintree, close adjoining, at 420. Again, at the union workhouse in Rochford, the well is 330 feet deep, and at Stroud Green, on the road to Rugleigh, where the surface is higher, it was necessary to sink 390 feet. At North Fambridge is a well 388 feet deep, the water rising to within 10 feet of the top: but at another well in the same parish, dug in lower ground, there is a constantly flowing stream.

In the New River Company's well at the end of Tottenham Court Road, chalk was found at the depth of 150 feet; but in that near Pond-street, at Hampstead, the main spring in the bed of sand between the London clay and the chalk, was 330 feet from the surface.

The London clay in Essex varies greatly in colour, being in some places yellow or red in the lower part, but in many localities it is blue to the bottom. It is sometimes uniform in composition throughout, but more frequently, even when only 100 feet in depth, divided into two or three portions by beds of sand. In the well at the site of Fairlop Fair it was 398 feet thick, and uniform throughout. In the Dengey and Rochford hundreds, where the clay is from 300 to 400 feet in thickness, it is divided by beds of sand into three or four parts. A bed of sand also usually occurs between the clay and the chalk. These alternations Dr. Mitchell is of opinion, indicate successive periods of turbulence and tranquillity.

A sufficient supply of water is sometimes obtained in the first bed of sand, but it is more often necessary to sink to that resting immediately on the chalk, on reaching which a vast volume of water rushes up, and compels the well-digger to ascend precipitately to the surface. Cement-stones are sources of great impediment, particularly to well-borers, a week or fortnight being occasionally spent in punching through a single mass. At the bottom of the clay a layer frequently occurs, and is technically called the water-rock, because, being penetrated, a powerful spring rushes up.

The water is sometimes, but not very often, combined with a saline substance, probably sulphate of magnesia, as that salt is abundant in the waters of the London clay in Surrey, and solid magnesia occurs at Stamford Hill, near London. Foul air is not unknown in the wells, though it has done little harm in Essex. Its nature has not been ascertained, but Dr. Mitchell conceives, that it is probably sulphuretted hydrogen, as in Middlesex and Hertfordshire that gas has been most destructive. In the chalk of Surrey carbonic acid gas is very troublesome, and has sometimes produced fatal effects.

There is, perhaps, no part of the world where artesian wells are more general, or are more useful than in Essex. In the vale of the Lea they have been bored with the greatest facility and at a small expense. In Waltham Abbey the cost is usually about 16*l*. In the district of Bulpham Fen, seven miles south from Brentwood, they yield a large supply of water. In the marshes, as well as along the coast, and in the islands of Essex, they have proved of the greatest utility. Formerly, in some seasons, when the ditches became dry, the cattle suffered, the fishes died, and the farmer lost severely on his stock ; but by the aid of artesian wells the ditches are now kept full all the year, and the farmer and landlord are accordingly benefited. In Foulness Island there are no natural springs, and until lately no water, except atmospheric, collected in the ditches. In hot seasons this water became putrid, but the inhabitants and the cattle continued to partake of it as long as it lasted; and supplies were then obtained, at the distance of seven miles, from the east end of the island. Artesian wells now keep the ditches full of fresh and sweet water, labourers are obtained at reduced wages, and farmers of a higher class are beginning to reside on the island. Wallisea, Mersea, and other islands have profited in a similar manner.

A great addition is made annually to the land along the coast of Essex, and valuable districts, one amounting to five hundred acres, and another to between one hundred and two hundred, have been recently protected by embankments. Outside of these inclosures are tracts of sand, estimated equal to 33,000 acres, not yet covered with vegetable mould, but dry eight hours out of every tide. Towards the close of 1837, preparatory steps were taken for forming a company to inclose these sands, but Dr. Mitchell is of opinion that they would not yield in 300 years a rental of 300 pence.

To this paper was appended a notice, by the same author, of constant and occasional outbursts of water from the chalk.

The localities of constant outbursts are, the Bourne Mill, near Farnham; the head of the river Mole, near the church at Merstham; (this river flows south of Ryegate to Dorking, below which town the bed of the river is dry in summer, but an abundant stream passes under the chalk, and reappears lower down;) Leatherhead, close to the Guildford road; the powerful spring near the church below Croydon; Orpington; the Holy-well at Kempering, on the south side of the North Downs; the spring a quarter of a mile west of Sittingbourne; Birchington, in the Isle of Thanet; the Lyddon Spout in the cliffs between Folkstone and Dover; the Holy-well, at the foot of the cliffs forming Beachy Head, one mile from Eastbourne; the spring which is the source of the Chadwell, and the main spring of the Amwell.

Occasional Outbursts.—The Bourne, near Birchwood House. During the last outburst, which was in the spring of 1837, the water flowed in great volume to Croydon, and continued to do so for six weeks. Later in the same year, another rivulet burst forth in Gatton Park, between Merstham and Ryegate; and a third in Nonsuch Park, near Ewell.

A communication was next read, entitled, "A notice on the discovery of the remains of Insects, and a new genus of Isopodous Crustacea belonging to the family Cymothoidæ in the Wealden Formation in the Vale of Wardour, Wilts," by the Rev. P. B. Brodie, F.G.S.

The quarry in which these fossils were found, is situated near the village of Dinton, about 12 miles west of Salisbury. Not having been worked for two years, its structure could not be clearly ascertained, but the following section may be considered as affording a near approximation to the order of the beds.

1. Clay, forming the surface, a few inches.		
2. White limestone	3	inches.
3. Clay	2 to 3	—
4. White limestone, similar to No. 2, containing shells and cypris	3 to 4	—
5. Crystalline grit with cyclas	2	—
6. Clay	2	—
7. Clay, with layers of grit..........	3	—
8. Clay	2 to 3	—
9. Light brown sandstone, full of small cypris and cyclas, and consisting in the lower part of comminuted shells	18	—
10. Blue and lower clay, abounding with fragments of shells.............	—	—

11. Thin-bedded grit		2 inches.
12. Fibrous carbonate of lime 13. Grit 14. Fibrous carbonate of lime		6 —
15. Soft shelly sandstone		2 —
16. Light brown and blue limestone, abounding with the Isopodous Crustacean; in the lower part, laminated and numerous cyclades, and a few small oysters		6 —
17. Blue compact grit, full of impressions of cyclas	2 or 3	—
18. White laminated crystalline limestone, very different from that forming Nos. 2 and 4.		
Water—inferior strata not visible.		

The Isopods in the bed No. 16 often occur in clusters. Lenses of the eye are sometimes detectable in the limestone, and more rarely attached to the head; traces of legs have also been observed, but no antennæ. In the same bed the elytron of a coleopterous insect was discovered.

Among the heaps of debris, consisting of grits and limestones, derived apparently from beds subjacent to No. 18, but not visible, Mr. Brodie found fragments of a limestone different from the varieties in the preceding section, being generally coarser, softer, and less compact, and often white on the edges, but blue in the centre. It passes into a grit, in which he procured oysters, numerous bones and palates of fishes, and a tooth of a saurian. The limestone is full of a large distinct species of cypris; it contains also traces of carbonized wood, impressions of small plants, some of which resemble grasses; likewise remains of Isopods, a few bivalves, apparently cyclades, one fragment of a univalve, and, dispersed throughout its substance, insects and small fishes, sometimes microscopic. The insects discovered by the author consist chiefly of coleoptera, but he procured a beetle with the antennæ attached, about half an inch in length; remains of a Homopterous insect, and probably of several species of Dipterus, presenting distinctly, in some specimens, the wings, legs, and striæ of the abdomen; also a wing of a Libellula. Mr. Brodie believes that this is the first instance of the discovery of insects in a Wealden formation; and he observes, that for abundance and variety of specimens, the beds of the quarry resemble more a tertiary (Aix and Œningen) than a secondary deposit.

Mr. Brodie infers, from the occurrence of oysters in some of the layers, that the beds were accumulated in an estuary which afforded considerable variations in the nature of the sediment accumulated, and of the animals by which it was frequented.

In conclusion, the author states, that he is indebted to Mr. Owen for determining the characters of the fossil Isopod.

A letter was afterwards read, addressed to the Rev. Dr. Buckland, President of the Society, by R. Griffith, Esq., P.G.S. of Dublin, respecting the geological relations of the several rocks of the South of Ireland.

This communication was accompanied by a copy of Mr. Griffith's Geological Map of Ireland; and its principal object is to explain why he has coloured, as old red sandstone and carboniferous limestone, extensive districts of the counties of Kerry, Cork, and Waterford, which had been previously considered to be transition.

The geological base of these counties is clay slate passing into quartzose slate, quartz rock, and occasionally conglomerates. This is particularly the case in the peninsula of Corkaguinny or Dingle in the county of Kerry; and as the succession of rocks forming the south of Ireland is well exposed in that district within a short distance, Mr. Griffith selected it for the purpose of explaining his views.

The lowest formation on the sea-shore at Brandon Bay consists of black and red clay slate, and gray quartz rock. The beds are nearly vertical, but occasionally dip 70° or 80° to the south. In some localities near the Bay, the slates alternate with red and gray quartzose conglomerates; and on the western coast of the peninsula, at Doonguin, Ferriter's Cove, and Filaturrio, S.E. of Dingle, the slate contains Orthis, Terebratulæ, corals, &c. This series is succeeded, unconformably, by beds composed of rolled masses of quartz and mica slate, in an arenaceous base, and it is assigned by Mr. Griffith to the old red sandstone. On the summit of Cahirconree mountains, this conglomerate, associated with beds of fine-grained red sandstone, dips to the east at an angle of 10°. Proceeding eastward, in ascending order, the conglomerate disappears, and the formation consists of red and reddish-brown quartzose sandstone, alternating with coarse-red slate, flagstone, and occasionally green slates. These strata are succeeded, conformably, by a fine, yellowish-gray sandstone, forming the commencement of the carboniferous series. The sandstone contains Calamites, and at Gortaclay, 2 miles west of Curreen's Bridge, indistinct bivalves. Its upper beds alternate with coarse and fine dark-gray clay slate, abounding with Productæ, Spiriferæ, Terebratulæ, Encrinites, corals, and other fossils. Continuing to ascend in the series, beds of carboniferous limestone, containing the same organic remains, alternate with the fossilliferous slate; then appear strata of gray, fine-grained, indurated sandstone, alternating in the upper part with slate; next, a series of strata of limestone and greenish-clay slate, containing the same fossils; beyond which the slate gradually disappears, and the whole mass is composed of limestone. In the flat central space between Curreen's Bridge and Castle Island, are probably shale and limestone. Near Castle Island occurs the upper limestone, abounding in nearly every known fossil of the carboniferous limestone of Ireland; and eastward of Castle Island is displayed, in conformable position, the millstone grit, the lower shales of which contain, in considerable quantity, Encrinites, Posidoniæ, Spiriferæ, Productæ, Ammonites, Orthocera, &c.

The change effected by Mr. Griffith in this district, consists in removing the dark-gray and greenish-gray fossilliferous slate at Curreen's Bridge from the transition series to the lower part of the carboniferous limestone system, in consequence of its resting conformably on the sandstone, and dipping regularly under the limestone, as well as on account of its fossils.

Mr. Griffith then describes a line of country between Mount Leinster, in the county of Wexford, and the sea-coast south of Cork. This district presents a succession of east and west valleys, in which flow the Suire, Blackwater, Bride, and Lea, with intermediate ridges, more or less elevated. The valleys are occupied by limestone, beneath which, in each instance, are, in descending order, the carboniferous slates, yellow sandstone, red slate, quartz rock, the conglomerate and subjacent greywacké, thus presenting the whole of the former section with the exception of the millstone grit.

Since the reading of his paper on this district at the Meeting of the British Association at Newcastle, Mr. Griffith has revisited the country, and found that his views of its structure, given in that paper, are perfectly correct; and during his examination he directed his attention more particularly to the limestones in the neighbourhood of Cork. A detailed section from French Furze, south of Currigoline to Middleton and Broomfield, intersecting the limestones of Cork Harbour, was exhibited and described in the paper. It displays the same succession of formations, namely, carboniferous limestone, carboniferous slate, yellow sandstone, red slate, and quartz rock.

To prove more particularly the correctness of his views, Mr. Griffith gives a minute account of the structure of the Monavollagh Mountains, in the county of Waterford. The base of these mountains consists of greywacké, covered unconformably by alternations of coarse-red or brownish conglomerates, coarse-red slate, and red quartzose slate. From Crotty's Rock the conglomerates are succeeded southward by alternations of coarse-red slate and quartz rock, the latter being interstratified, in descending towards the Blackwater, with beds of roofing slate, which occur only in the upper portions of the red slate series. On approaching the Blackwater, the clay slate is succeeded, conformably, by yellowish-white sandstone, and sandstone slate, containing casts of Calamites. These strata are again overlaid, conformably, by the greenish-gray imperfect clay slate, which alternates with the limestone of the valley of the Blackwater. The limestone of this valley is connected with that of the counties of Cork, Tipperary, &c., allowed by other geologists to belong to the carboniferous limestone of Ireland. The dip of the limestone strata in the valley of the Blackwater varies from 20° to 75°. Mr. Griffith then shows, that a similar though reversed order of succession prevails south of the valley; but as the strata dip southward 80°, they apparently overlie the limestone, the deceptive character being due to the contortions of the formations.

It is not possible to follow the author throughout his details, but he shows, as before stated, that there is a regular sequence of formation throughout the country to Cork Harbour, the only variations being in the direction and amount of the dips due to undulations in the formations, and in the strata themselves. The localities described in greatest detail are the valleys of the Bride and the vicinity of Cork.

Mr. Griffith is of opinion, that the bands of carboniferous limestone in the valleys of the south of Ireland are only patches of a vast deposit which once covered the old red sandstone and transition districts.

The memoir was accompanied by an extensive collection of fossils illustrative of the different formations of the country, but more particularly of the Cork limestone. This collection was presented by Mr. Griffith to the Society.

June 5.—J. B. Wigham, Esq., of Heigham, Norwich, was elected a Fellow.

A paper was read, "On bones of Mammoths found in the deep sea of the English Channel and German Ocean," by Capt. J. B. Martin, Harbour-Master, Ramsgate, and communicated by Sir John Rennie, F.G.S.

The Ramsgate fishermen employed in trawling in the North Sea and English Channel, frequently bring up in their gear, fragments of fossil bones. These remains being generally charged with worms, and covered with fetid marine substances, are seldom capable of being preserved; but specimens in a good condition are sometimes procured, and of the greater part of these, Capt. Martin has been the fortunate purchaser. The following is a list of the principal specimens:

1. A tusk, 9 feet long, and 8 inches in diameter at the lower end; but the part containing the alveolar cavity is wanting, and therefore its length or greatest diameter, when perfect, cannot be ascertained. The outside consists of very thin laminæ, and the interior of a soft substance resembling putty. The specimen was found in 1827, and is in the possession of Mr. Forster of Ramsgate.

2. In 1835, a very large decayed bone, and a tusk 11 feet long, but so soft as to be cut through with a knife, the centre being of the consistence of pipe-clay, were dredged up between Boulogne and Dungeness. The bottom of the channel, at that point, consists of blue clay charged with rounded pebbles.

3. In 1837, a fisherman, trawling between the two shoals called Varn and Ridge, and in 21-fathom water, enclosed in his net a vast mass of bones, but of which only a humerus was preserved. The upper articulation is wanting, but the length of the portion obtained is 38 inches; the circumference of the upper part of the shaft, 31 inches; of the centre, 20 inches; of the part just above the condyle, 31 inches: and the width of the condyle is 10 inches. The Varn and Ridge lie in the mid-sea between Dover and Calais, forming a line of submarine chalk hills, which trend

towards the north, and are parallel with the cliffs on the opposite sides of the Channel. The Overfalls and Galloper Sands, continuations of the same line, are also steep, having deep gullies in their intermediate spaces filled with boulders and muddy ground.

4. A tusk, 78 inches long and 12 inches in circumference, but the part containing the alveolar cavity is wanting. Its curvature is equal to a semi-circle, turning out. It was trawled up at the back of the Goodwin Sands. Capt. Martin has also a fragment of a fossil tree from the same locality.

5. In the early part of 1839, a nearly perfect femur of a mammoth was obtained about midway between Yarmouth and the coast of Holland, in 25 or 26 fathoms, low-water. The length of this femur, from the ball of the socket-joint to the lower condyle, is 49 inches; the circumference of the ball, 24 inches; of the upper part of the shaft, 42 inches; of the centre, 18 inches; of the lower part above the condyle, 29 inches.

6. Two molars of the mammoth brought up in the gear of the fishermen, in different parts of the English Channel, and likewise in Capt. Martin's cabinet.

Mr. Fairholm of Ramsgate has also in his possession a molar of a mammoth, found in King-street of that town, in red clay resting upon chalk.

Independently of the remains of mammalia, the fishermen are occasionally impeded in their operations by large masses of various descriptions of rock. Some of these blocks are much worn and rounded; but the remainder never present that irregularity of form which might lead to the supposition, that they had composed part of shipwrecked cargoes.

With respect to the distribution of the animal remains and the boulders, Capt. Martin states, that they are never found on the summits of the banks or shoals, but in deep hollows or marine valleys; and that they thus agree, in position, with analogous remains and masses of rock found upon dry land.

An extract from a letter addressed to Dr. Buckland by Sir John Trevelyan, Bart., was then read.

That gentleman possesses a very large molar of an elephant, found 38 years ago in the bed of the Severn near Watchet. He also states, that Roman pottery has been frequently dredged up during the last 50 years from the estuary of the Thames near Margate; that there is an island off Herne Bay, called Pot Island, on account of the quantity of earthenware found near it. A Roman vessel, laden with pottery, is supposed to have been wrecked in the neighbourhood of this spot.

A paper entitled, "Description of five Fossil Trees found in the excavations for the Manchester and Bolton Railway," by John Hawkshaw, Esq., F.G.S., was next read.

The largest of these trees was discovered about two years since, and the other four during the spring of the present year (1839), in that portion of the Lancashire coal-field intersected by the railway. They are all in a vertical position with respect to the plane of the bed, which dips about 15° to the south; and they stand in a straight line, though obliquely to the strike of the strata. The distance between the first and the last is about 100 feet, but the intermediate trees are not equally distributed. The roots are imbedded in a soft argillaceous shale; and in the same plane with them is a bed of coal 8 or 10 inches thick, which has been ascertained to extend across the railway, or to the distance of at least 10 yards. Just above the covering of the roots, yet beneath the coal-seam, so large a quantity of *Lepidostrobus variabilis* was discovered enclosed in nodules of hard clay, that more than a bushel was collected from the small openings around the base of the trees. The trunks were wholly enveloped by a coating of friable coal, varying from $\frac{1}{4}$ to $\frac{3}{4}$ of an inch in thickness; but it crumbled away on removing the matrix. The internal casts of the trees consist of shale traversed beneath the place of the bark by irregular longitudinal flutings less than $\frac{1}{4}$ of an inch broad, and about 2 inches apart. These markings, however, are stated to be very irregular. Mr. Hawkshaw also mentions indications of a waving, irregular, fibrous structure. The dimensions of the trees are as follows:

	Circumference.	Height.
No. 1,	$15\frac{1}{2}$ feet at the base, $7\frac{1}{2}$ feet at the top......	11 feet.
No. 2,	9 —	$2\frac{1}{2}$ —
No. 3,	6 —	3 —
No. 4,	6 —	5 —
No. 5,	$7\frac{1}{2}$ —	6 —

No. 2 has three large spreading roots, nearly 4 feet in circumference; and they separate 5 or 6 feet from the trunk into 8 branches. The roots of Nos. 3 and 4 extend apparently but a short distance; those of No. 5, as far as exposed, are five in number, 4 feet in circumference, solid and strong, and are presumed to extend to a considerable distance. The position of No. 1 prevents its roots from being exposed.

Respecting the genus to which the fossils belonged, no positive opinion is offered.

The paper concludes with some observations on the disputed question, whether the plants associated with coal, grew on the spots where they have been found. Mr. Hawkshaw admits, that the vertical position of trees does not prove that they had not been drifted: but he conceives, from the experience which a residence in South America has afforded him, that it is more difficult to suppose that five drifted trees could be deposited erect in one spot, than that they grew where they occur.

Mr. Hawkshaw has not only prevented the trees from being removed, but he has had them protected, as far as possible, from the action of the weather.

A paper was then read, entitled "A notice of some Organic

Remains recently discovered in the London Clay," by Nathaniel Wetherell, Esq., F.G.S.

The fossils described in this communication, were found about three years since in the excavations on the line of the Birmingham Railway, between Euston Square and Kilburn. They occurred at depths varying from 12 to 40 feet, and generally in small hard nodular masses of a pale-brown colour. Some of the specimens, when cleared from the matrix, are oval or spindle-shaped; others are cylindrical and branched, varying in diameter from half an inch to less than a tenth, and in length from 2 to 5 inches; and several are flabelliform, with a more or less rugose surface, the width of the largest being 4 inches and three quarters, the length about 5 inches, and the thickness half an inch. The whole of the specimens are more or less covered with small oviform grains, occasionally furrowed down the middle, and generally distributed without any definite arrangement, but in some instances are disposed in rows, the grains being chiefly placed parallel to their longer axis. Besides the above more regular-shaped masses, Mr. Wetherell has obtained a vast quantity of others, which present no definite form, but are composed of small rough angular bodies, generally amorphous internally, but occasionally composed of concentric lamellæ. These specimens are likewise often more or less covered with the oviform grains, some of which may also be discovered in the substance of the specimen. The author referred to a description by Mr. Richardson, of branched bodies, in the London clay near Herne Bay, but which are not covered by the oviform grains*.

Mr. Wetherell offers no opinion relative to the true nature of these fossils, leaving their determination open to the result of future researches.

Lastly, a paper was read "On the relations of the different parts of the Old Red Sandstone, in which organic remains have recently been discovered, in the counties of Murray, Nairn, Banff, and Inverness," by J. G. Malcolmson, M.D., F.G.S.

The author commences by stating, that in a paper read before this Society in April 1838†, he announced, that Mr. Martin had discovered fossil scales and bones in the old red sandstone under the cornstone four miles to the south of Elgin, and that he had himself ascertained that many of the specimens belonged to fishes from Clashbinnie, since figured in Mr. Murchison's Silurian System‡ under the name of *Holoptychus Nobilissimus*. A careful examination of the Ichthyolite beds discovered by Mr. Miller on both sides of the south Sutor of Cromarty, convinced the author, that they also belong to the old red sandstone; and he has identified several of the fishes found there with those of Gamrie, Caithness, and Orkney; and this identification M. Agassiz confirmed with reference to the Cromarty species of Cheiracanthus, Diplopterus, and

* Geol. Proceedings, vol. ii., p. 78. † *Ibid.*, vol. ii.
‡ Plate, 2 *bis*.

the remarkable fossil called by that naturalist Coccosteus; the Gamrie species of Acanthodes, M. Agassiz likewise recognised among the Cromarty specimens. Mr. Murchison has given further proof of the age of the Caithness beds by showing that the *Dipterus macrolepidotus* so common in them, is found also in the tilestone or lowest member of the old red sandstone of England.

Dr. Malcolmson then proceeds to describe the discoveries recently made by himself, the Rev. G. Gordon, and Mr. Staples, of fossil fishes in a district of old red sandstone, extending from the village of Buckie, near Cullen, to Culloden Moor, 6 miles south of Inverness. The southern parts of this tract are occupied by primary rocks, which send off spurs and transverse ridges into the sandstone country, and they are likewise exposed in different places within its area. Wherever the contact of the two classes of rocks is exhibited, the old red sandstone rests on the edges of the older formations, dipping 8° or 12° a little west of north. The granite series also terminate at the junction with the sandstones. The old red sandstone Dr. Malcolmson divides into three portions, the lowest of which he calls the *Inferior* or *Great Conglomerate*; the middle, the *Central* or *Cornstone* division; and the uppermost, the *Fine Grain Sandstone* and *Quartzose Conglomerate*.

The lowest division is shown to belong to the great conglomerate at the base of the old red sandstone of Sutherland and Ross. The beds of which it consists are exposed in ravines on the right bank of the Nairn to the east of Inverness, also in the ravines above Cawdor Castle; but at Rait Castle they thin out, or were denudated, according to the author's view, before the deposition of the upper beds. On the east side of the hill of Rait they reappear, and extend along the Burn of Lethen for several miles. They occur also at Binnie in the vale of Rothes, south of Elgin, and along the Spey. The division consists of partially-rounded fragments of the primary rocks of the neighbourhood, cemented by a calcareous and ferruginous sandstone.

The Cornstone division consists of sandstones, calciferous concretions, conglomerates, and marls, and contains scales of the *Holoptychus Nobilissimus* and other fishes; also teeth and ichthyodorulites of new genera. This fossilliferous rock is exposed for a short distance at Scot-craig near Elgin, resting on the great conglomerate, and it passes below the cornstone of Elgin.

Resting on the Elgin cornstones is a series of very beautiful white and yellow siliceous sandstones, containing pebbles of quartz, gneiss, and granite. It may be traced from Quarry Hill near Elgin, to Burge, 3½ miles east of Forres, extending over a considerable part of the north-eastern district of Murray.

Dr. Malcolmson next describes, in detail, the cornstone series as it is displayed on the banks of the Findhorn, particularly where it is exposed between the gneiss and the Cothall limestone*, various

* Dr. Malcolmson refers to Prof. Sedgwick and Mr. Murchison's paper on this district for other information respecting the Cothall limestone, Geol. Trans., 2nd series., vol. III., p. 151.

remains of fish having been found there; and at Altyn, where he obtained scales of *Holoptychus Nobilissimus*, and abundance of Ichthyolites identical with those at Scot-craig near Elgin; also a section through the middle and inferior sandstones on the Burn of Lethen. Along this burn, from Earlsmill to Cald Hame, fine sections of sandstones, calciferous conglomerates, and marls similar to those of the Findhorn beds, are laid open, and the same organic remains are found in considerable numbers, with the addition of buckler-shaped bones allied to Cephalaspis. These beds rest at Cald Hame on a deposit of thin-bedded red sandstones and hard conglomerates, which are succeeded by a considerable thickness of hæmatitic red schistose sandstone, resting apparently on the Clunes limestone, containing Ichthyolites. These slaty beds resemble the upper red sandstones of Cromarty and Ross. In a small quarry in the grounds of Lethen, thin seams of shale and clay dip under the red sandstones, and contain nodules resembling those of Gamrie, and bituminous layers and remains of the species of Cheiracanthus common at Clunes; also plants resembling Fuci. Beneath the shales are a few feet of soft white sandstone, succeeded by the great inferior conglomerate.

The finest fish, often of a plum-blue colour, have been obtained from an excavation on the farm of Lethen-bar, in large nodules enclosed in a soft, reddish-brown schist, probably a prolongation of the shales. At Clunes, a mile to the eastward, similar remains occur in a stratum of clay and decomposed shale. The author has ascertained, by careful comparisons, that the known species obtained at the above localities are the same as those found in Orkney, Caithness, Cromarty, and Gamrie, and belong to the genera Dipterus, Diplopterus, Cheiracanthus, Cheirolepis, Osteolepis, Coccosteus, and another singular creature, which he proposes to describe hereafter. The plants above noticed, and fish scales, are also found near the hill of Rait in a ridge of red schistose sandstone.

The fossils of the valley of the Nairn are then described. Fragments and casts of tuberculated scales and bones, resembling some of those of Lethen-bar, occur at Balfreish in a compact light-blue limestone, containing angular fragments of gneiss, porphyry, &c., and an overlying conglomerate. At the S.E. extremity of Culloden Moor, and opposite the Druidical temples of Clova, are beds of bituminous shale, and a black calcareous rock, similar to the Caithness pavement, some of which contain nodules, often very small, enclosing fish scales and vegetable impressions. The bituminous rock, Dr. Malcolmson is of opinion, is continuous with that at Inches, 4 miles to the west, and 2 south-west of Inverness, described by Prof. Sedgwick and Mr. Murchison, and shown by them to be a prolongation of the bituminous schists of Caithness and Strathpeffer.

The banks of the Spey, the Burn of Tynat, and the strata at Buckie in Banffshire, have been discovered by Dr. Malcolmson and the Rev. G. Gordon, to contain the same remains. The localities mentioned are the beds of shale and red sandstone opposite Dipple, where remains of the Coccosteus, Dipterus, and *Osteolepis magus*, occur. These beds are overlaid by others resembling those which cover the Ichthyolites of Lethen and Cromarty.

Following the strike of the Dipple beds into Banffshire, the author and the Rev. G. Gordon discovered, at the Burn of Tynas, 4 miles E. of Fochabers, a similar series of shales and sandstones containing Ichthyolites, enclosed, as usual, in flattened nodules. Many fine specimens of species common to Lethen, Cromarty, &c., were procured in the highest stratum. At Buckie, the inferior conglomerate is partially covered by patches of a red schistose sandstone, in which a tuberculated bone, similar to those in the Burn of Tynat, was found. The shore near this point is said to exhibit fine examples of a raised beach.

From the facts contained in the paper, the author concludes,

1. The primary strata were thrown into highly-inclined positions before the deposition of the old red sandstone. The elevation of the secondary strata to their present position, he conceives may have been produced by elevation in the line of the Grampians, or of the Great Caledonian Canal, subsequent to the accumulation of the Purbeck beds at Linksfield.

2. The great conglomerate and red sandstones containing Dipteri, Cheiracanthi, &c., represent the Orkney, Caithness, and Gamrie strata in Scotland, and the inferior beds of the old red sandstone of England.

3. The superimposed marly conglomerates, sandstones, and marlstones, with a distinct series of fossils, are equivalents of the central division of the old red sandstone system to the south of the Grampians, and in England.

Lastly, That there are no indications of the coal strata.

Dr. Malcolmson terminates his memoir by stating, that the Gamrie Ichthyolites clearly belong to the old red sandstone, and not to the coal measures.

This being the last evening of the Session, the Society adjourned, at the conclusion of its business, to Wednesday, the 6th of November.

ERRATA.

Page 15, bottom line, *for* Herculis *read* Hercules.
— 101, line 1, *for* George Long, Esq. *read* Henry Lawes Long, Esq., Hampton Lodge, Surrey.
— 126, — 23, *for* miles *read* inches.

INDEX

TO THE COMMUNICATIONS READ DURING THE SESSION

1838—1839.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. IV. 1839. No. 65.

November 6.—George Samuel Fereday Smith, Esq., of Manchester; William Taprell, Esq., Caroline Place, Mecklenburgh Square; and Edmund Morris, Esq., Oxford Terrace, Hyde Park, were elected Fellows of the Society.

A notice of showers of ashes which fell on board the Roxburgh, at sea, off the Cape de Verd islands, February, 1839, by the Rev. W. B. Clarke, F.G.S., was first read.

The object of this communication is to register an interesting occurrence, though the author possesses no direct evidence of its probable cause.

On February 2, when the Roxburgh was in latitude 21° 14′ N. long. 25° 6′ W., the wind, which had blown from the north-east, during the passage from Plymouth, changed to the east and south-east, and was accompanied with a thick haze of a peculiar kind. The same description of weather prevailed on the 3rd, when the ship was off St. Anthony, one of the Cape de Verd islands.

On Feb. 4, the latitude at noon was 14° 31′ N., long. 25° 16′ W. The sky was overcast, and the weather was thicker than before and insufferably oppressive, though the thermometer was only 72°. At 3 P.M. the wind suddenly lulled into a calm, then rose from the south-west, and was accompanied with rain, and the air appeared to be filled with dust, which affected the eyes of the passengers and crew. At 10½ P.M. the wind returned to the east and blew strongly. During the continuance of the haze, which was as thick as a November fog, and extended all around the horizon, dust was gradually deposited on every part of the ship that offered a lodgement. At noon, on the 5th of February, the Roxburgh was in lat. 12° 36′ N., long. 24° 13′ W., thermometer 72°, barometer 30°, the height at which it had stood during the voyage from England. The volcanic island Fogo, one of the Cape de Verd's, was about 45 miles distant. The weather was clear and fine, but the sails were found to be covered with an impalpable reddish-brown powder, or a kind of triturated pumice, which Mr. Clarke says resembled many of the ashes ejected from Vesuvius, and was evidently not sand blown from the African desert. On the 6th the wind returned to the south-east, and the weather afterwards resumed its ordinary characters.

The circumstances connected with these atmospherical changes induced the author to infer that they were due to an eruption in the Cape de Verd group.

In June, 1822, the ship Kingston, of Bristol, bound to Jamaica, while passing near Fogo, had her sails covered with a similar brownish triturated pumice, which it is stated smelt strongly of sulphur.

Mr. Clarke also mentions the following instances of similar phenomena on the authority of the officers of the Roxburgh :—

In the lat. of the Canaries, and long. 35° W., showers of ashes have been noticed two or three times. At Bombay the decks of the vessels were on one occasion covered to the depth of an inch with dust, which was supposed to have been blown from Arabia.

In January, 1838, dust was noticed by the crew of a vessel navigating the China sea, a considerable distance from the Bashee islands, one of which had been previously seen in eruption*.

In 1812, ashes fell on the deck of a packet bound to the Brazil, and when 1000 miles from land.

Mr. Clarke also mentions the ashes which fell at sea during the eruption of Vesuvius in 1822, and 400 miles from that volcano; likewise the reddish dust which fell in the south of Italy and in Sicily on the 16th May, 1830, as well as in 1807 and 1813, during eruptions of Etna, and at first attributed to those outbursts, but afterwards found to be sand similar to that of the desert of Africa. During the eruption in May, 1830, a caravan perished beneath a whirlwind of sand, and similar storms occurred during the eruptions of 1807 and 1813†.

A letter was then read from Mr. Caldcleugh, dated St. Jago de Chili, 18th February, 1839, containing the following translation of the declaration of the master and crew of the Chilian schooner Thily.

"I, the undersigned, Joseph Napoleon Escofier, master of the said vessel, and with the corroborating evidence of my crew, declare as follows :—

"This, the 12th day of February, 1839, at ten minutes past 9 o'clock in the morning, being in lat. 33° 32′ S., and 74° 32′ W. long. of the meridian of Cadiz (80° 51′ W. of Greenwich), we felt an earthquake, which lasted more than a minute. The noise which accompanied it was similar to that caused by the running out of a heavy chain cable. At fifteen minutes past 7 o'clook of the same evening we saw an island rising out of the sea, of the height of Curauma Point, bearing south 79° W. by compass, distant from six to nine miles. A considerable time afterwards the island divided itself into the form of two pyramids, the most northern one crumbled away diagonally towards the north, and the southern one disappeared in pieces, the base however always remaining above the surface of the sea. At half-past 7 o'clock the same island appeared again, or its size became considerably increased, but shortly afterwards its summit be-

* Mr. Clarke believes that this is the first announcement of a volcano in that group.

† Bulletin, Soc. Geol. France.

came flattened. At thirty-five minutes past 7 o'clock two other islands appeared to the southward of the first. Of these, the most southern bore south 56° west. The three islands appeared to run in the direction of north and south. The sea broke with violence upon their shores and seemed violently agitated. In the distances between these islands nothing was visible but chains of rocks, among which a great explosion was discernible.

"At eight minutes before 8 o'clock, the most northern island was the only one visible : it appeared much higher than before, and of the shape of a sugar loaf. The darkness of the night prevented us seeing the other two islands.

"The following day, the 13th of the month, at a quarter past 1 o'clock in the morning, the larboard watch and myself saw at intervals a light in the same direction as the islands, south 72° west, which appeared to be caused by a volcano.

Position of the most northern island:
Long. W. of meridian of Cadiz, 70° 33′ (76° 52′ W. of Greenwich.)
Lat. S.............................. 33 34.

Position of the most southern island:
Long. W. of meridian of Cadiz, 70° 34′ (76° 53′ W. of Greenwich.)
Lat. .... 33 40.

"I consider my longitude to be correct from having sighted Juan Fernandez on the 11th, at 8 o'clock in the morning, and compared its bearings with my latitude by observation.

"Signed, &c. &c. &c."

Mr. Caldcleugh adds, the master of another vessel reported that the islands bore 30 leagues due east of Juan Fernandez ; and that a ship had been despatched from Valparaiso to discover whether they remained above water or had crumbled away.

The larger Curauma Point, referred to in the declaration, is a bluff point, about 400 feet in height, and situated to the southward of Valparaiso.

A letter was next read, addressed to Charles Lyell, Esq., V.P.G.S., by John Buddle, Esq., F.G.S., on depressions produced in the surface of the ground by excavating beds of coal.

Subsidence of the surface invariably follows the working of the subjacent beds of coal where sufficient supports are not left, but the extent of the subsidence is governed by the following circumstances :

1st. The depth of the seam of coal below the surface.

2nd. The thickness of the seam or seams removed.

3rd. The nature of the strata between the surface and the seams of coal.

4th. Whether the pillars of coal are wholly or partially worked.

If the depth from the surface does not exceed 30 fathoms, and sandstones form the predominant strata, the subsidence is about equal to the thickness of the seam of coal removed ; but if metal-stone constitute the greater portion of the intervening mass, the amount of depression in the surface is less. This rule is considered to hold good at all depths.

The degree of subsidence does not depend so much on the thickness of the bed of coal, as on the entire removal of it; but Mr. Buddle states, that he has had no opportunities of making correct observations on the relative effect produced in the surface. If a considerable portion of the coal be left, although quite inadequate to the support of the superincumbent strata, the subsidence is retarded. This is more particularly the case in the Newcastle system of working, where rectangular pillars are left in the first instance and afterwards removed. In working these pillars, stooks or blocks of coal of considerable strength are left as props to protect the colliers from the exfoliation of the roof; and though a subsidence of the superincumbent strata invariably takes place, yet the extent in the first instance, is governed by the degree of resistance of the stooks; and it frequently happens, that a large tract of a coal mine remains for several years only filled in part, and without any perceptible change occurrlng. In course of time, however, from the exfoliation of the stooks and the operation of the atmosphere, a further subsidence, called a second creep, takes place, and generally continues until the excavation is completely closed.

In the Yorkshire system, by which all the coal is taken out in the first instance, except small pillars, the roof being principally supported by wooden props and stone pillars, the subsidence of the strata takes place immediately after the coal is removed, and there is no second settlement.

It is only where water accumulates on the surface or a railway traverses a coal-field, that the amount of subsidence can be accurately ascertained.

In one instance, mentioned by Mr. Buddle, the excavation of a bed of coal 6 feet thick, one-fourth having been left in "stooks," the depth of the bed from the surface being 100 fathoms, and the overlying strata principally sandstone, the amount of subsidence was shown by the accumulation of a pond of water, to have been rather more than 3 feet deep.

In another instance, it was found necessary to restore the level of a railway three times, in consequence of three distinct sinkings of the surface having followed the successive excavating of three seams of coal. The tract in question is of a quadrangular form and about 23 acres in area, and contains the following five seams of coal:

Coal.	Depth below the surface. fath.	Thickness. ft.	in.
1. The three-quarter seam	$54\frac{1}{2}$	1	8
2. The five-quarter	62	3	6
3. The high main	73	6	3
4. The Maudlin	$83\frac{1}{2}$	5	0
5. The Hutton	107	3	8

The high-main seam was first worked, then the Maudlin, and afterwards the Hutton, and the removal of each was attended with a depression in the line of the railway. The extent of each settlement was not measured, but the whole amount was 5 feet 6 inches, the aggregate thickness of the seams being 14 feet 11 inches. This small effect Mr. Buddle explains by showing, that the railway passes near one end of the excavated tract, and that metal-stone predominates over sandstone in the superincumbent strata. The working of the five-quarter seam is now in progress, and the effects occasioned by the removal of the three lower seams are well exposed. Innumerable vertical cracks pass through the coal, its roof and pavement, but they are perfectly close except around the margin of the settlement. Along this line the strata are bent down, the cracks in the pavement are frequently open, forming considerable fissures, the coal is splintered, and the roof-stone is shattered. In the interior of the settlement the pavement is as level and smooth as if it had never been disturbed, and the cracks are quite close, passing through the seam without splintering it or producing any effect except that of rendering it tougher, or, in the language of the colliers, " woody." This effect, Mr. Buddle conceives, may be attributed to the escape of the gas, and he states that it is sometimes produced by other operations, when the coal is said to be " winded." The smoothness of the pavement, he is of opinion, is due to the direct downward pressure of the superincumbent mass; and he states, that he has never noticed any tendency to a sliding or sideway movement in any subsidence of strata occasioned by the working of the coal, except the slight obliquity occasioned by the offbreak at the sides of the settlement.

A paper was afterwards read, " On the relative ages of the tertiary and post-tertiary deposits of the Basin of the Clyde," by James Smith, Esq., of Jordan Hill, F.G.S.

In former memoirs, Mr. Smith described the indications which he had observed of changes in the relative level of sea and land in the basin of the Clyde, by which deposits had been laid dry during an extremely recent geological epoch*; and the evidences adduced by the arctic character of several of the shells, that the climate of Scotland was colder while these beds were accumulating than it is at present†. In this paper he confines his remarks to the results of subsequent observations, which prove, that in these comparative modern deposits there are two distinct formations, differing in climate and the character of their fauna, and separated by a wide interval of time. In the lower or older of these formations, Mr. Smith has found from 10 to 15 per cent. of extinct or unknown species, and he accordingly places it in Mr. Lyell's proposed pleistocene system; whilst in the upper or newer he has found only one species which exists in the present seas, and he accordingly ranges it among the post-tertiary formations of that author. Both these deposits, however, are anterior to the recent or human period.

In the lower or pleistocene formation, Mr. Smith includes the " till " or unstratified accumulation of clay and boulders, and the overlying beds of sand, gravel, and clay containing a mixture of unknown species of shells. He is of opinion that the beds presenting

* Proceedings, vol. ii. p. 427.

† *Ibid.* vol. iii. p. 118. See also Mr. Smith's paper on the Wernerian Society's Transactions, vol. viii.

the same order of superposition in the basins of the Forth and the Tay, including the submarine forest of the latter, will be found to be of the same age, though nothing at present is known of their fossils, except the discovery in the elevated beds of the Tay of the *Nucula Corbuloides* by Mr. Lyell; and that the parallel roads of Glenroy, recently shown by Mr. Darwin to be of marine origin, may be of cotemporaneous formation. Mr. Smith is also convinced, that a very great proportion of the superficial beds of sand, gravel, and clay are tertiary, although the evidence must sometimes be uncertain, owing to the want of organic remains.

During the post-tertiary period, Mr. Smith is of opinion, an elevating movement to the extent of 40 feet took place, and that at this height, the relative level of sea and land remained stationary for a considerable time, exceeding the present period of repose. The proof of this, he states, is a magnificent range of inland sea cliffs, with beds of gravel and sand interposed between them and the sea*. At first Mr. Smith supposed that the beds of this period contained a small proportion of unknown species; latterly, however, he reduced the number to one, the *Arca papillosa*, which has within a few weeks been discovered recent by Capt. Portlock on the coast of Ireland.

During the existing geological epoch no change of level appears to have taken place in the Basin of the Clyde†.

To the paper is appended a list of the shells found in these beds, but not known as inhabitants of the British seas, and of which the following is a summary.

Fossil in the Basin of the Clyde.	Fossil in other localities.	Recent in the
Tellina proxima		Arctic Seas.
Crassina multicostata	Norway and Sweden.	
Withami	Wirk and Bridlington	Rothsay Bay.
borealis	Dalmuir	Arctic Seas.
Mya truncata, var.?	Uddevalla; Canada	St. Lawrence.
Pecten Islandicus		North Seas; coast of Newfoundland.
Nucula oblonga.		
antiqua.		
corbuloides	Dundee; crag of Norwich.	
Mactra striata.		
Saxicava sulcata.		
Panopæa Bivonæ	Crag; Sicily	Yorkshire coast.
Natica clausa	Uddevalla	North Seas; coast of Newfoundland.
glaucinoides.		
fragilis	Crag.	
Nassa Monensis	Isle of Man.	
Buccinum granulatum	Crag.	
striatum.		
Trochus inflatus.		
Turbo expansus		Arctic Seas.
Velutina undata		North Seas; coast of Newfoundland.
Fusus Peruvianus	Crag	Arctic Seas.
imbricatus.		
Bulbus Smithii.		

* Proceedings, vol. ii. p. 428.

† *Ibid.*, vol. ii. p. 428.

A paper was last read, "On the foul air in the chalk and strata above the chalk near London," by James Mitchell, LL.D., F.G.S.

In the chalk, the most abundant deleterious gas is the carbonic acid, but it has been found to exist in greater quantity in the lower than in the upper portion of the formation, and in that division to be unequally distributed. In sinking wells, it has been noticed to issue with force from one stratum, whilst none has been perceived to be given out from the beds immediately above and below it. Dr. Mitchell mentions fatal effects due to its occurrence in a well near the race-course at Epsom, where it was met with at the depth of 200 feet; and in Norbury Park, near Dorking, at the depth of 400 feet. On Bexley Heath, after sinking through 140 feet of gravel and sand and 30 feet of chalk, it rushed out and extinguished the candles of the workmen; and in making a well in Long Lane, Bexley Heath, after penetrating 124 feet of overlying deposits, and then 90 feet of chalk, considerable inconvenience was felt from it, but 6 feet lower no gas was emitted.

In chalk, sulphuretted hydrogen gas is also occasionally met with, and is supposed to be generated from the decomposition of water and iron pyrites.

In districts in which the chalk is covered with sand and London clay, carburetted hydrogen gas is sometimes emitted, but more frequently sulphuretted hydrogen gas.

Carburetted hydrogen has seldom inflamed in wells, but in making the Thames tunnel it has sometimes issued in such abundance as to explode by the lights and scorch the workmen.

Sulphuretted hydrogen gas is more abundant, and it has been observed almost always to proceed from a coarse black sand charged with oxide of iron, whether the bed be above the blue clay, within it, or below it. It has streamed out with great violence in the Thames tunnel, but has in no instance produced fatal effects. At Ash, 3 miles from Farnham, a well was dug in sand to the depth of 36 feet, and one of the workmen on descending into it was instantly suffocated. Fatal effects have also resulted from the accumulation of this gas in wells in Maiden-lane, Battle-bridge, and at Applebury-street, near Cheshunt. This gas is much increased, after long-continued rain, in consequence of the swelling of the clay driving it out of the interstices; and it is diminished after a long drought. The prevalence of a north-east wind has been noticed by well-diggers to diminish the quantity of the gas, but the effect is ascribed by Dr. Mitchell to the dry weather which usually accompanies the wind from that quarter. The author also suggests, that if wells are to be dug in dangerous districts, they should be undertaken when there is least water in the ground, or from the beginning of July to October.

The noxious gas in the Weald of Kent and Sussex is stated to be sulphuretted hydrogen.

November 20.—John Williams, Esq., Lieutenant, Royal Engineers, employed on the Trigonometrical Survey of Ireland, was elected a Fellow of this Society.

An extract from a letter addressed to Dr. Andrew Smith by A. G. Bain, Esq., dated Graham Town, Cape of Good Hope, February 21st, 1839, and communicated by Charles Darwin, Esq., was first read.

The object of this extract is to announce the discovery, by Mr. Martin Smith, of the piths and portions of the head of an ox in the alluvial banks of the Modder, one of the tributaries of the Orange river, and 40 feet below the surface of the ground. The piths with the breadth across the *os frontis* measured 11 feet 7 inches, but it is calculated that 5 inches had been broken off the end of each tip; and the circumference of the piths at the root was 18 inches. The orbits were situated immediately under the base of the horns. Part of the upper jaw, containing five molar teeth and other fragments of the head, as well as a cervical vertebra, were found at the same time.

A paper "On the origin of the vegetation of our Coal-fields and Wealdens," by J. T. Barber Beaumont, Esq., F.G.S., was next read.

An examination of the fossil trees discovered on the line of the Manchester and Bolton Railway* has confirmed Mr. Beaumont in the opinion, that in no instance has the vegetation of the coal-fields arisen from drifted trees sunk to the bottom of mighty rivers and estuaries, but that it grew where it is found; and he is further of opinion, that the districts composing our present coal-fields were originally islands.

The principal objections of the author to the theory of the transportation of the fossil vegetation are the following:

1. The existence of a mighty river or estuary at the time of the deposition of the coal-measures, would require the existence of a vast continent of which there are no traces.

2. The coal strata near Newcastle are 380 yards in thickness, and consequently, the lowest strata must have been deposited at the bottom of a river or estuary, exceeding in depth, six times the mean depth of the German Ocean.

3. A continent producing such a river, it is reasonable to expect, would have left an abundance of fossils on its surface, as well as at the bottom of its great river; but all the land for hundreds of leagues around the coal and wealden formation swarms with the remains of marine animals, and is clearly an ancient sea bed.

4. In the coal-measures not a bone of a land quadruped is to be found, or a large timber tree, with the exception of a few Coniferæ.

5. In order that the vegetation should have sunk to the bottom of a deep river, it must first have decayed; but the plants preserved in the beds associated with the coal, present a freshness and perfection incompatible with such a condition.

6. Drifted trees are stopped in deltas only from the shallowness of the water being insufficient to float them on; we know of no deposits of trees in deep water.

The author then offers the following theory as affording a preferable explanation of the origin of coal-fields and Wealden formations.

* See the Abstract of Mr. Hawkshaw's Paper, *ante*, p. 139.

He conceives they were originally swampy islands, formed out of disjointed fragments which resulted from the first elevation of the rocks; that on these islands grew a luxuriant vegetation consisting of Ferns, Calamites, coniferous trees, &c. which, decaying and regenerating, accumulated in the manner of peat bogs; that the islands, by the settling down of the disturbed crust of the earth, were depressed beneath the surface of the sea, and covered over with drifted sand, clay, and shells, till they were again, by this process, converted into dry land, and clothed with another vegetation; and he is of opinion, that the operation was repeated as many times as there are alternations of coal and sedimentary strata.

A notice on the Fossil Fishes of the Yorkshire and Lancashire Coal-fields, by W. C. Williamson, Esq., was then read.

About four years ago, Mr. Williamson first met with remains of fishes in the coal-measures of Lancashire. Nearly at the same time Sir Philip Grey Egerton detected them in the Staffordshire fields; Mr. Hutton had previously found them near Newcastle; Dr. Hibbert Ware had brought them before the public in Scotland; Mr. Bowman had detected scales of Holoptychus in Wales; and two or three instances had been noticed of their existence in the coal-fields of Yorkshire. Since that period, however, the coal-measures of Lancashire and Yorkshire have proved to be exceedingly rich in Ichthyolites. In the former, they occur throughout the whole series from the Ardwick limestone to the millstone grit; and at Middleton colliery, near Leeds, they have also been found in considerable quantity. At that locality there are three seams of coal, but only two are wrought. The following is a general section of the pits:—

Fish coal	14 inches.
Interval	60 yards.
Yard coal	3 feet.
Interval	32 yards.
Main coal	$4\frac{1}{2}$ feet.

Ichthyolites occur in the shale in connexion with all the seams, but principally in the uppermost one, to which the colliers have in consequence given the name of Fish Coal. They are contained in a fine bituminous shale, and in greatest abundance at the junction of the roof with the coal, where a very thin seam of coprolitic matter occurs. The author has obtained from it the following remains:—

Teeth of *Diplodus gibbosus* and *Ctenoptychus pectinatus*; scales, jaws, and teeth of *Megalicthys Hibbertii*, and of another smaller species; rays of *Gyracanthus formosus*; scales, fins, and other portions of two species of Holoptychus, of a species of Acanthodes, or Cheiracanthus? and of a species of Platysomus; also three kinds of Ichthyodorulites, and other remains of which he has not yet determined the genera.

In the shale of the main coal Ichthyolites are much less abundant, but they are remarkable for their great size. They occur in a coarser shale, and consist chiefly of large teeth and vertebræ of a species of Holoptychus and rays of Gyracanthus.

The yard coal shale is still less fruitful than either of the other seams, and has yielded only a few small teeth of Holoptychus, Ctenoptychus, and some other unimportant fragments. It has however been very slightly examined.

On comparing these fossils with the Ichthyolites which he has found in Lancashire, the author has ascertained that many are identical, but that others differ. The species of Diplodus, Ctenoptychus, Megalicthys, Gyracanthus, one of Holoptychus ? and Platysomus ? exactly correspond in each district. In the Lancashire field he has found remains of *Ctenoptychus apicalis* and *C. denticulatus*, which he has not noticed in the Yorkshire; and he is inclined to think, that the former field is characterized, if there be a difference, by the greater prevalence of Lepidoid fishes, and the latter by those of the Sauroid family.

The Ichthyolites occur chiefly in highly bituminous shales, with the exception of the Ardwick limestone, and most abundantly where it is finely grained. They are rarely associated with any quantity of vegetable remains; and this disposition of the two kingdoms, Mr. Williamson is of opinion may assist in determining the conditions under which the coal-measures were deposited. The Ichthyolites also are in general more common in the roof than the floor of the coal; but in the cannel-seams of Wigan in Lancashire, and in the thin seams connected with the limestones at Ardwick, they are most abundant in the floor. They are rarely found in the coal itself, and the instances in which they have been met with in that position by the author, have been chiefly in the Middleton colliery.

The manner in which Ichthyolites are associated with other remains, Mr. Williamson states, is well worthy of attention. At Burdiehouse they occur in the midst of Unios, Cyprides, and *Microconchus carbonarius*; at Colebrook Dale, with species of Orbicula, Trochus, Nautilus, Orthoceras, and Conularia; in the lower measures of Lancashire in beds nearly associated with those containing *Goniatites Listeri* and *Pecten papyraceus* ; in the higher measures of Lancashire and in Yorkshire, with Unionidæ and Entomostraca; at Middleton, with Lingulæ; at the top of the series in Lancashire and Derbyshire, with Mytili.

In conclusion, the author acknowledges his obligations to Mr. Thomas Seale of Leeds, and to Mr. Embleton, the manager of the Middleton collieries.

A paper was last read, entitled, "A brief notice of the Geology around the shores of Waterford Haven," by Major Austin.

In this memoir, the author describes topographically the geology of Waterford Haven, commencing at Bag and Bun Head, near its eastern entrance, and proceeding around its shores terminates his account at Ballymacaw. The formations of which the district consists are, 1. limestone; 2. a conglomerate; 3. clay-slate; 4. various trap-rocks; and 5. alluvium.

1. The limestone constitutes the promontory forming the eastern boundary of the Haven from Hook Point to the parallel of Sand Eel Bay, a distance of about $3\frac{1}{2}$ miles. Some of the beds are of a dark colour, and are so fissile as to be used for roofing-slate; they are also highly sonorous when struck with a hammer, and are in consequence locally called the "Black Bell." In the lower part of the formation, in Bryce's Bay, the limestone is yellow. Fossils, including spined Productæ and Crinoideæ compose the greater part of some of the strata. Near the conglomerate the limestone alternates with thin layers of slate, and at the immediate junction is a stratum of fine red sand containing impressions of numerous fossils. The strata, where undisturbed, dip to the S.S.W. at an angle of about 22°, but they are sometimes considerably contorted.

2. The conglomerate composes a band about half a mile broad, stretching across the promontory from Sand Eel Bay to Herrylock, and is of a deep-chocolate colour. It constitutes Broom Hill, where it assumes partly the character of a compact grit, and partly that of a coarse compound of fragments of schist, quartz, and other pebbles imbedded in a chocolate-coloured cement; the quartz pebbles being traversed by numerous fissures. Other patches of conglomerate occur between King's Bay and Buttermilk Castle, and are said to overlay the edges of highly-inclined strata of clay-slate. It forms also the hills north of the Suire in the county of Kilkenny, where it is worked for millstones, and it composes, with a few interruptions, the whole of the west side of the Haven.

3. The clay-slate is extensively developed on the east side of the Haven from Temple Bay to Great Island at the confluence of the Suire with the Nore and the Barrow, forming a series of cliffs, in which the strata are excessively contorted. It also forms the cliffs from the west shore of the Nore opposite Little Island and the right bank of the Suire; a small patch of it occurs likewise south of Passage. The contortions in the cliffs on the east side of the Haven, Major Austin ascribes to lateral pressure, and he states that the ridges of clay-slate range at right angles to the band of conglomerate which traverses the promontory at Sand Eel Bay. These contortions are more especially marked and numerous between Dollar Bay and Bluff Head, ranging from the top to the bottom of cliffs 250 feet in height. At the south point of Booley Bay the slate affords beautiful examples of ripple marks. It is stated to be perforated along the whole line of coast, by hollows varying in size from a pin's point to five inches in length, and to the height of 20 feet above high-water mark. On the hill above the Roman Catholic chapel, north of Duncannon sands, the slate has a prismatic structure. It is stated to have been altered by igneous operations on the west side of Great Island and in Little Island. Near Ballyhack the cleavage is diagonal to the plane of stratification.

4. Trap forms at Herrylock a mass protruding from the beach; also the narrow point on which Duncannon Castle stands, where it is stated to rest on the tilted edges of clay-slate, and to have altered that rock into an indurated, stratified, yellow stone. A basaltic dyke

occurs opposite Great Island on the Kilkenny side of the Nore. It rises abruptly to the height of 100 feet, and from its white colour, due to the decomposition of the felspar, is called the White Horse. A considerable mass of trap is also at the Orphan School House ; and other masses at Cheek Point in the bend of the Haven to the southward, and at Newtown on the western shore of the Haven.

5. Alluvium. Modern accumulations occur in Dollar Bay; Aldridge Bay; to the north of Bluff Head, where a layer of slate shingle is converted into a coarse conglomerate by carbonate of lime; between Bluff Head and Duncannon, constituting the Duncannon sands, and extending inland up a small valley, in which is a peat bed; the narrow valley at King's Bay or Arthurstown ; to the south of Dunbrody Abbey; and in Woodstown valley, on the west side of the Haven. Major Austin states, that greenstone boulders occur in all parts of Wexford, but that no rock *in situ* of character similar to them is to be found in the county.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

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December 4.—Angus Friend Mackintosh, Esq., Chenies Street, Bedford Square, was elected a Fellow of this Society.

A paper was first read, entitled "A Description of the Soft Parts and of the shape of the Hind Fin of the Ichthyosaurus, as when recent," by Richard Owen, Esq., F.R.S., F.G.S.

The osseous frame-work of the fin of the Ichthyosaurus, Mr. Owen observes, having alone been the subject of direct examination, the exact shape and the nature of the soft parts had been matters of conjecture. A very striking deviation from the reptilian and mammalian types had, indeed, been recognised, and resemblance also to the fins of fishes had been admitted in the digits of the fin exceeding five, in their being sometimes bifurcated, and in consisting of an extraordinary number of ossicles; yet owing to the form of the digital ossicles, their breadth and flatness, and their large size, as compared with the joints of the fin-rays of fishes, it had been generally supposed that the locomotive organs of the Ichthyosaurus were enveloped, while living, in a smooth integument, which like that of the turtle and porpoise, had no other support than was afforded by the bones and ligaments within.

Sir Philip Grey Egerton in a recent examination of Ichthyosaurian remains in the possession of Mr. Lee of Barrow-on-Soar, detected, with the penetration which has enabled him to bring to light many other obscure points in the structure of the Ichthyosaurus, traces of the soft parts of the fin in a slab of lias containing a mutilated paddle; and having submitted the specimen to the examination of Mr. Owen, a detailed account of its character forms the subject of this memoir.

Mr. Owen considers the specimen to be a posterior fin of the *Ichthyosaurus communis*. It presents impressions and fractured portions of six digits, with the impression,—and a thin layer, most distinctly preserved,—of the dark carbonized integument of the terminal half of the fin, the contour of which is thus most beautifully defined.

The anterior margin is formed by a smooth unbroken well-marked line, apparently a duplication of the integument; but the whole of the posterior margin exhibits the remains and impressions of a series of rays by which the fold of the integument was supported. Immediately posterior to the digital ossicles, is a band of carbonaceous matter of a distinctly fibrous structure, varying from two to four lines in breadth, and extending in an obtusely-pointed form for an inch and a half beyond the digital ossicles. This band Mr. Owen believes to be the remains of the dense ligamentous matter which immediately invested the bones of the paddle, and connected them with the enveloping skin. The rays, above mentioned, are continued from the posterior edge of this carbonized ligamentous matter, in which their bases appear to have been implanted, to the edge of the tegumentary impression; the upper rays being directed transversely, but the others gradually lying more in the direction of the axis of the fin, as they approach its termination. The most interesting feature in these rays, Mr. Owen says, is their bifurcating as they approach the edge of the fin.

From the rarity of their preservation, their appearance and co-existence in the present instance with remains of the integument, he states, it is evident they were not osseous, but probably either cartilaginous, or of that albuminous horn-like tissue, of which the marginal rays consist in the fins of the sharks and other plagiostomous fishes. Besides the impression of the posterior marginal rays, the specimen presents a series of fine, raised, transverse lines, which cross the whole fin, and probably indicate a division of the rigid integument into scutiform compartments, analogous to those on the paddle of the Turtle and webbed foot of the Crocodile; but they differ in the absence of subdivision by secondary longitudinal impressions. The structure of the integument of the fin agrees, therefore, with the known reptilian characters of the skeleton of the Ichthyosaurus; and, as the skin with its appendages gives a character to the great primary groups of vertebrata, it might be expected that the skin of the Ichthyosaurus would exhibit some of the characters of the integument of existing reptiles.

In conclusion, Mr. Owen remarks, that the other new facts presented by the specimen, accord with the indications of the natural affinities of the Ichthyosauri afforded by their less perishable remains; and that all the deviations from the reptilian structure of the skeleton, tend to the type of fishes and not to that of cetaceous remains.

A paper was afterwards read on as much of the great graywacke system as is comprised in the group of West Somerset, Devon, and Cornwall, by the Rev. D. Williams, F.G.S.

This communication is supplementary to one read in April 1839*, and contains the results of the author's last investigation into the structure of country. Before he details his present views, he corrects what he conceives was an error in his former paper, and states, he is now convinced that the slates and limestones of South Devon and Cornwall are not a prolongation of the trilobite slates (No. 7)†

* See *antè*, p. 115.

† The following is the descending arrangement given in Mr. Williams's former paper: 9, floriferous slates and sandstones (*culm measures*); 8, Coddon Hill grits; 7, trilobite slates; 6, Wollacomb sandstones; 5, Morte slates; 4, Trentishoe slates; 3, calcareous slates of Linton; 2, Foreland or Dunkerry sandstone; 1, Cannington Park limestone, see *antè*, p. 116.

of Exmoor, but a distinct formation superior to the floriferous grits or culm measures (No. 9,) of central Devonshire, and consequently the newest deposits of the country. For this formation he proposes the name of Killas or Cornish, and he considers it as No. 10 in the ascending series. According to the new arrangement therefore, in proceeding from those parts of West Somerset bordering the Bristol Channel to the south of Devon and Cornwall, he conceives a regular ascending series is passed over, the central portion of which he is of opinion, consists of the floriferous grit or culm measures (9). He places the whole series also in the graywacke system.

Mr. Williams's reasons for this arrangement are drawn from observations made at several localities in South Devon.

At Doddiscombe Leigh, about four miles to the north of Chudleigh, the Posidonia limestone, a member of No. 8, the Coddon Hill grit, underlies, Mr. Williams says, a long series of alternations, exposed on the turnpike road towards Chudleigh, and consisting of high hills of Coddon and floriferous grits with intercalated killas, the whole dipping beneath the coral limestones of Chudleigh, which pass under the ridge of Ugbrook considered by Mr. Williams to be composed of floriferous grits. On closely examining the limestones about Chudleigh, the author discovered minor alternations, which exhibited in juxtaposition the several varieties of Cornish killas, pale green, light blue, and purple volcanic ash and Coddon Hill grits (the two latter containing plants), interstratified beyond any doubt among the coral limestones, and these limestones inclosing carbonaceous beds, underlaid and overlaid by thick accumulations of Coddon Hill and floriferous grits. On the road by Grayleigh, and descending further on to Waddon Burton, Mr. Williams has traced these alternations foot by foot, and he says the sequents are so manifestly palpable in their interchanges, great and small, that nothing is left for inference or conjecture.

The inseparable connexion of the coral limestone and Cornish killas with the floriferous series, he states, is also most plainly exhibited to the N.E. of Kingsteignton, at Ashburton, Newton Bushel, Abbots, and King's Kerswell, Marldon, Berry Pomeroy, Higher and Lower Yalberton, and thence to Brixham and Berry Head. At Meadfort sands, on the south, the author says, there is a strange intermixture, yet in regular stratified order, of Cornish clay slate, and buff-coloured, finely arenaceous beds inclosing shells and corals, with true floriferous sandstones containing plants, also with culmy slates, and strata of volcanic ash and coral limestones, forming an anticlinal axis, ranging north and south, and throwing off the great mass of the Torquay limestones to the east and west.

To the east of Dartmoor, Mr. Williams has little doubt the same alternations on a great and small scale occur, as far as the parallel of Torquay, immediately to the south of which line, but west of the bay, are said to be lofty conspicuous hills of the floriferous strata (No. 9), which he conceives "may be abruptions"; but their bases are commonly concealed by a thick mantle of new red sandstone. To the west of Dartmoor, independent of what he believes to be an axis of No 8, and forming the southern margin of the culm-trough, Mr. Williams has been led to conclude, that the floriferous beds, by other arcs of undulation, have broken through the thinner northern border of the killas, throwing it off on each shoulder and intercepting it in troughs. Instances of this, he says, are sufficiently apparent on each side of a line drawn from Greston Bridge on the Tamar, S.E. of Launceston, to Heath Field, north of Tavistock; the high central ridge consisting of floriferous and Coddon girts, flanked on the north by undoubted killas and volcanic ash and breccia. To the N.W., W.S.W. and S. of Greston Bridge, the floriferous series is stated to be exposed in great force, extending almost uninterruptedly in a straight line into the great body of the culm-field; but to the west it is said to be generally concealed by killas, though a continuous contracted range branches off to the westward by Lezant, Lawanick-down, and Alternau; and it appears to be depressed under, or to pass into the killas and speckled slates of Davidstow, N.E. of Camelford.

A small area of an inverted arc of undulation is exposed in and around Tavistock; and the floriferous grit, principally identified by its associated slates, is stated to underlie the high killas range of Whitcombe Down on the south; and on the north to be laid open in the road to Launceston, similarly associated, with the additional accompaniment of intercalated killas and Coddon Hill grit dipping beneath the volcanic ash of Marly Mead. Mr. Williams also mentions a shaft sunk in a copper lode close by the turnpike gate on the road from Tavistock to Callington, as another instance of floriferous grit, or a rock exactly the same as that which contains the copper lode of Wheal Friendship, underlying pale green slate or killas: and he adds, there can be no doubt that Wheal Friendship mine is in No. 9 or the floriferous series. The next instance mentioned in the paper, is at Linkinghorn and South Hill, north of Callington, where there is stated to be an entire suite of alternations of killas, Coddon grits, and floriferous grits with plants, all dipping south. Again, near Pillaton, between Callington and Saltash, there are said to be countless minor alternations of floriferous and Coddon grits, each thinning out and interlocking like the teeth of a trap. Another instance of the killas overlying the floriferous grit, is said to occur in a hill at Penter's Cross on the road from Callington to Saltash, where a cutting exhibits in the lower part, a series of alternations of floriferous sandstone, and culmy slates which in ascending disappear, and in their place a delicate pale green killas alternates with the sandstone beds, while at the summit the sandstones disappear and are replaced altogether by killas. A fault traverses the hill, and to the south of it only killas occurs.

The general results of his observations, Mr. Williams says, show, that in the ascending order, from Cannington Park and the Quantocks in Somersetshire, to the Land's End, there is a group constituted of ten strikingly simple, consecutive series, severally varying in their mineral and zoological character; that as respects the limestone suites, the thin and spare dimensions of such as occur in the Trilobite slates of Exmoor (No. 7) render them too insignificant to be noticed; that the Posidonia limestones, which by mineral gradation succeed and conformably overlie the latter, are elliptically included in the Coddon Hill grits (No. 8), and together distinctly underlie and constitute the base of the great floriferous series (No. 9): that higher up in No. 9 is an extended horizon, which separates the series into an upper and a lower, containing the Bampton, Hockworthy, Holcomb Rogus, and Hastleigh limestones, with red and black slates on the north; the Petherwen and Landlake slates and limestones on the south; and the entire suite of coral limestones to the east of Dartmoor, extending from Chudleigh to Berry Head and Brixham: that the Plymouth limestones included in the killas (No. 10) are higher in the group than those just mentioned, and are introduced first at Millaton, about a mile and a half west of St. Germains.

Mr. Williams considers the slate or killas series of S. Devon to be distinguished from the slates of Exmoor by a peculiar extraneous cleavage. In Exmoor the cleavage, he says, is at all angles, from less than 10° to the vertical, its planes having a direction of about east and west; whilst the cleavage lines of the killas either coincide with the magnetic or true meridian, or depart from it to the east or west only a few degrees, and the inclination approaches the vertical with a strike N. and S., or nearly perpendicular to that of Exmoor.

What, says Mr. Williams, are the results, if the question be tested by the assumed law, that strata may be identified by their organic remains? If the Posidoniæ and Gonitatites of the lenticular, black limestones, never exceeding thirty-five feet in thickness, be appealed to, to identify them with the mountain limestone, the weight of organic remains opposed to them in the Launceston and Petherwen fossils, the corals and other organic remains of South Devon belonging to the floriferous series, reduces the evidence to dust. If mineral characters be appealed to, he says, they fail altogether.

In conclusion, Mr. Williams remarks that in this supplement, he has endeavoured faithfully to transfer the simple truths of nature to his pages, without reference to the theories of others. He would, however, remind geologists that the proposed law of Mr. W. Smith, is no law, if it do not imply a final and universal extinction of species. This being his own view, Mr. Williams says, he could not admit that the Gonitatites and Posidoniæ of Devonshire were first introduced and became extinct with the mountain limestone, being justified by the fact of superposition, and more reasonable analogy, in concluding that these genera existed elsewhere in congenial conditions during the entire period of the deposition of the Trilobite slates, when that formation ceasing in Devonshire, the ova of the creatures or the creatures themselves were transported to a region favourable to their existence, and were continued during epochs of duration up to the period of the mountain limestone, and probably beyond it, if they be not now in existence. They appear, in his opinion, like the corals of Devon, to have been subject to repeated mineral accidents, and to have been locally destroyed in groups, not universally effaced in species. To guard himself, however, from misconstruction, Mr. Williams adds, he believes entirely in the extinction of genera and species; but at very distinct epochs, and in far thicker and more extended groups of strata than is imagined; and that consequently the identification of strata must be regulated by a per-centage test similar to that applied by Mr. Lyell to the tertiary series. Lastly, he protests against the determination of the age of the Devonshire formations by reference to the structure of a foreign district.

Dec. 18.—William Sidney Gibson, Esq., Essex Street, Strand, was elected a Fellow of this Society.

A paper was first read, entitled "Description of the fossil remains of a mammal, a bird, and a serpent, from the London clay," by Richard Owen, Esq., F.R.S., F.G.S.

The author commences by observing, that only a few months had elapsed since the highest organic animal remains known to exist in the London clay were those of reptiles and fishes; and that the danger of founding conclusions in Palæontology from negative evidence was perhaps never more strikingly illustrated than by the fact, that the first scientifically determined relic of a warm-blooded animal from that formation proved to belong to the highest order of that class, if man be excepted; and that besides those quadrumanous remains, there have since been discovered in the London clay underlying the coralline crag, near Kyson, in Suffolk, teeth of cheiroptera, and of a species probably belonging to the marsupial order*.

Mr. Owen then proceeds to describe the fossils, the immediate objects of the communication.

1. The portion of the mammal was discovered by Mr. Richardson in the cliffs of Studd Hill, near Herne Bay, and belongs to a new and extinct genus of Pachydermata. It consists of a small mutilated cranium about the size of that of a hare, containing the molar teeth of the upper jaw nearly perfect, and the sockets of the canines. The molars are seven in number on each side, and resemble more nearly those of the Chæropotamus† than of any other known genus of existing or extinct mammalia. They present three distinct modifications of the grinding surface, and increase in complexity from before backwards. The first and second spurious molars have simple sub-compressed crowns, surmounted by a single median conical cusp, with a small anterior and posterior tubercle at the outer side, and a ridge along the inner side of its base. They are separated by an interspace nearly equal to the antero-posterior diameter of the first molar. The second and remaining molars are in close juxtaposition. The third and fourth molars form the principal difference between the dentition of the present genus and that of the Chæropotamus, being larger and more complex in the grinding surface. They present a sudden increase in size and change of form. The plane of the crown is triangular, with the base outwards, and the

* Annals of Natural History, Nov. 1839.

† See *antè*, p. 1.

posterior and inner side convex: it supports three principal cusps, two on the outer, and one on the inner side; there are also two smaller elevations with a depression on the summit of each, situated in the middle of the crown, and the whole is surrounded with a ridge which is developed into a small cusp at the anterior and external angle of the tooth. The three true molars closely correspond with those of the Chæropotamus. The sockets of the canines indicate that these teeth were relatively as large as in the peccari.

The bones of the head are separately described: the palatal processes of the maxillary bones are shown to be rugous, as in the peccari; the eye to have been full and large, as indicated by the size of the optic foramen and the capacity of the orbit, equalling an inch in vertical diameter: the general form of the skull is described as partaking of a character intermediate between that of the hog and the hyrax, though the large size of the eye must have given to the physiognomy of the living animal a resemblance to that of the Rodentia.

These indications, Mr. Owen says, scanty though they be, of the form of a species nearly allied to the Chæropotamus, are extremely interesting, on account of the absence of similar information regarding that genus. The resemblance of the molar division of the dental system in the new genus, for which the name of Hyracotherium is proposed, and the Chæropotamus, is sufficiently close to warrant the conclusion, that the canines and incisors if not similar would differ only in form and proportion; and that hence it may be ventured to solve analogically some of the doubts entertained by Cuvier respecting the dental characters of the Chæropotamus, and to affirm confidently that it had canines in the upper as well as the lower jaw. The incisor teeth with the ossa intermaxillaria are wanting in the specimen of the Hyracotherium, and have not been found in any fragment of the Chæropotamus.

2. The remains of birds described in the paper consist of a sternum, with other bones, and a sacrum, the former belonging to the collection of the late John Hunter, in the Royal College of Surgeons, and the latter to the cabinet of Mr. Bowerbank. Both the specimens were obtained from Sheppey. The Hunterian fossil includes the sternum nearly entire, the proximal ends of the coracoid bones, a dorsal vertebra, the distal end of the left femur, the proximal end of the corresponding tibia, and a few fragments of ribs. Mr. Owen first shows, in approximating to which of the three great groups of birds, terrestrial, aerial, or aquatic, the Ornitholite belonged, that from the length of the sternum and the remains of the primary intermuscular crest or keel, it could not have been a strictly terrestrial bird, though these characters do not prove that it was a bird of flight, as they occur in the Penguins or other Brachyptera, which have need of muscular forces to work their wings as paddles under water. In the present fossil, however, from the lateral extent and convexity of the sternal plate, the presence and course of

the secondary intermuscular ridges, the commencement of the keel a little way behind the anterior margin of the sternum, Mr. Owen says there is no affinity with the brachypterous family. The coracoid bones or posterior clavicles, he also shows are less available in determining the habits of the Ornitholite, as they relate much more closely to the respiratory actions than to the movements of the wings, and are strongly developed even in the Apteryx. There remained consequently for comparison the ordinary birds of flight; and of these, the native species, which resemble the fossil in size, first claimed Mr. Owen's attention. Though the sternum is not complete, yet sufficient remains to have enabled him to set aside the Gallinaceous, and those Grallatorial and Passerine birds which have deeply incised sternums, and to restrict the field of comparison to such species as have the sternum either entire, or with shallow posterior emarginations. After a rigid comparison of the minor structural details and pursuing it from the sea gulls and other aquatic birds upwards through the Grallatorial and Passerine orders, omitting few British species, and no genus, he at length found the greatest number of correspondences in the skeleton of the accipitrine species. The resemblance, however, was not sufficiently close to admit of the fossil being referred to any native genus of Raptores: the breadth of the proximal end of the coracoid removes it from the owls (*Strigidæ*), the shaft of the same bone is too slender for the Falconidæ; and the femur and tibia are relatively weaker than in many of the British Hawks or Buzzards. It is with the Vultures that Mr. Owen has found the closest agreement; but he says the fossil indicates a smaller species than any known to exist in the present day, and is probably a distinct subgenus.

The professed ornithologist, Mr. Owen remarks, may receive with reasonable hesitation a determination of family affinities arrived at, in the absence of the usual characters deduced from the beak and feet; but in the course of a long series of close comparisons, he says, he has met with so many more characters, both appreciable and available in the present problem, than he anticipated, that he confidently expects, in the event of the mandibles, the bones of the feet, or the entire sternum of the bird in question being found, they will establish his present conclusion, that the Sheppey ornitholite is referrible to a member of the group of Accipitrine Scavengers, so abundant in the warmer latitudes of the present world.

The Ornitholite in Mr. Bowerbank's museum consists of ten sacral vertebræ anchylosed together, as is usual in birds with a continuous keel-like spinal ridge. Four of the vertebræ are analogous to the lumbar vertebræ in the mammalia, and they are succeeded by five others, in which, as in the Vultures, the inferior transverse processes are not developed. This character, however, Mr. Owen says, is not peculiar to the Vulturidæ. Though the part of the fossil preserved is eminently characteristic of the class of birds, yet it is not calculated to throw light on the closer affinities of the species to which it belongs: nevertheless it supports rather than affects the determination of the Hunterian specimen. For the apparently extinct bird indicated by these fossils, the name of *Lithornis vulturinus* is provisionally proposed.

3. Mr. Owen commences his description of the remains of an extinct species of Serpent found at Sheppey, by pointing out the essential characters by which the vertebræ of an Ophidian Reptile are distinguished.

Vertebræ joined enarthrodially by a deep anterior transversely oblong cup and a corresponding prominent posterior ball, and further articulated by projecting posterior oblique processes, wedged liked the carpenter's tenon into a mortice, excavated in the anterior oblique processes of the succeeding vertebra, supporting moreover on each side of the fore part of the body an oblong convexity for the moveable articulation of the rib, can belong, Mr. Owen observes, to no other than a reptile of the Ophidian order.

One of the specimens described in this portion of the memoir, consists of about 30 vertebræ possessing the above characters; also of a number of long slender ribs, having expanded concave vertebral extremities cemented irregularly together by a mass of indurated clay, and it forms part of the Hunterian collection of fossils; another specimen, consisting of 28 vertebræ, and some others of less magnitude, belong to Mr. Bowerbank's collection. All the specimens, Mr. Owen considers, are referrible to the same species, and they were all found at Sheppey.

The vertebræ in each specimen present the same conformation, and nearly the same size, being equal in this respect to those of a Boa Constrictor 10 feet long. They belong to the ordinary dorsal or costal series, and differ from those of the Boa and Python in their superior length as compared to their breadth and height. The ridge continued from the anterior to the posterior oblique processes on each side is less developed: the oblique processes themselves do not extend so far outwards; and the spinous process is narrower in its antero-posterior extent but longer. In the first two of these differences, the fossil agrees with the Linnean Coluber and its subgenera, but differs from the Crotalus; and in the remaining points it differs from Crotalus, Coluber, Naja and Trigonocephalus. The long and comparatively narrow spine, the outward prolongation of the upper angle of the posterior oblique processes, the uniform convexity of the costal protuberance, the uneven or finely wrinkled external surface of the superior arch of the vertebra, are characters which distinguish these Ophidian vertebræ from those of any other genus of the order with which Mr. Owen has been able to compare them. He therefore proposes to call the species provisionally *Palæophis Toliapicus.*

The ribs are hollow as in all land serpents.

From the agreement in the configuration of the under surface of the body of the vertebræ of the fossil with that in the vertebræ of the Boæ and Pythons more nearly than with the Colubri, and in none of the differences above noticed indicating any obstacle to the entrapping and destroying a living struggling prey, as well as from the length (11 feet) which it may be inferred the creature attained, Mr. Owen concludes it was not provided with poisonous fangs. Serpents of similar dimensions exist in the present day only in tropical regions, and their food consists principally of the warm-blooded animals. Mr. Owen therefore in conclusion states, that had no evidence been obtained of birds or mammals in the London clay, he would have felt persuaded that they must have coexisted with the *Palæophis Toliapicus*.

A paper was afterwards read, entitled " Observations on the locality of the Hyracotherium," by William Richardson, Esq., F.G.S.

In 1829, when Mr. Richardson first examined the coast from Whitstable to Herne Bay, it presented an uniform, geological structure, composed of a capping of vegetable mould, under which was a stratum 3 or 4 feet thick of yellow brick earth, containing in the upper part rolled and angular flints, mammalian remains and fossils derived from secondary strata; and beneath, forming the mass of the cliff, was London clay of a dark brown colour, abounding in septaria, selenite, pyritous wood, teeth and vertebræ of fishes, Nautili with other characteristic marine testacea, Encrinital and Pentacrinital remains, and crustaceans.

The whole of the line of coast undergoes rapid degradation in consequence of the encroachment of the sea and land springs; and the changes thus annually produced, effect great alterations in the physical outline of the cliffs. The geological structure, however, presented by them in 1829 remained for the greater part the same in the autumn of 1839, except at the part called Studd Hill. At this point, the dark brown incoherent clay had been removed, and a deep blue, tenacious one exposed. A change had also taken place in the character of the fossils, the marine remains having gradually become less prominent and been replaced by others of a fluvio-marine character. In the autumn of last year, Mr. Richardson could not find a single marine shell, and only a few fragments of crinoidal stems. Terrestrial vegetables have, however, become so prodigiously abundant, that he has obtained at different times above 500 fossil cones, fruits, and other seed-vessels; and fragments of small trees converted into pyrites occur in so great quantities, that they have been removed by barge loads for œconomical purposes, and become a source of considerable profit to the neighbouring peasantry. These remains present no indications of having been transported from a distance. Neither land nor fresh-water shells have been observed.

From the abundance of vegetables, and the knowledge that Nature ever directs her means as well in number as in fitness to particular ends, Mr. Richardson inferred, that remains either of quadrupeds or birds would be found in Studd Hill; and though his search was long fruitless, it was at last rewarded by the discovery of the portion of the Hyracotherium described by Mr. Owen in the preceding memoir.

January 8, 1840, Robert Fellows, Esq., LL.D., Dorset Square;

and James Philip Kay, M.D., the Albany; were elected Fellows of this Society.

A paper was first read, on the carboniferous and transition rocks of Bohemia, by David T. Ansted, Esq., F.G.S.

After alluding to the difficulties which beset the researches of a geologist in a country so little frequented as that visited by himself, and noticing the granite and gneiss mountains which constitute the south-eastern and south-western boundaries of Bohemia, he proceeds to the main object of the memoir. The district described by Mr. Ansted is included within a triangle, having the country between Luditz and Pilsen for a base, and Prague for its apex; and its structure is explained by a series of sections from Luditz to Pilsen—Radnitz to Rakonitz—Zebrak to Ginetz—and Przilep to Karlstein, all of them being more or less in the dip of the strata. The formations composing the district, are granite, gneiss, graywacke, coal measures, trap rocks and accumulations of superficial debris. It is stated that a line drawn from Eger on the west to Prague on the east would completely separate the sedimentary deposits of a newer date than the carboniferous system from the coal measures and transition rocks; and that the latter occur only to the south of the line. Near Eger is a small local deposit of upper tertiary sandstone, mentioned by Mr. Ansted on account of its containing myriads of fossil infusoria cases.

Section 1. *Luditz to Pilsen.*—Luditz stands upon a range of round topped gneiss hills, but in a depression between two of them, and about 3 miles from the town, is a bed of thinly laminated micaceous sandstone, containing a few obscure vegetable markings, and believed by Mr. Ansted to be a recent deposit. Proceeding in the direction of Pilsen, the gneiss is succeeded by a hard cherty stone, considered by the author to belong to a rock which underlies the coal measures in other parts of the country, but to have been protruded at this point by igneous agency. The next hill is formed of trap, and beyond it, is a bed of similar cherty sandstone, covered up towards the S. E. by the red conglomerate on which Manotin is built. To the south of this town, slate rocks are finely developed for several miles, forming precipitous cliffs, with the strata dipping to the S.E. They are covered in part by gravel, and are succeeded by rotten shales, assigned by Mr. Ansted to the graywacke system. These shales are visible for only a short distance, being superficially replaced by a thick covering of gravel, which extends for ten miles. At the end of that distance, hills of sandstone commence, and contain near Pilsen workable seams of coal. The sandstone is coarsely grained and not very coherent; and the coal bands, which are accompanied by shales, are of variable thickness. The dip is very small, and to the S. E., but the stratification is totally unconformable with the graywacke. Pilsen is situated on a little stream, which unites close to the town with the Beraun; and the eastern limit of the sandstone seems to be a small tongue of coarse grit, which reaches the Beraun, and exposes a bed of coal on its western bank. At that point, however, the graywacke comes in, having been brought up by a mass of trap.

Section 2. *Radnitz to Rakonitz.*—The direction of this section is nearly S. and N., Radnitz being about 12 miles east of Pilsen, and Rakonitz 20 miles east of Luditz. Radnitz stands upon an incoherent coal measure sandstone; and two bands of coal are worked a little south of the town. Beyond the sandstone rises a hill of graywacke shale, protruded, Mr. Ansted believes, by the agency of a mass of trap visible a short way off. To the north of Radnitz is an abrupt hill of the shale, considered to have been also brought up by a fault; and on its northern face commences a broad valley formed of coal measures, and bounded at its further extremity by another hill of graywacke, likewise thrown up by a fault. Coal is worked on three sides of this hill. The graywacke continues thence for six or seven miles, when the coal sandstone again constitutes the surface for a short distance (2 miles), and, after another interval occupied by graywacke, reappears forming the country around Rakonitz.

Section 3. *Zebrak to Ginetz.* — This section refers to a more southerly part of the district, and traverses a portion of the coal measures situated south of that line of graywacke which extends from Pilsen to Prague, and separates, except at one point, the coal field connected with the two first sections, from the district about to be noticed. At Zebrak, the point just mentioned, the coal measures intersect the graywacke range, in consequence apparently of a fault; and the section commences at Zebrak in graywacke shale near the junction of the coal measures with the graywacke. These shales extend to Horzowitz, where they are overlaid unconformably by the coal sandstone, which constitutes the surface of the country for about two miles. At that point is a hill, on the summit of which occurs a cherty sandstone considered by Mr. Ansted to be the base of the coal measures and to have been forced up into its present position. The beds dip about 60° S. E., and rest apparently upon a very coarse, hard, red conglomerate, to which succeeds a vast development of shale, containing occasionally Trilobites. This division of the graywacke series, is at some distance, covered again by the conglomerate upon a change of dip, and then continues nearly three miles to Ginetz, with the strata moderately inclined to the N.E. At that town a band of limestone occurs reported to be rich in Trilobites.

Section 4. *Przilep to Karlstein.*—This section is parallel to the last and crosses the line of country between Pilsen and Prague. Two or three tolerably thick beds of coal are worked near Przilep and supply Prague with fuel. Fossils also are not deficient. About 6 miles towards the north-west, other but inferior beds of coal are wrought; but towards the east, the coal thins out between lofty precipices of shale, which form a narrow gorge. Pursuing the line of section towards the south-east, the direction of the dip, and at no great distance from Przilep, the coal basin is shut in by the steep face of a hill. At this point, Mr. Ansted believes, that the lower beds of the coal measures are not only brought up, but are bent over the upper, because, though the dip of the strata is to the S. E. or in the direction of the section, yet, on the summit of the hill above mentioned, is exposed an excellent natural surface of chert; and in a quarry near the top the inclination of the beds is about 25° S. E. or in the regular dip of the coal measures; and in a narrow valley at the bottom of a somewhat rapid descent, the lowest division of the greywacke is exposed dipping S. or actually overlying the coal measures. This inversion of superposition, Mr. Ansted explains by assuming, that the granite comes near the surface, and that by its agency the graywacke has been thrown into a trough, and its lowest beds so brought up as to be made to rest against inverted beds of the coal measures. Proceeding in the line of section, the author found in graywacke shale, portions of a Trinucleus, *Trilobites ornatus*. (Trans. Prague National Mus. Soc. 1833.*)

The graywacke shell extends with contorted strata to an anticlinal hill of limestone, beyond which occur broken and rotten shales, then limestone, next shales again, and lastly the picturesque limestone hill of Karlstein. Further south is a valley of graywacke bounded by an altered rock, which is succeeded by granite. The Karlstein limestone is stated to be identical with that at Ginetz, (see section 3) and the two other localities in the present line of section. It is of a pale blue colour, very hard, contains several species of Orthocera and Trilobites, and is of great œconomical importance. The recurrence of the same limestone at different points, Mr. Ansted explains, by supposing, that the granite in these cases, is also near the surface, and that a displacement of it, bent the yielding shales, but snapt asunder a brittle band of limestone once continuous, the portions of which not removed by subsequent operations, are exhibited at the points mentioned in the line of section; and that the consequences of these operations have been, a disturbance in the regular succession, and an exhibition of the beds in the following order: granite, altered rocks, newest graywacke with limestone, oldest graywacke, coal measures.

In conclusion, Mr. Ansted offers the following observations as the results of his examination of this portion of Bohemia. The graywacke series is imperfectly developed, presenting at only one spot a passage upwards into the carboniferous series, and no passage downwards into the graywacke, resting always unconformably upon it; the secondary rocks are also very imperfectly developed, the mountain limestone being absolutely wanting, and the only indications of beds newer than the coal measures being a red conglomerate, into which they pass upwards. The flora of the coal measures is however well known to be rich, and to have yielded near Radnitz the fossils described by Count Sternberg. A genus allied to Scorpio is

* Impressions of shells were also found by the Author in a greyish sand rock, a little nearer Prague; and the Trinucleus is found at Zebrak and Praskoles, on the south side of the high road about 10 miles south of Beraun.

also stated to have been found in them. The fossils of the greywacke are said to be not very numerous; but the Trinucleus appears to be abundant on the line of road between Prague and Pilsen; and in a gorge near Lodentz, about fourteen miles from Prague, is a quarry which yields shells and other organic remains; and on the opposite side of the road, near the same spot, similar fossils may be obtained. Trilobites occur at Ginetz, and Orthocera at Karlstein; and both these localities and the neighbourhood of Prague are mentioned as rich in organic remains. The *Trinucleus Caractaci* is stated to occur near Zebrak.*

A letter was afterwards read, addressed to Dr.Buckland, P.G.S. by the Rev. John Gunn, and dated Dec. 21st, 1839.

This letter was accompanied by three paramoudras from the chalk near Norwich; and they had been selected by Mr. Gunn on account of one of them presenting a tuberculated exterior, a character which he states a paramoudra commonly assumes when it is in contact with horizontal lines of nodular flints; and the other two had been chosen because Belemnites and shells are imbedded in their substance. The letter contains some observations on the irregularities in the surface of the Norfolk chalk, and on the pipes or sand galls by which it is penetrated. With reference to these tubular hollows, Mr. Gunn refers to Mr. Lyell's description of them, read at the meeting of the British Association at Birmingham, but he calls attention to their being constantly filled in the district examined by himself, with sand, gravel, or crag, to the total exclusion of all materials belonging to the strata between the chalk and the crag; and he therefore infers, that the sand galls were not eroded during the eocene period, but that during that long period the Norfolk chalk was denudated.

The letter was also accompanied by some specimens from the boulders contained in the diluvial (drift) strata of Norfolk and Suffolk. Mr. Gunn is of opinion that these masses of rock indicate what were the strata that formed the shore against which the (so-called) diluvial waves washed; and that the masses were borne out to sea in a similar manner to the portions of cliff now annually destroyed by the waves. If the bottom of the present sea were raised, he says it would present features analogous to those of the crag and diluvial formations of Norfolk and Suffolk.

* See the fossils of Caradoc sandstone, Silur. Syst. pl. 23, f. 1.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

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Jan. 22.—William Laverack, Esq., of Catherine Hall, Cambridge; Zacharius Daniel Hunt, Esq., Aylesbury, Bucks; Robert Maulkin Lingwood, Esq., M.A., F.L.S., Mordiford, near Hereford; the Rev. William Strong Hore, M.A., Stoke, Devonport; Joseph Dobinson, Esq., of Egham Lodge, Egham, Surrey; and Walter Ewer, Esq., late of the Bengal Civil Service; were elected Fellows of this Society.

A paper was read on the Boulder Formation or Drift, and associated freshwater deposits composing the mud cliffs of Eastern Norfolk, by Charles Lyell, jun. Esq., F.G.S.*

The cliffs described in this memoir extend from Happisborough or Hasborough lighthouse to near Weybourne, west of Cromer, a distance of about twenty miles, and vary in height from sixteen to 400 feet. Mr. Lyell first examined them in 1829, and subsequently in 1839; and the details given in the paper are the results of the observations made during the two visits. The changes produced by the destruction of the cliffs, have enabled him to explain some of the more complex phænomena presented in the sections exposed in 1829. The greater portion of the cliffs consists of the boulder formation or drift, which is partly stratified and partly unstratified, and for the latter he has adopted the term "till," employed in Scotland to designate a similar deposit. Other formations are occasionally exposed, but the whole series is nowhere exhibited in one vertical section; it may however be stated to be composed of the following beds, in ascending order:—1. Chalk—2. Norwich crag—3. freshwater accumulations with subterranean forests,—and 4. the boulder formation or drift. This line of coast, Mr. Lyell says, is ably treated of by Mr. R. C. Taylor (Geology of East Norfolk, 1827) and Mr. S. Woodward (Outlines of the Geology of Norfolk, 1833), in works, the result of careful personal surveys, and containing original observations of great merit.

1. *Chalk*.—This formation is occasionally displayed at the foot of the cliffs in horizontal beds, but it claims notice more especially on account of the masses which protrude from the face of the cliffs near their base, or are enveloped in layers of the drift. Three of the more remarkable of these protuberances rise from the beach

* This memoir is published in the London and Edinburgh Phil. Mag. for May 1840.

near Trimmingham. They are noticed in Mr. Greenough's geological map of England, and are stated by Mr. R. C. Taylor to be continuous with the solid beds of chalk, which extend from the base of the cliff outwards under the sea. The most southern mass was, in 1839, twenty feet high, a few yards in apparent thickness, and extended along the beach about 100 feet. The surface of the chalk, where in contact with the drift, inclined at an angle of about 45°, and the beds of gravel, sand, and finely laminated clay, composing the newer deposit, presented a similar dip; but at the distance of a few hundred yards to the south, they recovered their horizontality, and at the top of the cliff behind the chalk protuberance, but not immediately over it, the strata of drift are likewise horizontal. Mr. Lyell is of opinion, that both the chalk and the drift have been acted upon subsequent to the deposition of the greater part of the latter, by some common movement, either sudden or gradual, and that this remark applies to the two other masses. He is further of opinion, that the effect was produced probably at the upheaval of the country above the level of the sea. The second or middle protuberance is near the first, and the front of it measured, in 1839, sixty-five yards, and its height was from fifteen to twenty feet. The third and most considerable mass extended 106 yards, and projected about thirty beyond the general line of the cliff. The beds in one part were nearly vertical, but in another only slightly curved; and the strata of drift, which were in contact with the mass, were also vertical, though in the lofty cliff behind they were but moderately inclined. At both visits, the northern end of the mass of chalk rested on blue clay, containing broken flints. Some of the Preventative Service men informed Mr. Lyell, that in digging a well at Trimmingham at the top of the cliff, chalk was reached at the depth of 120 feet, though the height of the cliff is stated to be about 400. Without relying on the accuracy of these measurements, Mr. Lyell is of opinion, that the protuberances may belong to a much larger mass of chalk, forming the nucleus of the hill called Trimmingham Beacon. In other localities further to the north, where masses of chalk are included in the stratified drift and till, and accumulations of white chalk rubble enter largely into the composition of the cliff, chalk crops out in the interior at a short distance from the sea. The cliffs in front of Overstrand, south-east of Cromer, consist of clay and sand; but at the hamlet itself is a chalk pit, in which the strata are much disturbed and associated with accumulations of chalk rubble. If the progress of destruction continues, the frontage towards the sea will in time present a face solely of chalk. Another remarkable mass of chalk protrudes from the drift at Old Hythe Point, about three miles and a half west of Sherringham. To the west of Sherringham, the fundamental chalk with horizontal layers of flints rises a few feet above high water mark, and is generally covered by a ferruginous breccia of angular chalk flints, and locally called "The Pan," in some parts of which both entire and broken shells of the Norwich crag are found. On approaching from the eastward the mass of chalk, which is eighty feet high, the horizontal beds of drift suddenly give place to a vertical wall several feet thick of alternating layers of loam, clay, and chalk rubble; and on the opposite side of the pinnacle of chalk are other vertical beds of drift, but of a different character, being composed of unrolled flint gravel next the chalk, then layers of sand, and afterwards yellow sand with loam. Beyond these vertical beds, the strata of drift are first waved or contorted, and at a greater distance recover their horizontality. The relative position of the pinnacle of chalk with the fundamental, was not visible in 1839, but Mr. Lyell inferred that the two were not connected*. Between 1829 and 1839 it altered its form considerably; for at the former period, two masses of chalk were exhibited, but the eastern, or the one since removed, consisted of re-deposited chalk or rubble. Between Cromer and West Runton, and near the bottom of the cliff, is a large mass of pure white chalk traversed by several rents, and arched over by alternating beds of laminated clay and sand, the whole being twenty-five feet high. At Lower and Upper Runton are other masses of chalk; and near the Cliff End, Weybourne, the fundamental chalk rises above the level of the shore, presenting a waved outline, and covered by a bed of flints mixed with crag shells.

2. *Norwich Crag.* The most south-eastern point at which this formation has been seen is at Bacton Gap, where a thin layer of it was found, about the level of low water, in the form of a ferruginous breccia with shells resting on the chalk and covered by lignite. The next example occurs at Cromer, where it also constitutes a thin stratum seen at very low water resting upon chalk, and containing the usual characteristic fossils. It is also found between the chalk and freshwater beds at Runton; but it is only between Old Hythe Gap and Weybourne that it appears, in its usual characters, above the level of the sea. Mr. Lyell describes two points where the chalk is in contact with several feet of shelly sand and clay, containing pebbles and the shells of the Norwich crag, and overlaid by clay and loam without shells. Half a mile from Cliff End, Weybourne, the following section was displayed in a cliff about forty feet high:

Horizontal chalk with flints	8 feet.
Sand and flint pebbles with crag shells	1 foot.
Fine sand with perfect crag shells	10 feet.
Sand and pebbles without shells..........	3 feet.
Unstratified clay or till with flints	10 feet.

The shells are well-characterized Norwich crag species.

At the extremity of the cliff near Weybourne is an interesting section ten feet high, in which the strata are bent into an arch.

3. *Freshwater deposits, with beds of lignite and subterranean or submarine Forests.* These accumulations occur for the most part in patches

* In consequence of the late heavy gales, the base of the cliffs was laid open, and Mr. Simons of Cromer has informed Mr. Lyell, that the pinnacle rests upon the crag or pan, and therefore confirms the above opinion. It also appeared that on both sides of the pinnacle there was a mass of till between the stratified drift and the pan. April 1840.

at the bottom of the drift and immediately upon the chalk or crag. They are most largely developed at Mundesley and Runton, underlying the drift at the latter locality, and partly cotemporaneous with it and partly superimposed upon it, at the former. The shells contained in the deposits are with few exceptions existing British species; and Mr. Lyell consequently infers that the entire formations of the mud cliffs, both freshwater and drift, belongs either to the latest period of the newer pliocene tertiary æra, or to the post tertiary period. Hasborough has been long celebrated as one of the principal submarine forests of East Norfolk; and Mr. Lyell quotes the description by Mr. R. C. Taylor respecting the deposits generally. (See Geol. of Norfolk, pp. 7 and 23.) He has not seen the stools of the trees *in situ*, owing to the state of the beach during his visits, but he has no doubt of their existence, from the testimony of independent witnesses, particularly of Mr. Simons of Cromer. During the winter of 1838–1839, a bed of lignite containing bones of Elephants, pieces of wood, and roots of trees *in situ*, was exposed at Woolcot Gap, between Hasborough and Bacton, by the removal of a mass of incumbent drift thirty feet thick. At this point, therefore, the lignite bed was ascertained clearly to underlie the drift; and at other localities, the same extension inland has been proved by similar destructions of the cliffs; Mr. Lyell consequently observes, that after the chalk, previously covered in part at least with Norwich crag, had been overspread with layers of sand and clay, the surface was converted into dry land, on which forest trees grew; that the surface was again submerged, the trees broken off near their roots, and gradually buried, with their branches, leaves, and occasionally bones of land animals, beneath the drift. The following details are given of the points which more particularly engaged the author's attention.

Mundesley. North and south of this town, the cliffs vary in height from forty to seventy feet, and consist in their lower part of blue clay or till covered with stratified yellow sand and loam; but at Mundesley the cliff is only twenty or thirty feet high, and is occupied for several hundred yards by a freshwater deposit covered with about ten feet of flint gravel. The freshwater beds are irregular in extent, and consist of brown, black and gray sand and loam mixed with vegetable matter, sometimes almost passing into a kind of peat containing much pyrites. A few layers of rounded flint pebbles are interspersed in the mass. The bottom of the deposit was not visible; but Mr. Lyell is of opinion, that it is not much below the level of the sea, Mr. Simons having seen chalk *in situ* at Mundesley at low water. In 1829 a mass of till was prolonged into the freshwater beds at their southern junction with the drift in such a manner as to imply the contemporaneous origin of the lower part, at least, of both formations. The interpolation of this freshwater accumulation, Mr. Lyell conceives, may have been effected by a small river flowing through the banks of drift during the subsidence of the cliffs, and depositing its earthy contents, with the drift wood and other transported materials. The shells obtained by the author, Mr. Fitch of Norwich, and Mr. J. B. Wigham, are *Paludina impura*, *P. minuta* (Strickland), *Valvata cristata, V. piscinalis, Limnea glutinosa, L. peregra, Planorbis albus,* var., *P. vortex, P. lævis* (Alder), *Cyclas pusilla,* and *C. cornea*: of those eleven species, nine are British, and only two unknown in a living state. Fragments of Unios and Anodons also occur. The insects found in the Mundesley deposit consist of elytra of beetles, especially of the genus Donacia, presenting when freshly exposed their beautiful colours. Mr. Curtis is of opinion that there are two species of Donacia, both possibly identical with British insects: the same entomologist has also detected the thorax of an Elater, an elytron of one of the Harpalidæ (*Harpalus ophonus* or *H. argutor*), also another which he confidently refers to *Copris lunaris,* a British beetle. The remains of fishes collected by Mr. Lyell and Mr. J. B. Wigham are considered by the Rev. Leonard Jenyns and Mr. Yarrell to belong to the genera Perch, Carp, Pike, and Trout. The horns of the Irish Elk are reported to have been found in making a road to the beach some years since. The common and best preserved vegetable remains, are seed-vessels of an aquatic plant, referred by Mr. Brown to *Ceratophyllum demersum.*

West Runton Gap, two miles and a half from Cromer. A freshwater deposit, on the east side of this point, contains many of Mundesley shells, and passes unequivocally beneath about seventy feet of unstratified drift, while a thin bed of subjacent Norwich crag is interposed between it and the chalk. The beds are black and peaty. Twelve species of shells have been obtained by Mr. Lyell and Mr. Fitch, and determined by Mr. George Sowerby to be *Paludina vivipara, P. impura, P. albus, P. marginatus, Valvata piscinalis, Limnea palustris, L. stagnalis, Planorbis imbricatus, Ancylus lacustris, Cyclas appendiculata, C. cornea* and *C. amnica,* var.? also a species of Anodonta. The *Cyrena trigonula* has not yet been observed in these deposits, though it accompanies a similar assemblage of shells at various localities in Suffolk and Essex.

From the occurrence of two species of shells distinct from any at present known in a living state, Mr. Lyell refers these freshwater deposits to the newest tertiary epoch; whether the fishes and plants of Mundesley are all referrible to existing species cannot be determined without fuller evidence. With respect to the mammalian remains, he says it is extremely difficult to speak with certainty of the exact beds from which they may have been derived, because they are picked up at the base of the cliffs, after portions of the drift had been removed by the sea. It is the opinion of collectors, however, that they are chiefly derived from the freshwater beds, and more particularly the lignite, where it rests immediately upon the chalk or patches of Norwich crag. These remains belong to the Elephant, Rhinoceros, Hippopotamus, Horse, Ox, Pig, Beaver, Deer, &c.; but as the Norwich crag underlies the drift at Cromer and Weybourne, and fragments of crag shells are dispersed through the latter, Mr. Lyell suggests, that some mammalian remains may have been washed out of the crag into the drift; but, he adds, none of the characteristic crag fish-bones have been noticed in it, and that such bones of land animals, as have been distinctly obtained from the marine crag, are more rolled than those found so abundantly in the mud cliffs.

Drift. This important formation is strictly analogous in character with that which has been called in Denmark and Sweden the boulder formation, and which, from the numerous erratics included in it, presents so remarkable a feature in the superficial geology of Scandinavia, the countries surrounding the Baltic, and those extending thence, uninterruptedly, to the borders of Holland, to re-appear in Norfolk and Suffolk. Mr. Lyell believes, that the boulder-fragments in all these districts were accumulated on ground permanently submerged, and not by one or many transient rushes of water over land previously emerged; and he therefore prefers using the term drift instead of that of diluvium, by which the deposit has been generally designated. The subdivisions of stratified and unstratified (till) materials exist in Scandinavia and Scotland as well as in Norfolk, and therefore indicate some peculiarity in their distinct mode of origin; yet in all these countries, as Mr. Lyell observes, part of the till was accumulated contemporaneously with the stratified drift, and both are often identical in composition; the distinction consisting solely in the arrangement of the materials. The only recent deposits precisely similar in character known to the author, are the terminal moraines of glaciers; and he has no doubt, that similar accumulations must take place in those parts of every sea, where drift ice, charged with mud, sand and blocks, melts, and the earthy materials are allowed to fall tranquilly to the bottom. The occasional intercalation of stratified matter in the till, or the association of the two on a larger scale, he is of opinion, may be explained by the temporary action of currents during the melting of the ice. The pebbles and erratic fragments of larger dimensions found in the Norfolk drift, consist of granite, porphyry, greenstone, lias, chalk, &c. No fossils have yet been obtained in the drift from which the æra of its formation can be inferred; and this absence of characteristic organic remains, Mr. Lyell says, marks also the boulder formation in Scandinavia and Scotland. Near Upsala, however, he has seen large erratics resting on stratified beds corresponding in age to the till of that neighbourhood, in which numerous shells peculiar to the Baltic were imbedded;—a fact which leads him to attribute, to some parts at least of the boulder formation of Scandinavia, as recent an origin as can possibly be ascribed to the Norfolk drift.

At their commencement near Hasborough the cliffs are not more than twenty feet high, and are composed generally of blue clay covered with yellow sand, both, in some places, being stratified with great regularity. At some points where the stratified reposes on the unstratified, the surface of the latter is very uneven, and was evidently in that condition when the superior deposit was thrown down upon it. In 1829 the section at Hasborough was sand and loam thirteen feet—till, eight to sixteen feet—laminated sand and clay, partly bituminous, and inclosing compressed branches and leaves of trees, one and a half feet. The cliffs between Hasborough and Bacton Gap (about three miles) consist generally of the lignite or forest bed at the bottom, overlaid by till containing boulders of granite, quartz and fragments of Norwich crag shells; then in ascending order, laminated blue clay; and at the top stratified yellow sand; the entire height being from thirty to forty feet. Between Bacton Gap and Mundesley the cliffs are higher, and consist of drift with boulders; and they exhibit the first fine exemplifications of contortions, and of folded or contorted beds resting upon others which appear to have undergone no disturbance. From Mundesley to Trimmingham, the cliffs in the lower part are composed of till containing fragments of white chalk, and the upper of stratified drift. Whether the lignite bed is interposed between the chalk and the drift all the way, Mr. Lyell could not ascertain; but he found about a mile north-west of Mundesley, at the bottom of the cliff, a substratum inclosing numerous flattened leaves and branches. To the north-west of Cromer, the drift includes a much larger quantity of chalk rubble than to the southward.

Disturbance of the strata. In no portion of Great Britain, Mr. Lyell observes, are there evidences of more complicated disturbances of a modern date than in the mud-cliffs of Norfolk, or disturbances more difficult to explain. In many parts of the cliffs the beds are twisted and contorted into every possible curvature, and the replications are in some instances so numerous, that a bed may be intersected three times in the same vertical well or boring. Occasionally the beds are vertical; sometimes they present concentric crusts enveloping a nucleus of sand, gravel or chalk, occasionally more than twenty feet in diameter. One instance, mentioned by Mr. Lyell, consists of a nucleus of blue clay successively surrounded by layers of white sand, yellow sand, striped loam and clay, laminated blue clay: and in another case he counted thirty distinct strata enveloping a nucleus of sand. These strange bendings, twistings and other irregularities are not continuous, though characteristic of the greater portion of the cliffs, but are in some cases limited to a small area, both in vertical height and lateral extension. Occasionally they range from the top to the bottom of the cliff; but not unfrequently beds thus disturbed rest upon others perfectly horizontal.

To account for these phænomena, Mr. Lyell says, is extremely difficult, and he prefers leaving their final elucidation to the assistance which future sections may afford to offering any positive explanation. The nuclei, he is of opinion, are only the inner portions of a series of strata bent into a convex form, as the removal of portions of the cliff gradually develop other layers within those which had formed previously an apparent nucleus. When the disturbed beds are in the immediate vicinity of protuberances of chalk, he is inclined to think that the greater resistance offered by the hard masses of chalk at the time the country was raised above the level of the sea might have produced a disturbance in the yielding strata of drift; but he thinks that this explanation will not account for all the phænomena presented in the neighbourhood of the chalk pinnacle at Old Hythe Point, near Sherringham. Where the disturbed strata are associated with indications of partial subsidences, he admits that the effects may have been produced by landslips; and that it is possible to account for contorted strata resting upon others, which are horizontal, by supposing that the latter were not operated upon by agents which set the superincumbent masses in motion. To account, however, for some of the more complex phænomena of the coiled or contorted drift, he proposes an explanation founded on the effect of drifted ice upon loose materials. In the account given by Messrs. Dease and Simpson, of their discoveries in the arctic regions*, it is stated, that in latitude about 71° N. and longitude 156° W. they found a long low spit of land, named Point Barrow, composed of gravel and coarse sand, and in some parts more than a quarter of a mile broad, which the pressure of the ice had forced up into numerous mounds, resembling at a distance huge boulder rocks. Mr. Lyell also states, that so many facts have come to his knowledge of the manner in which masses of ice, even of moderate size, in the Baltic, and still more in the Gulf of St. Lawrence, push before them large heaps of boulders, that he can scarcely doubt of its power to produce, under favourable circumstances, phænomena similar to those exhibited in the mud cliffs of Norfolk.

The intercalation of huge masses of solid chalk, and of chalk rubble, in the body of the drift, Mr. Lyell also states is not easy, under all circumstances, of being explained. With respect to the masses of solid chalk, he thinks they may, in part, be accounted for by the action of the sea on the ancient line of chalk cliffs, before or during the deposition of the drift, and by which pinnacles or needles of chalk would be undermined, thrown down and subsequently enveloped in the till or stratified clay and sand: he also explains the occurrence of accumulations of chalk rubble unmixed with any of the adjacent materials, by considering the rubble as the talus of former chalk cliffs, buried up at a later period by drift.

In describing the boulders associated with the drift, Mr. Lyell refers to Mr. R. C. Taylor's memoir for an account of their nature and great diversity of character. On the shore near Cromer, Mr. Taylor mentions some derived from the cliffs, four tons in weight: one called Black Meg standing six to eight feet high; and another composed of granite being nearly six feet in diameter. Mr. Rose is quoted as an authority for the occurrence of boulders several tons weight, in the till, in the interior of Norfolk. It is impossible, Mr. Lyell states, for those who have seen the boulder formation of the countries surrounding the Baltic, to doubt that the so-called diluvium of the east of England had a similar origin. Of the sources from which the blocks were derived, he conceives that some of them may be ascribed to rivers flowing from the westward, and transporting masses of ice charged with detritus derived from secondary strata, in the same manner as the St. Lawrence annually sends down into the gulf shoals of drifting ice, laden with fragments of rock and other earthy materials; but he is inclined to think that a

* Journ. of Royal Geograph. Soc., vol. viii. p. 221.

portion of the boulders and smaller masses may have been obtained, as proposed by Dr. Mitchell, from strata which once occupied the site of the German Ocean. The blocks of primary formations, he assigns to a northern origin.

Feb. 5.—Alexander Robertson, Esq., of Inverugie House, in the county of Moray; and William Sharpe, Esq., President of the Bradford Philosophical Society, were elected Fellows of this Society; M. Puillon de Boblaye, of Paris, Professor Adolphe Brongniart, of Paris; and Professor Gustav Rose, of Berlin, were also elected Foreign Members.

The President first read from the chair, an extract of a dispatch from Consul Chatfield, dated San Salvador, Oct. 10, 1839, and forwarded to the Society by Mr. Backhouse, by direction of Viscount Palmerston.

San Salvador is very subject to earthquakes, and on the 22nd of March, 1839, it experienced a strong shock, which was followed during nearly a fortnight, by ten to twenty daily, though of less force. The shocks were afterwards continued at intervals, but as they were not unusually violent, they attracted no particular attention. On the first of October, at 2 A.M., a powerful earthquake was felt, and at 3 o'clock a second, which nearly demolished the town. The shocks were afterwards repeated with alarming violence and frequency, and at the date of the dispatch, not a house remained standing secure. The shocks were supposed to originate in operations immediately beneath the town, as places five or six miles distant had received no injury; and the motion was considered to have been decidedly perpendicular.

A paper was next read, on Orthoceras, Ammonites, and other cognate genera; and on the position they occupy in the animal kingdom, by Robert Alfred Cloyne Austen, Esq., F.G.S.

The object of this memoir is to examine whether the fossil shells to which it refers, have been properly classed; or whether they do not belong to a higher order than that in which they are generally placed. Mr. Austen is of opinion that the shells of cephalopods were enveloped in the body of the animal; first, on account of the apparently extreme tenuity of certain genera, as Turrilites, Scaphites, Clymene, Cyrtoceras, Baculites, and Ammonites, which would render the shell extremely liable to injury. Secondly, from the mouths or openings of the outer chambers of some cephalopods being exceedingly contracted, as in the genera Scaphites and Baculites, in which the upper edge of the outer chamber is so nearly in contact with the body of the shell, or is so bent over, that the chamber could not have served, he conceives, as a place of retirement for the animal: certain Orthocera, *O. pyriforme*, *O. ventricosa*, are also mentioned by Mr. Austen as having the last chamber closed, or perforated only for the passage of the siphunculus; and he refers to the capacity of the outer chamber of *Ammonites Calloviensis*, *A. depressus*, *A. canaliculatus*, *A. discus*, *A. sublævis*, *A. Gervillii* and *A. funiferus*, being so greatly diminished as to have rendered it difficult, " nay impossible," for the animal to have retreated within it.

In the third place, Mr. Austen observes, that more awkward contrivances in progressive motion could not well be conceived than the shell of the genus Hamites, on account of its form, supposing it to have been external; as well as the thin shells of Orthocera and Baculites, on account of their great length.

He then compares the structure of the Nautilus with that of the fossil extinct cephalopods, and from the greater thickness of the shell of the Nautilus he infers, that the shells of the extinct genera were internal. From the liability of those external shells to be injured, and thus rendered incapable of performing the office of a float, he also infers, that the fossil shells were internal; and he adds, that he has searched in vain for an instance of such a shell having been repaired by the animal. On these grounds, therefore, he proposes to remove the fossil extinct cephalopods from the order Tetrabranchiata, to which the Nautilus belongs, and to place them on the supposition that they were internal shells, with the Spirula, in the order Dibranchiata.

The memoir to accompany the Second Edition of the Geological Map of England and Wales, by George Bellas Greenough, Esq., V.P.G.S., was then read.

Mr. Greenough first points out the changes which have been made in the topography of the present edition of his map; he then alludes to the alterations in the table of formations, and in the boundaries; and afterwards explains the principles by which he was guided in the choice of the pigments used in colouring the map.

Of the six copper-plates upon which the first edition was engraved, four and the lower portion of the fifth, have been used again; the upper portion of the fifth and the entire sixth are new.

The southern sheets were drawn originally, in part, at least, from those of the Ordnance Survey: for the topography of the northern, good authorities are still wanting; and the inaccuracies of the eastern are geologically of little importance: for thus much of the map therefore new copper plates were not thought necessary; not so for the remainder. To do justice to the great mass of information which is now possessed of Wales, and Siluria more especially, a detailed and scrupulously correct drawing was essential. Such a drawing the admirable maps which have recently issued from the Ordnance press have afforded Mr. Greenough the opportunity of obtaining; and the result will, he trusts, be approved not merely by professed geologists, but by all who feel an interest in the progress of art, more especially when exerted in furtherance of science.

Having always felt the close connexion which necessarily exists between the outward form of a country and its geological structure, Mr. Greenough has made it a primary object to represent with distinctness and fidelity all undulations of the surface as far as the scale of the map would allow. In the first edition more than thirteen hundred heights are distinguished, and in the present more than fifteen hundred. Equal attention has been paid to hydrography. The course of rivers and brooks has been drawn neither fancifully nor negligently, and in the new parts will be found minutely correct. The names of the smallest streams have been also diligently sought and recorded; and those of rivers are generally inserted both at their mouths and at their forkings.

In the table of formations the following changes have been made. The upper and lower members of the green-sand, formerly united, are separated by a streak of gault. The fuller's earth, the upper lias marl, and the marlstone are separated from the other members of the Cotswold series. The new red sandstone group has been dissected after the manner of the Germans; and in Siluria the divisions first established by Mr. Murchison have broken up the unity of the greywacke formation.

In determining the boundaries of the strata, Mr. Greenough has added to his own personal experience that of other competent observers; and he acknowledges among the most valuable communications, those of Mr. De la Beche, Mr. Jukes, Mr. Logan, Mr. MacLauchlan, Mr. Milne, Mr. Murchison, Prof. Sedgwick, Mr. Sopwith, Mr. Strickland, Mr. J. Taylor, Mr. N. Wood, Mr. Lonsdale, Dr. Fitton and Mr. J. Phillips.

On comparing the geological boundaries of the old map with those of the new, Mr. Greenough hopes to be excused for indulging some slight feeling of self-congratulation. Though almost every part of the kingdom has undergone within the last twenty years a rigid scrutiny owing to increased facilities of investigation, yet the geological errors of the first edition are far less grave and numerous than might reasonably have been apprehended. The only errors which he thinks require to be specified, are a false colouring in Leicestershire of small extent, arising from accidental carelessness, and that in Devonshire and Cornwall due to imperfect information*.

The lower deposits of these counties, as formerly represented, consist either of clay-slate with cross courses of elvan, or greywacke slate, with its usual suite of greywacke, transition limestone and culm. In place of these is now presented Old Red Sandstone, with subordinate bands of limestone, mountain limestone and coal.

This change, Mr. Greenough says, will no doubt appear uncalled

* Mr. Greenough states in a note, that between the representation of the Cornish and Devonian rocks, and that put forth in a small skeleton map by Professor Sedgwick and Mr. Murchison, the resemblance is so obvious, that it is necessary for him to notice only the difference. The object of their map, he says, was to disconnect the Devonian from the older transition beds, in his to connect them. Hence the colour chosen by them presents a contrast to that of the Cambrian, which he proposes to term the lower killas system; while that which he has chosen presents an attempt, however imperfect, at approximation.

The Devonian rocks, Mr. Greenough has always believed, and still believes to agree with those of the Hartz; and if Professor Sedgwick and Mr. Murchison arrive at the same conclusion, they will only confirm, by the high authority of their names, the correctness of a doctrine laid down in the former edition of the map, as well as the present.

for, when he states, that in the metalliferous rocks of Tavistock tunnel, Redruth and St. Agnes, &c., he still recognises all the characters of Wernerian clay-slate; and in the tract formerly coloured as greywacke, all the characters of that group as it exists in the Hartz, the district where the term originated, and to which therefore, in all cases of doubt, the geologist is bound to appeal in *dernier ressort*, as the true and undoubted type of the greywacke formation. Hence, continues Mr. Greenough, it becomes necessary to observe, first, that the characters which Werner assigned to clay-slate are not confined to it; and secondly, that the old red sandstone has obtained admission into this part of his map only by a sacrifice of its independence, and upon condition of taking rank there, but as an *integrant member of the greywacke formation*.

The term greywacke, if employed in a mineralogical sense, Mr. Greenough says, may safely continue to be used to designate that granular compound of semi-crystalline fragments cemented by clay-slate, found in rocks of every epoch in the Grampians, in Cardiganshire, the Tarantaise, along the whole range of the Alps, the Carpacks, the Apennines, &c.; in a geological sense, if employed at all, it should be strictly confined in its application to the Hircynian system and its equivalents.

The English language, he adds, is rich enough to dispense with a word which has long since been objected to with reason as being harsh in utterance, as well as uncertain in signification, and therefore he thinks geologists ought to abstain from all further use of it. The phrase old red sandstone is equally superfluous. Therefore, he ventures to apply the designation of *Upper Killas* to the series of beds above the Silurian, and that of *Lower Killas* to the series below the Silurian.

To the terms Devonian and Cambrian, Mr. Greenough entertains the following objections:

1. If by Devonian system is to be understood only a part of the rocks of Devon, there is lost the only name whereby the whole can be designated.

2. If this name be applied to denote the agreement of the Devon rocks with those of Herefordshire and other midland counties, the only name is lost whereby may be denoted (what is equally worthy of being denoted) their disagreement.

3. The expression "Devonian system" is just as applicable to the culmiferous beds of Devon as to the beds beneath them.

4. The name of an English county is not a proper designation for an extensive European range.

5. The title Cambrian system, according to its natural and obvious signification, should include all the rocks of the principality,—among others the very system to which it is opposed, the Silurian.

Mr. Greenough then adverts to Mr. Bakewell's including the old red sandstone and mountain limestone in the transition class, (Introduction to Geology, 5th edit. p. 135, 136,) and quotes at length Dr. Macculloch's description of the old red sandstone as laid down in that author's System of Geology (vol. ii. p. 213, *et seq.*). This description, he says, characterizes in every important particular the killas and shillot beds of Devonshire and Cornwall; and he therefore considers himself fully entitled, on lithological evidence, to assign to these rocks that place in the general series which they occupy in the present map. The evidence to be derived from Palæontology, though incomplete, he is of opinion, also points out to the same conclusion.

The "earthy sooty limestone" which rests conformably on these beds near Barnstaple, Holcomb Rogus and West Leigh, with a southerly dip, and rises again with a contrary dip at Launceston and South Petherwin, Mr. Greenough considers on zoological evidence to be the representative of the true mountain limestone. Under these circumstances, he thinks it highly probable that the culm limestone of Barnstaple, &c., occupies the same place in the general series as that which in other countries forms the floor of our coal-field; and consequently that the superincumbent shales, marked with vegetable impressions, are legitimate members of the great carboniferous system.

If further evidence on this subject be required, Mr. Greenough says, there is still in reserve another argument with which Mr. Murchison has kindly supplied him, derived from his recent researches in Germany,—an argument of analogy.

The transverse sections in descending order from the well-known coal-field of Westphalia (notably in the zone between Hagen and Iserlohn) exhibit clearly a descending order from the productive coal strata, through beds representing the English millstone grit, and then through various schists and sandstones, with minute plants resembling those of the culm-measures of Devon; next through bands of flag-limestone, undistinguishable from the black limestones of Barnstaple, and, like them, containing Posidonia and Goniatites, and associated with bands of flinty slate (Kiesel-schiefer). Passing to still lower strata of schists and psammites, other calcareous courses appear, including the great limestone of the tract, which contains the same fossils as the limestone of South Devon; and finally, these are underlaid by greywacke and subordinate courses of limestone, which rise into the higher mountains of the region, and contain Homalonoti, Pterineæ, and other shells characteristic of the upper members of the Silurian System.

In the third place, Mr. Greenough explains the principles by which he was guided in the choice and distribution of colours.

In the choice of pigments he sought the most transparent, the most distinct; those least subject to fade by exposure to air, light, or damp; those which are most soluble, and those of which the ingredients will not act chemically one upon another.

In the distribution of pigments, he endeavoured to accommodate the colour of the pigment to that of the substance represented; to apply to substances mineralogically similar, similar tints; to substances mineralogically dissimilar, dissimilar tints; to place in juxtaposition those colours only which would either harmonize or contrast, as the occasion might require; to confine the opake colours to those parts of the map which are least charged with engraving; to reserve the most forcible colours for the smaller spaces; to denote marked differences in adjoining rocks by strong opposition of hue; to avoid spottiness; and lastly, to apply the brightest colours to the centre, carrying them off by gradation towards the extremities. All these objects, Mr. Greenough states, can rarely be attained in any case, but all were taken into consideration before the colouring of any portion was finally decided upon.

He then alludes to the attention which is necessary in the application of the pigments, and the difficulties of securing uniformity of tint as well as correctness of boundaries; also to the necessity of employing artists of acknowledged skill and established character.

As the accomplishment of the above requisites requires great care, and is necessarily attended with considerable expense, Mr. Greenough enters at some length into the application of machinery to geological mapping. He shows, that by the employment of shaded grounds the number of tints may be diminished, and colours not be required to do more than they can perform; and that where the shade is produced by lines repeated at small intervals, there is obtained a tint cheaper, purer, brighter, more constant and uniform, more durable, and far less injurious to the engraving beneath than any wash. The breadth, depth, and mutual distance of the lines being all capable of modification, a large series of such lines may be obtained, varying from the faintest grey to absolute black, every one of which being neutral, must harmonize with whatever colour may happen to be next to it. The direction of the lines also may vary indefinitely; and a further resource may be obtained in the use of dots; and the form of these again may be varied indefinitely. When engraved lines or dots are employed, not as single tints, but as a ground for other tints, they have the great merit of subdividing a formation without destroying its unity. Mr. Greenough availed himself of this expedient in laying down the beds of the Weald and of the Cotswolds.

The preparing of an uniform system of tints, and inducing its adoption, Mr. Greenough states is not very easy of execution on the old plan; first, because the number of substances to be distinguished varies indefinitely, according to the nature and object of the several maps in which the uniform system is to be employed; secondly, because different minds frame different schemes of classification, and enlarge or diminish the groups as their own good pleasure or the nature of the countries represented may suggest; thirdly, because the same colour employed under different conditions, would lead to very different optical results, being in perfect harmony when applied to one map, when applied to another, painfully discordant.

Though the list of formations in elementary books is not long, yet the number of divisions and subdivisions which require admission into geological maps very constantly exceeds the number of tints which the most practised eye can discriminate; nor is it expedient, under any circumstances, that these tints should be repeated. To overcome this difficulty, Mr. Greenough proposes the combination of colours with linear shadows; and he indulges a hope that it will not be found difficult, by the judicious application of this simple contrivance, to give to the geological map-maker the blessing of an easy, copious, elegant, precise, and universal language.

To the Memoir are appended an Alphabetical Index to the Hills, and a list of the Hills arranged according to counties.

A paper was afterwards read, "On the Detrital Deposits of part of Norfolk, between Lynn and Wells;" by Joshua Trimmer, Esq., F.G.S.

The part of Norfolk described in this paper, is bounded by a line drawn from Lynn through Fakenham to Wells. The secondary strata consist of chalk and a band of green-sand and Kimmeridge clay on the borders of the Wash. The crag is considered to be wanting; but above the chalk are two deposits, neither of which, in Mr. Trimmer's opinion, is due to ordinary, long-continued marine action, but to powerful currents of water. The upper deposit consists of ferruginous sand or loam, containing numerous chalk flints, and a few fragments of red chalk, ferruginous sandstone, quartz rock, trap, porphyries and other formations. Mr. Trimmer does not pretend to identify any of these rocks with those of Scandinavia; but he says, if some of them have not been derived from that country, he knows of no other deposit in that part of Norfolk in which Scandinavian detritus is to be found. He has not seen any fragments actually imbedded of sufficient size to merit the appellation of boulders, though such masses are often placed to protect the angles of houses and gateposts. The lower deposit is composed of the ruins of chalk mixed with variable proportions of argillaceous and arenaceous materials. In its purest form it resembles chalk, but in adjoining sections it is often laminated with irregular layers of sand or gravel, or so much mixed with them, as to assume the appearance of a gravelly, calcareous loam. Near Lynn it consists of fragments of chalk in blue clay. It is in general destitute of detritus foreign to the chalk, Mr. Trimmer having noticed in it only one small pebble of sandstone. Unabraded tabular masses of flint, from 12 to 24 inches broad, are dispersed irregularly through it.

In neither of the two deposits has the author found any organic remains, except those derived from the chalk or the oolites.

The depth of these accumulations varies so greatly, that within a few hundred yards the chalk may in one place be barely covered by a film of sand and gravel, and in another be overlaid by a bed 20 feet thick. The deepest and purest bed of chalk-rubble examined by Mr. Trimmer is at Gallows Hill, near Burnham Market, and consists in its upper portion of finely comminuted chalk, partially worn fragments of chalk, and tabular, unabraded flints; but the lower four feet contain irregular layers of sand, which in one part increase to a lenticular bed of rounded and angular flint gravel.

The surface of the chalk-rubble is constantly indented with sand-galls, many of which Mr. Trimmer assigns to the action of currents of water; and he suggests that those which are cylindrical and a few inches in diameter, descending obliquely into the body of the rubble, may have been formed by eddies, whirling pebbles in their vortex.

A sand-gall 20 feet in depth at Gallows Hill, may, he says, be advanced as an objection to this hypothesis. The phænomena presented by the sand-galls are stated to agree with those mentioned by Mr. Lyell in his paper read before the British Association at Birmingham. The sides are stated to be lined with yellow clay, stained black in some parts; and between the galls, the chalk-rubble is separated from the superincumbent gravel by a nearly continuous layer of similar clay, from one to two inches thick. The sand-gall at Gallows Hill, 20 feet deep, is described in detail, and stated to terminate upwards in a depression in the chalk-rubble. Its trunk is filled with flint pebbles enveloped in ferruginous sand, and in general more water-worn than those in the horizontal bed of gravel. The author found in it one perfectly rounded pebble of quartz rock. At the time he examined the district, he had not read Mr. Lyell's paper on sand-galls, and therefore made no observations relative to their being the effects of acidulated water; and he will not venture to assert, that there were no fragments of chalk in the sand-gall described by him; but he says, if they exist, they are so much more rare in the gravel which fills it, than in that of the superincumbent bed, as to give to the contents of the sand-gall a very different aspect. The surface of the bed of gravel was indented in a similar manner to that of the chalk, the furrows cutting through layers of loam and sand; but the line of separation between it and an overlying loosely aggregated mass of ferruginous sand, was not so neatly defined as between the bottom of the gravel and the surface of the chalk-rubble.

In conclusion, Mr. Trimmer explains, that his reasons for assuming that the two deposits were not produced by long-continued marine action, are founded on the condition of the materials composing them. The chalk alone is worn to smooth pebbles, and in some cases the abrasion even of it is not complete; the flints also imbedded in the rubble, are as sharp as in their native strata; and those contained in the gravel beds have undergone little more attrition. He calls attention, lastly, to the importance of determining, whether the deposits described in this paper have any equivalents in the cliffs of Cromer.

On the same evening, after the ordinary business of the Society had been transacted, a Special General Meeting was held to consider the propriety of passing a Bye-Law, to enable Geologists residing in the British dependencies, and being British subjects, but known to Members of the Geological Society only by their works, to be recommended as Candidates for election into the Geological Society, as Ordinary Fellows, such persons not being eligible into that class by Section III. Clause 3, or into the class of Foreign Members by Section VIII. Clause 1.

And further, to consider the articles of agreement upon which Mr. Greenough proposed to assign to the Geological Society the copper plates and manuscript description of the second edition of his Geological Map of England.

The following resolutions were passed unanimously:

I. That British Subjects residing in British Colonies and desirous of becoming Fellows, but known to Members of the Geological Society only by their works, may be recommended as Candidates into the class of Ordinary Fellows, and balloted for in the usual manner, provided, that instead of one of the proposers certifying to personal knowledge, three Fellows of the Society shall certify their acquaintance with the works or scientific attainments and respectability of the Candidate.

II. That the Articles of Agreement by which Mr. Greenough proposes to transfer to the Society the Copper-plates and Manuscript description of the Second Edition of his Geological Map of England and Wales, be adopted and approved*.

III. That the thanks of the Society be given to Mr. Greenough for his great exertions in preparing the Map, which he has so liberally made over to the Society.

* For the principal Articles of the Agreement, see the second page of the Annual Report, *postea*, p. 190.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. III. 1840. No. 68.

AT THE

ANNUAL GENERAL MEETING,

21st February, 1840.

The following Report from the Council was read:—

It is with great satisfaction that the Council are again enabled to congratulate the Society on the increased number of its Fellows, which, at the close of 1838, was (exclusive of Honorary and Foreign Members, and Personages of Royal Blood) 742. During the year 1839, 36 new Fellows were elected and admitted, besides 7 more who had not before paid their admission fees, making an addition of 43 new Fellows, whilst during the same period there were 9 deaths and 8 resignations, which leaves an absolute increase of 26, thus making the total number of Fellows at the close of 1839, 768. On the other hand, during the same year the number of Foreign Members was diminished by 2, there having been 3 deaths and only one election. The number of Honorary Members and Personages of Royal Blood remains the same as at the last Anniversary, viz. 40; the total number of Members is therefore increased from 831, the number at the close of 1838, to 855.

In directing the attention of the Society to the state of the Finances, which show an excess of Expenditure over Income to the amount of 346*l*. 14*s*. 2*d*. during the last year, the Council consider it their duty to state that this excess has been mainly caused by the expense incurred in preparing for publication the part of the Transactions now on sale, the whole of which excess may therefore be considered as capital vested in the Stock of Transactions. At the same time they feel it their duty to observe, that the expenses of the year 1839 have been considerably within the estimates prepared and laid before the Society at the last Anniversary.

The whole amount of the three compositions received during the last year has been funded, although one Compounder has died during that period. It will thus be seen that the Council steadily persevere in the principle recommended in the Auditor's Report for 1833, viz. of accumulating an amount of capital equal to that of sums received for the total number of existing Compounders. The number of Compounders at the close of 1839 was 108, and the value of their compositions was 3244*l.* 10*s.*, while the estimated value of the funded property of the Society is now 2010*l.*, or within 1234*l.* 10*s.* of the whole amount received for actual compositions, a much nearer approach than the Society has ever yet made to the object which it has in view.

The Council have to state that, following up the plan with regard to the salaried department of the Society which was laid down in the Report of 1838, Mr. Woodward has been appointed to the office of Sub-Curator, and that they have every reason to expect, from the manner in which he has entered upon his duties, that the Curator will be enabled to devote more of his valuable time to the other business of the Society.

A new Part of the Transactions has been already published since the last Report, and another is ready to be laid upon the table in the course of a few days.

The Council has also to announce that the following Bye-Law has been passed, in strict compliance with the prescribed forms, to enable British subjects residing in the Colonies and not personally known to Fellows of the Society to become Members:

That British Subjects residing in British Colonies and desirous of becoming Fellows, but known to Members of the Geological Society only by their works, may be recommended as Candidates into the class of Ordinary Fellows, and balloted for in the usual manner, provided that instead of one of the proposers certifying to personal knowledge, three Fellows of the Society shall certify their acquaintance with the works or scientific attainments and respectability of the Candidate.

The Council have further the great satisfaction of informing the Society that Mr. Greenough has generously transferred to the Society the copper-plates of the second edition of his Geological Map of England, on conditions, which received the sanction of the Special General Meeting, held on the 5th of February, the Articles of Agreement having been duly prepared and drawn up by the Society's Solicitors. The principal conditions of the transfer are, that the Map shall be published by the Society, who shall defray the cost of paper, printing, colouring, &c.; that these costs shall be reimbursed to the Society from the sums received on account of copies sold, the price of which is also fixed in the Articles of Agreement; and that the surplus received from such sales shall be paid over annually to Mr. Greenough, until he shall have been repaid the sum of 718*l.* 2*s.* 5*d.*, the cost of drawing and engraving, incurred by him in the preparation for the second edition of the said Map; after which the copper-plates are to remain the absolute property of the Society.

The Council have resolved that the Wollaston Gold Medal be assigned to M. Dumont of Liége, for his Memoir, Map, and Sections of the Geological Constitution of the Province of Liége, published in 1832, and that one year's interest of the said fund, amounting to

32*l.* 10*s.* 4*d.*, be assigned to Mr. James Sowerby, in order to facilitate the continuation of his researches in Mineral Conchology.

Report of the Museum Committee.

The Committee has to congratulate the Society on the great progress which has been made in the arrangement of the collection during the past year.

The most important feature in this progress has been, 1st, the determination by Mr. Lonsdale of Plants from the Coal, presented by Sir P. Egerton, Messrs. Hutton, Murchison, Stokes, Meade and others, occupying fifty drawers.

2ndly, The working into the cabinet of the valuable collection of Silurian fossils, filling thirty-six drawers, presented in former years by Mr. Murchison; and the comparison by Mr. Lonsdale of the names accompanying the specimens with published figures and descriptions. Besides these steps in the arrangement of the English series, eleven drawers of shells and corals from the mountain limestone have also been named. Also more than forty specimens of Saurian remains from the Lias, together with miscellaneous specimens from the Diluvium of Essex, Crag, Pliocene strata of the Clyde, London Clay, and Chalk Marl.

Labels, containing generic or specific names, localities, references to books, and the names of donors, have been affixed by Mr. Woodward to all the above-mentioned rocks and fossils: corresponding entries have also been made by him in the hand catalogues. The specimens above alluded to, many of which have been now introduced for the first time into our English collection, occupy no less than 160 drawers.

Four new Cabinets, ordered by the Council at the last Anniversary, have been placed in the Lower Museum, and have been already in great part filled.

The Committee have learnt with pleasure that the number of persons who have made use of the Society's collections during the past year has considerably exceeded that of the years immediately preceding.

Mr. Woodward entered upon his appointment as Sub-Curator on the 1st of June. Since that period his time has been fully employed in the labours above mentioned, in affixing new bracket labels to the larger specimens,—in drawing illustrations for the Evening Meetings, and in attending the visitors who have consulted the Society's Museum.

The Committee cannot conclude this Report without congratulating the Council on the success which has attended the new arrangements which were made last year in regard to the duties of the Curator and Sub-Curator. By relieving Mr. Lonsdale from attendance on visitors to the Museum, and from many secretarian labours in labelling and cataloguing specimens, they have enabled him to devote his energies far more successfully than on any former occasion to the classification of our English collections, and we have pleasure in expressing our admiration of the varied and profound acquirements which he has displayed in determining since the last Anniversary the names of so many species of fossil plants, shells, corals, and saurian reptiles.

Library.

With respect to the Library the Committee have only to report that 160 volumes and pamphlets have been added, and have been duly entered into the catalogue.

(Signed) CHARLES LYELL.
CHARLES DARWIN.
PH. GREY EGERTON.

Comparative Statement of the Number of the Society at the close of the years 1838 *and* 1839.

	Dec. 31st, 1838.	Dec. 31st, 1839.
Fellows having compounded	106	108
——— Contributing	243	255
——— Non-residents	393	405
	742	768
Honorary Members	37	37
Foreign Members	49	47
Personages of Royal Blood	3	3
	831	855

General Statement explanatory of the alteration in the Number of Fellows at the close of the years 1838 *and* 1839.

Number of Fellows, Compounders, Contributors, and Non-residents, 31st December, 1838		742
Add Fellows elected during 1839 and paid	36	
in former years and paid in 1839	7	
		43
		785
Deduct, Deceased	9	
Resigned	8	
		17
Total number of Fellows 31st Dec. 1839		768

Number of Fellows liable to Annual Contributions at the close of 1839, *with the Alterations during the year* 1839.

Number at the close of 1838		243
Deduct, Deceased	6	
Resigned	8	
Compounded	1	
Became Non-residents . . .	3	
		18
		225
Add, Elected during 1839, paid and not Compounded . . .	14	
Elected during former years and paid in 1839	5	
Non-residents who became Resident and did not Compound	11	
		30
Total number as above		255

Deceased Fellows:

Compounders (1): Davies Gilbert, Esq.

Residents (6): Earl of Caledon; Henry Hubert, Esq.; William Taylor Esq.; William Shutt, Esq.; Sir John St. Aubyn; Colonel Silvertop.

Non-residents (2): Louis Hunton, Esq.; Captain Alexander Gerard.

Foreign Members (3): Professor Esmark; Professor Mohs; M. Carlos de Gimbernat.

The following Persons were elected Fellows during the year 1839.

January 9th.—Captain Alexander Jack, Bengal Native Infantry; George Cunningham, Esq. of 41, Harley Street; Rev. Samuel Wilberforce, M.A. of Brighton, Isle of Wight; Rev. William Bilton, M.A. of Port Hill, near Bideford; and Richard Clewin Griffith, M.D. of 10, Gower Street, Bedford Square.

January 23rd.—H. Sockett, Esq. of Swansea; John Thomas Barber Beaumont, Esq. of Regent Street; and Rev. Thomas Rees, LL.D. of 39, Woburn Place.

February 6th.—Mathew Dawes, Esq. of Acres Field, Bolton; Capt. Alexander, Royal Staff Corps, Southwold, Suffolk; John Cunningham, Esq. of Hope Street, Liverpool; and S. R. Pattison, Esq. of Launceston.

February 27th.—Lewis Llewelyn Dillwyn, Esq. of Burrows Lodge, Swansea.

March 13th.—Major George Walter Prosser, of 22, Cambridge Terrace, Hyde Park; William Sanders, Esq. of Park Street, Bristol; W. Marshall, Esq. M.P.; and Robert Blagdon Hale, Esq. M.P. of Alderley Park, Gloucestershire.

March 27th.—William Harris, Esq. of Charing in Kent; Rev. Robert Norgrave Pemberton, of Church Stretton, Salop; Rev. Alexander Thurtell, A.M. of Caius College, Cambridge; and Searles Valentine Wood, Esq. of 13, Bernard Street.

April 10th.—John Manning Needham, Esq. of Chiswell Street; Samuel Wright Fearn, Esq. of St. Peter's, Derby; Barratt Edward Lampet, Esq. B.A. of Corpus Christi College, Cambridge; and John Laurance, Esq. of High Street, Leicester.

April 24th.—James William Farrer, Esq. F.S.A. 7, John Street, Berkeley Square; C. B. Rose, Esq. of Swaffham, Norfolk; and William Haughton Stokes, Esq. M.A. of Caius College, Cambridge.

May 8th.—Thomas Griffin, Esq. of 25, Lansdowne Place, Cheltenham; John Griffith, Esq. of 16, Finsbury Place, South; and Robert Fitch, Esq. of 19, Castle Meadow, Norwich.

May 22nd.—William Fane De Salis, Esq. M.A. of 5, Carlton Gardens; and George Fleming Richardson, Esq. of the British Museum;—and Professor Ehrenberg, of Berlin, was also elected a Foreign Member.

June 5th.—J. B. Wigham, Esq. of Heigham, Norwich.

November 6th.—George Samuel Fereday Smith, Esq. of Manchester; William Taprell, Esq. of 8, Caroline Place, Mecklenburgh Square; and Edmund Morris, Esq. of 68, Oxford Terrace, Hyde Park.

November 20th.—John Williams, Esq. R.E. Lieutenant of the Royal Engineers employed on the Ordnance Survey of Ireland.

December 4th.—Angus Friend Mackintosh, Esq. of 18, Chenies Street, Bedford Square.

December 18th.—William Sidney Gibson, Esq. of 39, Essex Street, Strand.

The following Donations to the Museum have been received since the last Anniversary:—

British and Irish Specimens.

Bones from the Crag of Easton and Bulchamp Pit, Suffolk; presented by Capt. Alexander, F.G.S.

Corals from the Mountain Limestone of Lough Erne; Remains of Mammalia found in the Black Bog of Dunshaughlin, County of Meath; and Cast of the Femur of a Saurian from Shotover Hill; presented by Viscount Cole, F.G.S.

Plants from the Pembrokeshire Coal Field; presented by Henry Still, Esq. F.G.S.

Fossils from the Lias near Cheltenham; presented by R. B. Grantham, Esq. F.G.S.

A polished Specimen of *Spongus Labyrinthus* in Flint, from Sussex; presented by the Marquis of Northampton, F.G.S.

Section of an Alcyonite in Flint; presented by the Rev. Charles Watkins.

Shells from the recent deposit on the banks of the St. Lawrence; presented by Charles Lyell, Esq. V.P.G.S.

Fossils from the Ludlow formation near Ludlow; presented by the Rev. W. R. Evans.

Fossils from the London Clay; presented by N. T. Wetherell, Esq. F.G.S.

A Slab of New Red Sandstone from Eaton, Cheshire, with ripple-marks and impressions of Cheirotherium footsteps; presented by Sir Philip Grey Egerton, Bart. M.P. F.G.S.

A collection of Fossils from the South of Ireland; presented by R. Griffith, Esq. F.G.S.

Fossils from Cornwall; presented by Gideon Mantell, LL.D. F.G.S.

Portions of a Tortoise from the Freshwater Strata of East Cowes, Isle of Wight; presented by the Rev. W. Hennah.

Shells from the Coralline Crag at Gedgrove, and a Slab of Coralline Crag from Sudbourne; Cast of a Mastodon's Tooth dredged up off Easton, in June 1839; presented by Capt. Alexander, F.G.S.

Slates; presented by Leonard Horner, Esq. V.P.G.S.

Specimens of *Venericardia planicosta* and of Nummulites from the London Clay; presented by James Bowerbank, Esq. F.G.S.

Tiles from the Forest Marble and Purbeck Slate of Lady-Down; presented by Miss Benett.

Specimens from Muswell Hill, and the London Clay near Chalk Farm; presented by N. T. Wetherell, Esq. F.G.S.

Specimens of the Rocks of Waterford Haven; presented by Major T. Austin.

Specimens from Abereiddy Bay and from a Peat Bog near Fishguard; presented by H. MacLauchlan, Esq. F.G.S.

A Fossil from the Chalk at Merstham; presented by Newman Smith, Esq.

Three Paramoudras from Norfolk; presented by the Rev. John Gunn.

Fossils from the Chalk near Charing; presented by William Harris, Esq. F.G.S.

Specimens of Beekite from Devonshire; presented by Angus F. Mackintosh, Esq. F.G.S.

Part of a Fossil Tree from Portland; presented by John Fisher, Esq. F.G.S.

Foreign Specimens.

A Specimen of Polished Agate from Constantinople; presented by Edward Clark, Esq. F.G.S.

Minerals from Nova Scotia; presented by Abraham Gesner, Esq.

A Collection of Fossil Shells from the Apennines; presented by Sig. Michellotti.

Shells from the Pampas of Buenos Ayres; presented by Sir Woodbine Parish, K.C.H. F.G.S.

Shale with impressions of Plants from Philadelphia; presented by Gideon Mantell, LL.D. F.G.S.

Rocks from New Zealand and the Gold Coast; presented by Charles Lyell, Esq. V.P.G.S.

Fossils from Malta; presented by Miss Emily Attersol.

Specimens from Jamaica; presented by the Rev. Harry Jelly.

Hippurites and Spherulites from the Pyrenees and the South of France; presented by G. B. Greenough, Esq. V.P.G.S.

Specimens from Neuchatel; presented by Dr. Malcolmson, F.G.S.

Slice of the Limestone of the Rock of Gibraltar mounted upon Glass; presented by Mr. Darker.

Fossil Wood from Mount Wellington, New South Wales; presented by Josias Lambert, Esq. F.G.S.

Ammonites from the Tartary side of the Himalayas; presented by H. Clark, Esq.

Specimens of the Volcanic Rocks of St. Helena; presented by John Clark, M.D.

Specimens of Lava from the Island of St. Vincent; presented by H. J. Brooke, Esq. F.G.S.

Miscellaneous.

Casts of Echini and Shells; presented by M. le Prof. Agassiz.

Impression in Tin-foil of *Nereites Cambrensis*; presented by the Rev. J. B. Reade.

Scale for weighing Letters; presented by John Taylor, Esq. Treas. G.S.

A Series of Specimens illustrative of the external characters of Rocks; presented by G. B. Greenough, Esq. V.P.G.S.

The Library has been increased by the Donation of about 160 Volumes and Pamphlets.

Charts and Maps.

Geological Map of Germany and the neighbouring States, and Geological Map of the N.W. of Germany, by Frederick Hoffmann; presented by the Rev. Prof. Whewell, F.G.S.

Pilote Français, 4ème partie.—2. Carte des Mers du Nord, entre 48° et 75° Lat. Nord.—3. Carte générale des Bancs de Terre Neuve.—4. Carte des Côtes meridionales d'Afrique et de l'entrée du Canal de Mozambique.—5. Carte du Canal de Mozambique et de l'Ile de Madagascar.—6. Carte des Iles situés à l'Est et au Nord-est de Madagascar.—7. Carte des îles Sumatra, Java et Borneo; presented by the Director-General of the Depôt for the Marine of France.

Nos. 71 and 74 of the Ordnance Map, in continuation of the Trigonometrical Survey of Great Britain; presented by the Master-General and Board of Ordnance.

Ordnance Survey of the County of Kildare, in 42 Sheets, including Title and Index; presented by Colonel Colby, by direction of the Lord Lieutenant of Ireland.

The following List contains the Names of all the Persons and Public Bodies from whom Donations to the Library and Museums were received during the past year.

Academy of Sciences of Paris.
Admiralty, The Right Hon. the Lords Commissioners of the,
Agassiz, M. le Prof.
Alexander, Capt., F.G.S.
American Philosophical Society, held at Philadelphia.
Asiatic Society of Calcutta.
Athenæum Club.
Athenæum, Editor of.
Attersol, Miss Emily.
Austin, Major T.

Beaufort, Captain, R.N. Hon. M. G.S.
Benett, Miss.
Berwickshire Naturalists' Club.
Bilton, Rev. William, F.G.S.
Bland, Thomas, Esq. F.G.S.
Botanical Society of London.
Bowerbank, J. S., Esq. F.G.S.
British Association for the Advancement of Science.
Brongniart, M. Alex., For. Mem. G.S.
Brooke, H. J., Esq. F.G.S.
Buckland, Rev. Professor, D.D. Pres. G.S.

Cambridge Philosophical Society.
Catullo, M. Tommaso Antonio.
Charlesworth, Edw., Esq. F.G.S.
Clark, John, M.D.
Clark, Edward, Esq. F.G.S.
Clark, H., Esq.
Colby, Colonel, R.E. F.G.S.
Cole, Viscount, M.P. F.G.S.
College of Civil Engineers.
Commissioners of Her Majesty's Woods.
Coxe, Leonard S., Esq. F.G.S.

Dalmont, M. W.
Darker, Mr.
Darwin, Charles, Esq. Sec. G.S.
Daubeny, Prof., M.D. F.G.S.
Degenhardt, M. Charles.
Depôt Général de la Marine Française.
De Serres, M. Marcel.
De Waldheim, M. G. Fischer.
D'Omalius D'Halloy, M. J. J., For. Mem. G.S.
Dumont, M. A. H.

École des Mines.
Egerton, Sir Philip Grey, Bart. M.P. F.G.S.
Evans, Rev. W. R.

Fisher, John, Esq. F.G.S.
Fitton, W. Henry, M.D. F.G.S.
Forbes, Professor, F.G.S.
Forschhammer, Dr. G., For. M. G.S.
Frederick, Major-General.

Geneva, Natural History Society of.
Geological Society of Dublin.
Geological Society of France.
Gesner, Abraham, Esq.
Goeury, M.
Grant, Professor, M.D. F.G.S.
Grantham, Richard, Esq. F.G.S.
Granville, A. B., M.D. F.G.S.
Grateloup, Dr.
Greenough, G. B., Esq. V.P.G.S.
Griffith, Richard, Esq. F.G.S.
Griffith, William, Esq.
Gruithuisen, M.
Gunn, Rev. John.
Gussone, M.

Harris, William, Esq. F.G.S.
Hebden, Edward, Esq.
Hennah, Rev. W.
Hodson, Mr. J. S.
Horner, Leonard, Esq. V.P.G.S.
Humboldt, Alex. Baron Von, Foreign Member G. S.
Hunter, W. P., Esq. F.G.S.

Institution of Civil Engineers.

Jackson, Charles J., M.D.
Jameson, Professor, Hon. M. G.S.
Jelly, Rev. Harry.
Johnston, J. F. W., Esq. F.G.S.

Lambert, Josias, Esq. F.G.S.
Linnean Society of London.
Loudon, John Claudius, Esq.
Lubbock, J. W., Esq.
Lyell, Charles, Esq. V.P.G.S.

Mackintosh, Angus Friend, Esq. F.G.S.
MacLauchlan, H., Esq. F.G.S.
Madras Literary Society.
Malcolmson, J. G., M.D. F.G.S.
Mantell, Gideon, LL.D. F.G.S.
Michellotti, Sig. Giovanni.
Miller, Prof. W. H., M.A. F.G.S.
Milne, David, Esq. F.G.S.
Murchison, Roderick Impey, Esq. V.P.G.S.
Museum of Natural Hist., Paris.

Nasmyth, Alex., Esq. F.G.S.
Nattali, Mr. M. A.
Newman, Edward, Esq.
Northampton, Marquis of, F.G.S.
Numismatic Society of London.
Nutt, Mr. D.

Ordnance, Master-General and Board of.

Parish, Sir Woodbine, K.C.H F.G.S.
Portlock, Major, R. E., F.G.S.

Quebec Literary and Historical Society.

Reade, Rev. J. B.
Redfield, W. C., Esq.
Repertory of Patent Inventions, the Proprietor of.
Ridgway, Mr.
Roberts, George, Esq.
Royal Academy of Berlin.
Royal Academy of Brussels.
Royal Asiatic Society.
Royal College of Physicians.
Royal Geographical Society of London.
Royal Geological Society of Cornwall.
Royal Irish Academy.
Royal Medico-Botanical Society of London.
Royal Polytechnic Society of Cornwall.
Royal Society of Edinburgh.
Royal Society of London.
Royle, J. Forbes, M.D. F.G.S.

Scarborough Philosophical Society.
Schultz, Don Guillermo.
Scientific Society of London.
Sedgwick, Rev. Prof., F.G.S.
Sharpe, Daniel, Esq. F.G.S.
Shepard, Charles Upham, Esq.
Silliman, Prof., M.D. For. Mem. G.S.
Sismonda, Prof. Angelo.
Smith, James, Esq. F.G.S.
Smith, Newman, Esq.
Smith, Rev. J. Pye, D.D. F.G.S.
Still, Henry, Esq. F.G.S.
Studer, M. B.

Taylor, John, Esq. Treas. G.S.
Taylor, Richard, Esq. F.G.S.
Tenore, Sig.

Van der Maelen, M.
Vaughan, William, Esq.

Walker, Francis, Esq. F.G.S.
Watkins, Rev. Charles.
Weaver, Thomas, Esq. F.G.S.
Whetherell, Nathaniel, Esq. F.G.S.
Whewell, Rev. Prof., F.G.S.
Willimott, J., Esq. F.G.S.
Wood, Neville, Esq.
Woods, Henry, Esq.

Zoological Society of London.

List of PAPERS *read since the last Annual Meeting, February* 15, 1839.

February 27th.—On impressions of drops of rain, on slabs of new red sandstone, in the Storeton quarries, Cheshire, and coeval with the formation of the strata, by John Cunningham, Esq. F.G.S.

——————— Extracts from two letters addressed to Dr. Buckland, one from John Taylor, jun. Esq. F.G.S., On a slab of sandstone containing impressions of *Cheirotherium Hercules*, at the house of Mr. Potts of Chester; and the other from Sir Philip Grey Egerton, Bart. M.P. F.G.S., On the peculiarities of the impressions.

——————— On the occurrence of Swallow-holes near Farnham, and on the drainage of the country at the western extremity of the Hog's-back, by Henry Lawes Long, Esq., communicated by Charles Lyell, jun. Esq. V.P.G.S.

——————— A letter from Capt. Charters to Charles Lyell, jun. Esq. V.P.G.S., dated Cape Town, 12th of November, 1838, On the occurrence of Greenstone resting upon the horizontally stratified sandstone at various localities in the Colony of the Cape of Good Hope.

March 13th.—On the Geology of the North-western part of Asia Minor, from the Peninsula of Cyzicus on the coast of the Sea of Marmora, to Koola, with a description of the Katakekaumene, by W. J. Hamilton, Esq. Sec. G.S.

March 27th.—On a tooth and part of the skeleton of the Glyptodon, a large Quadruped of the Edentata order, to which belongs the tessellated bony armour figured in Mr. Clift's description of the Megatherium, and supposed by some Naturalists to belong to that Animal, by Richard Owen, Esq. F.G.S. Hunterian Professor in the Royal College of Surgeons.

April 10th.—On as much of the Transition or Grauwacke system as is comprised in the Counties of Somerset, Devon and Cornwall, by Rev. D. Williams, F.G.S. (1st Part.)

April 24th.—On the Climate of the Newer Pliocene Period, by James Smith, Esq. of Jordan Hill, F.G.S.

————— Remarks on some Fossil and Recent Shells collected by Capt. Bayfield, R.N. in Canada, by Charles Lyell, Esq. V.P.G.S.

————— Extract from a letter addressed to Dr. Fitton, F.G.S. by Herr F. A. Roemer, dated Hildeshiem, 20th of March, 1839, On the Wealden of the North of Germany.

————— Classification of the older Rocks of Devonshire and Cornwall, by Rev. Adam Sedgwick, V.P.G.S. Woodwardian Professor in the University of Cambridge, and Roderick Impey Murchison, Esq. F.G.S.

————— A Notice on the general relations of the various bands of slate, limestone, and sandstone in South Devon, by R. A. Cloyne Austen, Esq. F.G.S.

————— A Notice on the exact position in the old red sandstone of the bed containing fossil fishes, and exposed in the cliffs of the Moray Frith, by Mr. Miller.

May 8th.—On casts or impressions of Vermiform bodies on thin Flag-stones, belonging to the Carboniferous series near Haltwhistle in Northumberland, by G. C. Atkinson, Esq.

——— On the London and Plastic Clays of the Isle of Wight, by J. S. Bowerbank, Esq. F.G.S.

——— On the relative ages of the Tertiary deposits, commonly called Crag, in Norfolk and Suffolk, by Charles Lyell, Esq. V.P.G.S.

May 22nd.—On the Wells formed by digging and boring in the Gravel and London Clay in Essex, and on the Geological Phænomena disclosed by them, by James Mitchell, LL.D. F.G.S.

——— On Outbursts of Water from the Chalk, by James Mitchell, LL.D. F.G.S.

——— Notice on the discovery of the Remains of Insects, and a new Genus of Isopods, in the Wealden Formation, in the Vale of Wardour, by the Rev. P. B. Brodie, F.G.S.

——— Observations respecting the Geological Relations of the several rocks of the South of Ireland, in a letter addressed to the Rev. Dr. Buckland, Pres. G.S. by Richard Griffith, Esq. F.G.S. and Pres. G.S. of Dublin.

June 5th.—On remains of the Mammoth dredged up in the English Channel and German Ocean, by Capt. J. B. Martin, of Ramsgate.

——— A description of five Fossil Trees found in the excavations for the Manchester and Bolton Railway, by J. Hawkshaw, Esq. F.G.S.

——— A Notice of some Organic bodies recently procured from the London Clay, by N. T. Wetherell, Esq. F.G.S.

——— On the relations of the different parts of the Old Red Sandstone, in the Counties of Moiray, Nairn, Banff and Inverness, by John Malcolmson, Esq. F.G.S.

November 6th.—A Notice of Showers of Ashes, which fell on Board the Roxburgh, off the Cape de Verd Islands, in February 1839, by the Rev. W. B. Clarke, F.G.S.

——— A Letter from Alex. Caldcleugh, Esq. F.G.S. dated Santiago de Chili, 18th of February, 1839, containing the declaration of the Master and part of the Crew of the Chilian brig Thily, of the discovery during the evening of the 12th of February of three volcanic Islands, about thirty leagues to the east of Juan Fernandez.

——— A Letter addressed to Charles Lyell, Esq. V.P.G.S. by John Buddle, Esq. of Newcastle, On depressions produced in the surface of the ground, by the excavation of beds of Coal.

——— On the relative ages of the Tertiary and Post-Tertiary deposits of the basin of the Clyde, by James Smith, Esq., of Jordan Hill, F.G.S.

——— On the noxious Gases emitted from the Chalk and overlying strata in sinking Wells near London, by James Mitchell, LL.D. F.G.S.

November 20th.—An extract from a Letter addressed to Dr. Andrew Smith, by A. G. Bain, Esq., dated Graham Town, Cape of

Good Hope, February, 21st 1839, announcing the discovery of the skull and piths of the Horns of an Ox. Communicated by Charles Darwin, Esq. Sec. G.S.

November 20th.—On the origin of the vegetation of our Coal-fields and Wealdens, by J. T. Barber Beaumont, Esq. F.G.S.

——————— On the Fossil Fishes of the Yorkshire and Lancashire Coal-fields, by W. C. Williamson, Esq.

——————— On the Geology around the shores of Waterford Haven, by Major T. Austin. Communicated by the President.

December 4th.—A description of some of the soft parts, and the shape of the hind fin, of the Ichthyosaurus, as when recent, by Richard Owen, Esq. F.G.S. Hunterian Professor in the Royal College of Surgeons.

——————— Supplementary Memoir, On as much of the great Grauwacke system as is comprised in the group of West Somerset, Devon, and Cornwall, by the Rev. D. Williams, F.G.S.

December 18th.—On the Fossil remains of a Mammal (Hyracotherium), a Bird, and a Serpent from the London Clay, by Richard Owen, Esq. F.G.S. Hunterian Professor in the Royal College of Surgeons.

——————— On the locality of the Hyracotherium, by W. Richardson, Esq. F.G.S.

January 8th, 1840.—On the carboniferous and transition rocks of Bohemia, by D. T. Ansted, Esq. F.G.S.

——————— On some points in the structure of Paramoudras, and on the Boulder accumulations of Norfolk, by the Rev. John Gunn. Communicated by the President.

January 22nd.—On the Boulder formation or drift, and associated freshwater deposits composing the Mud Cliffs of Eastern Norfolk, by Charles Lyell, Esq. V.P.G.S.

February 5th.—An extract from a Dispatch from Mr. Chatfield, Her Majesty's Consul General at San Salvador, dated Oct. 10, 1839, giving an account of the earthquakes felt in that city during part of 1839, and communicated to the Society by direction of Vincent Palmerston.

——————— On Orthocera, Ammonites, and other cognate genera, by R. A. C. Austen, Esq. F.G.S.

——————— The Introductory Memoir to the New Edition of the Geological Map of England and Wales, by G. B. Greenough, Esq. V.P.G.S. explaining the principles upon which the Map has been constructed.

——————— On the detrital deposits between Lynn and Wells, in Norfolk, by Joshua Trimmer, Esq. F.G.S.

Sums actually Received and Expended

RECEIPTS.

	£.	s.	d.	£.	s.	d.	£.	s.	d.
Balances in hand, January 1, 1839:									
Banker (including 50*l.* 19*s.* 4*d.* Wollaston Fund)				433	2	0			
Accountant				40	0	0			
							473	2	0
Arrears:									
Admission Fees				52	10	0			
Annual Contributions				124	19	0			
							177	9	0
Ordinary Income:									
Annual Contributions				602	3	6			
Admission Fees:									
Residents (15)	94	10	0						
Non-Residents (21)	220	10	0						
				315	0	0			
							917	3	6
Compositions:									
Two at 31*l.* 10*s.*				63	0	0			
One at 28*l.* 7*s.*				28	7	0			
							91	7	0
Transactions				83	2	0			
Proceedings				10	17	0			
							93	19	0
Wollaston Donation Fund, 12 months' Interest on 1084*l.* 1*s.* 1*d.* Red. 3 per cents.							32	10	4
Dividends, 6 months 500*l.* Consols				7	10	0			
Ditto, 6 months 715*l.* 1*s.* 1*d.* Consols				10	14	6			
Ditto, 12 months 1412*l.* 12*s.* 9*d.* Red. 3 per cents				42	7	8			
							60	12	2
							£1846	3	0

We have compared the Books and Vouchers presented to us with these Statements, and find them correct.

Signed, FRANCIS BAILY, ROBERT HUTTON, SAMUEL CHARTERS, } AUDITORS.

Feb. 1, 1840.

during the year ending December 31, 1839.

PAYMENTS.

	£.	s.	d.	£.	s.	d.
Bills outstanding:						
Scientific Expenditure	3	3	0			
House Expenditure	2	1	0			
Sewers' Rates	1	10	0			
Household Furniture	22	7	9			
Transactions	45	7	0			
Stationery	3	14	6			
				78	3	3
General Expenditure:	£.	s.	d.			
Repairs of House	6	10	10			
House Expenses	199	1	3			
Taxes, Parochial	14	2	8			
——, Assessed	23	3	8			
Poor Rates	19	8	8			
Household Furniture	96	18	3			
———— Linen	4	18	11			
				364	4	3
Insurance				9	0	0
Salaries and Wages:	£.	s.	d.			
Curator	125	0	0			
Subcurator	77	10	0			
Clerk	61	5	0			
Porter and Housekeeper	70	0	0			
Servant	31	18	3			
Collector's Poundage	27	2	0			
				392	15	3
Scientific Expenditure				112	8	0
Stationery and Miscellaneous Printing				45	4	0
Investment in the Funds				94	10	0
Tea for Meetings				49	11	0
Cost of Publications:	£.	s.	d.			
Transactions	448	7	1			
Proceedings	63	13	0			
				512	0	1
Contributions repaid				9	9	0
Award of Wollaston Donation Fund:	£.	s.	d.			
Prof. Ehrenberg, Medal	10	10	0			
Balance of Proceeds	20	0	0			
				30	10	0
Balances in hand:	£.	s.	d.			
Banker (including *52l.* 19*s.* 8*d.* Wollaston Fund)	108	8	2			
Accountant	40	0	0			
				148	8	2
				£1846	3	0

VALUATION *of the Society's Property; 31st December* 1839.

PROPERTY.

	£.	s.	d.	£.	s.	d.
Balances in hand, including 52*l*. 19*s*. 8*d*. Wollaston Fund				148	8	2
Arrears due to the Society :						
Admission Fees	50	8	0			
Annual Contributions	499	5	6			
Transactions	3	15	0			
				553	8	6
Estimated value of unsold Transactions				923	8	6
Estimated value of unsold Proceedings				30	0	0
Value of Funded Property, 2212*l*. 12*s*. 11*d*. Consols at 91				2010	0	0
				£3665	5	2

[*N.B. The value of the Collections, Library and Furniture is not here included: nor is the " Donation Fund," instituted by the late Dr. Wollaston, amounting at present to* 1084*l*. 1*s*. 1*d*. *in the Reduced* 3 *per cent. Annuities; the dividends thereof being appropriated to the purposes of the Founder.*]

JOHN TAYLOR, TREASURER.

Feb. 1, 1840.

DEBTS.

	£.	s.	d.	£.	s.	d.
Bills outstanding :						
Scientific Expenditure	10	0	0			
Solicitor's Account	20	0	0			
House Expenditure	5	0	0			
Collector's Poundage	2	10	0			
Repairs of House	4	1	0			
				41	11	0
Cash belonging to the "Wollaston Fund"				52	19	8
Arrears not likely to be received				180	0	0
				274	10	8
Balance in favour of the Society				3390	14	6
				£3665	5	2

ESTIMATES *for the ensuing year* 1840.

INCOME EXPECTED.

	£.	s.	d.	£.	s.	d.
Arrears due to the Society, Dec. 31st, 1839. (See Valuation-sheet)				553	8	6
Ordinary Income of 1839 estimated:						
Annual Contributions (205 Fellows)				625	0	0
Admission Fees:						
Residents (15)	94	10	0			
Non-residents (15)	157	10	0			
				252	0	0
Sale of Transactions	300	0	0			
—— Proceedings	10	0	0			
				310	0	0
Dividends on "Wollaston Donation Fund"				32	10	4
Dividends on 6 months Consols, 2108*l.* 18*s.* 10*d.*				31	12	8
Ditto ditto 2212*l.* 12*s.* 11*d.*				33	3	9
				£1837	15	3

EXPENSES ESTIMATED.

	£.	s.	d.	£.	s.	d.
Debts outstanding. (See Valuation-sheet)				41	11	0
General Expenditure:						
Repairs of House	15	0	0			
Taxes	60	0	0			
Insurance	9	0	0			
House Expenses	200	0	0			
Household Furniture and Linen	20	0	0			
				304	0	0
Salaries and Wages:						
Curator	125	0	0			
Sub-Curator	84	0	0			
Clerk	75	0	0			
Porter and Housekeeper	70	0	0			
Servant	33	4	0			
Collector's Poundage	35	0	0			
				422	4	0
Scientific Expenditure				60	0	0
Stationery and Miscellaneous Printing				55	0	0
Tea for Meetings				55	0	0
Cost of Publications:						
Transactions	550	0	0			
Proceedings	80	0	0			
				630	0	0
Arrears not likely to be received				180	0	0
Employment of the "Wollaston Fund"				32	10	4
				£1780	5	4
Balance in favour of the Society				57	9	11
				£1837	15	3

The Reports having been read, it was resolved:

That they be received and entered on the Minutes of the Meeting, and that such parts of them as the Council may think fit, be printed and distributed among the Fellows.

The President then announced that the Wollaston Medal had been awarded to Prof. Dumont, of Liége, for his Memoir, Map, and Sections on the Geological Constitution of the Province of Liége, published in 1832; and one year's interest of the Wollaston Fund to Mr. James de Carle Sowerby, in order to facilitate the continuation of his researches in Mineral Conchology. On presenting the Medal to Dr. Fitton, who had been requested by M. Dumont to receive it on his behalf, Dr. Buckland said:—

Dr. Fitton,

I am highly gratified that it has become my duty on the present occasion, to commit to your care as the Representative of our common friend, Professor Dumont, the Wollaston Gold Medal, which has been awarded to him by the Council of this Society for his Memoir on the Geological Constitution of the province of Liége published at Brussels in 1832.

The grounds of our tardy recognition in 1840, of the merits of a work published so long as eight years ago, are the same that in 1830, prompted the Judges appointed by the Academy of Brussels, to select this Memoir as most worthy of the Prize then proposed by that Academy, for the best Geological description of the province which has formed the subject of M. Dumont's successful labours.

In the work thus doubly crowned, the Author has described the mineralogical and zoological characters of the rocks which occupy this district, and determined in minute detail, the relative places in order of succession, and the superficial extent of each subordinate division of the several formations. He has also illustrated the same by an accurately coloured Geological Map, and by coloured Sections, showing the general disposal of the strata in their original order of deposition, and the extraordinary derangements and disturbances that have subsequently thrown them into a state of almost inextricable confusion. In the execution of this work, M. Dumont has evidenced unusual powers of discriminating and accurate observation, combined with a high capacity of reducing the minutiæ of local details under the dominion of enlarged and masterly theoretical generalizations. Advancing at the early age of twenty one, to a task of gigantic labour, in a region where the unexampled disturbances, and almost incredible complexity of its component strata had baffled the sagacity of the most experienced geologists, this extraordinary youth at once withdraws the veil of confusion which had hitherto disguised the stratigraphical arrangements of his native province, and as it were, by an intuitive touch, reduces to order the entangled and almost incredible phænomena of dislocation, contortion, and inversion which had perplexed his predecessors in the same field of observation.

In addition to the scientific value of M. Dumont's exact and laborious researches, in illustrating a high and difficult problem in positive geology, his work assumes a place of great statistical and commercial importance, as describing the structure and contents of a rich and productive carboniferous district containing eighty-three beds of valuable coal; and its practical utility has been fully shown, by the fact of a second edition having been required to supply the demands of the landed proprietors, and persons practically interested in the operations and products of the coal mines.

The geological tribunal of Brussels, including the highly distinguished geologist Omalius d'Halloy, at once appreciated duly, and rewarded as they deserved, these brilliant discoveries; but the phænomena represented on M. Dumont's map and sections were so unusually complex and improbable, that the geologists of England could not but forbear to admit their reality, until it was fully confirmed by our personal examination, with the aid of that new light which M. Dumont's discoveries had thrown upon them. The result of such inquiry has been a full corroboration of M. Dumont's representations, and at this late hour we at length come forward with the homage of our tardy but sincere acknowledgements; a duty too long delayed, from the exercise of precaution in its administration, but for this very reason now become more urgent, when the grounds for conscientiously discharging it have passed the ordeal of severe and critical investigation. It is for this great work then on the geological constitution of the Province of Liége, such as in 1832 it issued from the hands of a young, and then unknown individual, and apart from any more recent attempts to identify the Belgian formations with those of England, that our Society has awarded to M. André Hubert Dumont their Gold Wollaston Medal for the present year; in testimony of their admiration of the almost precocious talents then displayed by him, and of their sense of his worthiness to fill the distinguished scientific position to which he is now advanced, as Professor of Mineralogy and Geology in the College of Liége.

Dr. Fitton, on receiving the Medal from the hands of the President, said, that he had been requested by M. Dumont to express his great regret that unavoidable duties prevented his appearing in person on this occasion. M. Dumont's letter states with deep feeling his sense of the honour which the Geological Society of London has thus conferred upon him, and his hope that he may soon be enabled to come into England, for the purpose of extending his personal acquaintance with the members of this Society, and of being enabled, with the aid of their knowledge, to perfect the comparison of the ancient strata of Belgium with those of this country. The Society could not but anticipate great advantage to Geology from the application of M. Dumont's talents to the comparative inquiries to which his letter alludes.

On presenting the prize awarded to Mr. James de Carle Sowerby, Dr. Buckland said:—

It is with no small pleasure that I rise to perform the duty of placing into your hands the award that has been made to you by the Council of the Geological Society, of one year's interest of the Wollaston Fund, in order to facilitate the continuation of your researches in Mineral Conchology.—The services are great which have been rendered to Geology by the extremely useful and well-timed work on fossil shells, which was many years ago begun by your excellent father, and continued by him to the end of his life, and has been since conducted by yourself; and the association of his name with that of Dr. Wollaston, recalls to my mind, as it must to the minds of most of my hearers, pleasing and grateful recollections of the benefits which during their lives they both conferred on this Society, and which their works will have extended to all our contemporaries and successors in this department of scientific inquiry. It was your father's peculiar merit to be one of those accurate and enthusiastic observers of nature, who have in modern times contributed so much to remove from science the rugged and austere aspect under which it used to be presented; and who by facilitating to every one the means of advancing pleasantly in its pursuit, have, in an essential manner, promoted, and given popularity to the study of Botany and Conchology.

It is to Mineral Conchology, which he so especially promoted, that we who are occupied with the investigation of the structure of the earth, have in modern times been mainly indebted for evidences which have led to the establishment of many of the most important stratigraphical distributions, that have been founded on the successive changes in animated nature which are made known to us by the study of fossil shells. It was on this foundation that Cuvier and Brogniart established their important divisions of the marine and freshwater strata of the Tertiary formations, which have since been more minutely distributed by Mr. Lyell into the eocene, pliocene, and miocene series, according to their relative numbers of extinct and recent species of fossil shells. It was on a similar foundation that Mr. William Smith rested his identification of the Secondary strata of England. It is on the same basis of conchological evidence that Mr. Murchison has founded his fourfold subdivisions of the Silurian portion of the Transition rocks; and it is chiefly to the illumination which this branch of Palæontology has shed upon the changes that took place on the surface of the earth, whilst its strata were in process of formation, that we owe the rapid advances in geological knowledge which have been made since the commencement of the present century. To this rapid progress, arising from the introduction of the evidences of mineral Conchology, your own publications and those of your family have largely contributed; you have further co-operated materially in advancing our inquiries by your personal assistance, at all times cheerfully and liberally rendered, to all your fellow labourers in the same fields of scientific research, who stood in need of your aid, for the elucidation of minute distinctions in the characters of fossil organic remains, which have at this time become so important an element in geology. The volumes of the Transactions of this Society, and other publications by many of its Members, including myself, bear further testimony to the importance of your labours, in illustrating our works with drawings and engravings of fossil shells and plants, expressing their characters with a degree of accuracy and truth, which no pencil or burine but those of a scientific artist could possibly accomplish; and I am sure I give utterance to the feelings of all our fellows now around me, when I thus publicly acknowledge the services you have rendered both to ourselves, and to the science we cultivate; and express the satisfaction with which we thus publicly recognise the value of your exertions.

Mr. Sowerby then expressed himself in the following terms:

Sir,

I hardly know what to say, so deeply do I feel the unexpected and kind award bestowed upon me by this Society, but I must assure you, that I am extremely grateful for the honour done me. When, Sir, you spoke of my father, you excited feelings most dear to me, and I have long felt that I have experienced more consideration than I have deserved, in consequence of the esteem that has ever been attached to his memory. But I must have been a most ungrateful son had I not, after his persevering and kind instructions, done something for the advancement of Natural History. What little I have performed, especially for Members of this Society, has been for the love of Science; and I feel far more than amply rewarded by the honourable present I have just received at your hands. You have stated, Sir, that you take a pleasure in associating the name of Wollaston with that of Sowerby; I shall never forget the kindness and patience with which Dr. Wollaston communicated information. When the reflecting goniometer was first completed by him, he spent several hours one morning with me in his study measuring the cleavages of various minerals related to hornblende and augite which I took to him for his opinion; and at another time he indulged me with an equally long lesson on the chemical examination of minute portions of minerals. Little did I think at that time that I should ever share encouragement continued by his bounty, after his departure from this world; but I have lived to feel that his benevolence lives beyond the grave.

Sir, I receive this award as a trust reposed in me, and hope that I shall not be found wanting in carrying out the object the Council has in view.

I beg sincerely to thank the Society for the confidence placed in me.

Address to the Geological Society, delivered at the Anniversary, on the 21st of February, 1840, *by the* Rev. Professor Buckland, D.D., F.R.S., *Corresponding Member of the Institute of France, President of the Society.*

Gentlemen,

By the Report just read, you have seen that the state of our Society is one of steady and salutary progression; forty-three new Members have been added to the List of our Fellows, from which seventeen have been removed by death, or resignation, leaving our actual number 768, with an increase of twenty-six during the last year. The vacancies that have occurred upon our foreign list have been supplied by three highly distinguished cultivators of science on the Continent, each preeminent for his successful labours in high departments of our subject, namely:

Major Puillon de Boblaye, in Positive Geology,

Professor Adolphe Brongniart, in Vegetable Palæontology,

Professor Gustave Rose, in Crystallography and Mineral Analysis.

We are rich in property, though our funds are, at this moment, low; but they will speedily be repaired by the sale of two large and costly parts which have been added to our Transactions.

The Reports of the Library and Collections in our Museum are satisfactory. The chief additions to the former consist of presents from Authors and Members of the Society. Our principal benefactor has been Mr. Greenough, who has given us a Collection of the older Authors,—supplying many of our deficiencies in the Literature of Geology and Mineralogy. Considerable progress has been made in the arrangement of the Cabinets by our Sub-Curator, Mr. Woodward, under the superintendence and directions of Mr. Lonsdale; one hundred and sixty drawers of rock specimens and fossil remains having been labelled, and in part catalogued, since the meeting of last year. It is satisfactory to find that the number of persons who come to study our Collections has been much increased.

Our entire establishment continues to receive the inestimable advantages it has long enjoyed, from the zealous superintendence, and scientific acquirements of our Curator, Mr. Lonsdale.

Our Wollaston Medal has been awarded to Professor Dumont, for his Map, Sections and Memoir on the Geological Constitution of the Province of Liége, published in 1832. And one year's interest of the Wollaston Fund has been presented to Mr. James De Carle Sowerby, to facilitate the continuation of his researches in Mineral Conchology.

More than a quarter of a century has now elapsed since I became a Member of this Society; and fifteen years have passed since I was first placed, by your kindness, in the honourable position of filling this Chair, at that important period of our history when we received the national recognition of a Royal Charter. I shall never cease to consider it one of the brightest rewards of my labours in geology, that my name is enrolled in that charter, as the first President of the Society in its corporate capacity.

Since that important epoch, our chartered body has received from the Government of the country the valuable sanction and advantage of an establishment in the very convenient apartments of Somerset House, which we now occupy. The number and character of the scientific labourers who have joined our ranks, and the volumes added to our Transactions, since these events, show that such encouragements have not been conferred on a society disposed to slumber under the sunshine of prosperity; but that, aided by these advantages, we have endeavoured to maintain a steadily progressive course, in the great work of illustrating the physical structure of the earth.

It is not my duty, on the present occasion, to notice geological memoirs or subjects which belong to years preceding that wherein I entered upon my present office. The usual practice rather confines me to the most remarkable events of the last twelve months, during which I have had the honour to fill this chair.

MUSEUM OF ŒCONOMIC GEOLOGY.

Among the most important of these events, we recognise with gratitude, and confident anticipation of great advantage, both to science and the arts, the establishment, by Her Majesty's Government, of an institution hitherto unknown in England, namely, a

Museum of Œconomic Geology. This is to be freely accessible to the public at stated periods, in the Department of Her Majesty's Woods and Forests, and Public Works, for the express object of exhibiting the practical application of geology to the useful purposes of life. In this Museum a large store of valuable materials has already been collected and arranged, chiefly by the exertions, and under the direction of Mr. De la Beche. In it will be exhibited examples of Metallic Ores, Ornamental Marbles, Building-stones and Limestones, Granites, Porphyries, Slates, Clays, Marls, Brickearths, and Minerals of every kind produced in this country, that are of pecuniary value, and applicable to the arts of life. Information upon such subjects, thus readily and gratuitously accessible, will be of the utmost practical importance to the miner and the mechanic, the builder and the architect, the engineer, the whole mining interest, and the landed proprietors. The establishment will contain also examples of the results of Metallurgic processes obtained from the furnace and the laboratory, with a collection of Models of the most improved machinery, chiefly employed in mining. A well-stored Laboratory is attached to this department, conducted by the distinguished analytical chemist, Mr. Richard Phillips, whose duty it already is, at a fixed and moderate charge, to conduct the analysis of metallic ores, and other minerals and soils submitted to him by the owners of mines or proprietors of land, who may wish for authentic information upon such matters.

The pupils in this laboratory are already actively employed in learning the arts of mineral analysis, and the various metallurgic processes.

A second department in the Œconomic Museum will be assigned to the promotion of improvements in Agriculture, and will contain sections of strata, with specimens of soils, sub-soils, and of the rocks from the decomposition of which they have been produced.

To this last-mentioned collection proprietors of land are solicited to contribute from their estates labelled examples of soils, with their respective sub-soils; and all persons who wish for an analysis of any sterile soil, for the purpose of giving it fertility, by the artificial addition of ingredients with which nature had not supplied it, may here obtain, at a moderate cost, an exact knowledge of its composition, which may point out the corrective additions which it requires. This portion of the Museum will more especially exhibit the relations of geology to agriculture, in so far as a knowledge of the materials composing the sub-strata may afford extensive means of permanent improvement to the surface.

MINING RECORDS OFFICE.

A third department, which it is proposed to add to this establishment, is an office, for the preservation of such records and documents relating to subterranean operations throughout the country, as are important to be preserved for the information of future generations.

To the keeper of these records will be assigned the duty of arranging the documents which may be transmitted to him from all parts of the kingdom, by any engineers, mineral surveyors, and proprietors of mines and coal works, who may be willing to send them; particularly maps, sections, and under-ground plans, which will record the state of each mine, when it is abandoned, for the information of those who at a future period may be disposed to bring it again into operation. This office will be accessible to all persons interested in obtaining the information it will afford. To this collection several engineers of most extensive experience in the mines of Newcastle and Cornwall have promised large contributions.

The keeper will make copies of documents of this kind, which proprietors of mines, who cannot conveniently part with the originals, may lend, for the purpose of being preserved in this national collection.

The public importance of such a records office was submitted to the Lords of Her Majesty's Treasury by a Committee of the British Association for the Advancement of Science, assembled at Newcastle in August, 1838; it being notorious that great losses of life and destruction of property have resulted both at Newcastle and in other coal mines throughout the kingdom, from the imperfect preservation of records of the operations previously conducted in them, and that still greater losses will inevitably ensue hereafter, unless advantage be taken of the experience of living engineers and coal proprietors, who are willing to place in a public national repository copies of the documents they possess relating to their respective mines.

In 1834, the attention of the public was called to this subject by Mr. T. Sopwith*, an eminent civil engineer and mine surveyor at Newcastle; and this gentleman is preparing a practical book of instructions on the subject of drawing geological and mining plans, the conducting of subterranean surveys, and examining mineral districts, with a view to the preservation of such information respecting the state of each mine at the period when it may be abandoned, as may be useful when further proceedings are afterwards commenced therein, or in its vicinity.

A museum of œconomic geology, comprehending institutions of this kind, demonstrates, even to the unlearned, the advantages that result from science in its application to the extraction of the treasures which Providence has laid up in the rich storehouses of the interior of the earth; and by exhibiting the results obtained from the elaboration of these materials, by the industry of man, in the workshop and at the forge, will afford a full and satisfactory reply to the question so often raised by persons to whom the value of the truths of pure science and philosophy, pursued for their own sake, are unintelligible,—and by whom everything is appreciated merely according to its immediate subserviency to the acquisition of wealth, or its ministration to the daily necessities or conveniences of human life.

BUILDING-STONE COMMISSION.

Another event which marks increasing attention to the practical importance of geology, is the publication of a Report to the Commissioners of Her Majesty's Woods and Forests, from a Commission appointed by the Lords of the Treasury; containing the results of an inquiry into the qualities and durability of the various Building-stones of this country, with a view to the selection of the best material to be employed in erecting the New Houses of Parliament.

The results of this inquiry have been arranged in Tables, which represent the composition, colour, weight, size, cost, durability, &c., of all the most important kinds of stone that have been used in an-

* See Sopwith on Isometric Drawing, p. 50, *et seq.*

cient edifices in England; the Commissioners having judiciously appealed to that which is the most severe test of the durability of any stone, viz. the existing condition of the decorated architecture in our most ancient buildings.

The Norman portions of the Church of Southwell, in Nottinghamshire, constructed of magnesian limestone, in the twelfth century, have been found to afford an example of stone which combines strength and durability with applicability to ornamental carved work, in a degree surpassing all other kinds of stone that have been employed in the most ancient fabrics of this country; the sharpest of the mouldings and carved enrichments of that church being throughout in as perfect a state as when first executed. The keep of Koningsburgh Castle, near Doncaster, built also of the magnesian limestone in that vicinity, offers another proof of the durability of certain beds of this formation, exceeding that of any other building-stone in Great Britain, which is equally fit for ornamental purposes. But there are also varieties of magnesian limestone, such as that of which York Cathedral is built, which are in far advanced stages of decay, where they have been used for mouldings and architectural decorations.

The general result of this elaborate inquiry into the durability of the different varieties of magnesian limestone is, that the stone resists decomposition in proportion as it is more perfectly crystalline; a result, the cause of which is further illustrated by the experiments of Professor Daniell, which show that the nearer the magnesian compounds approach to *equivalent* proportions of carbonate of lime and carbonate of magnesia, the more crystalline they are.

No investigation has been made by these Commissioners as to the capabilities of granite, porphyries, and other kinds of stone, which are inapplicable to the decoration of edifices without enormous expense.

The Report is followed by valuable tabular lists of the most remarkable ancient fabrics in England, specifying the materials of which they are constructed, and their various conditions of preservation or decay, as they are respectively built of sandstone, or of oolitic, shelly, or magnesian limestone.

To these are added tables of the chemical analysis, weight, cohesive power, specific gravity, and power of absorbing water, of many of the building stones most largely employed in England.

I consider this Report as of the highest value, in showing the general advantages which may be derived from connecting scientific knowledge with practical arts; and I trust we shall hear no more of such discreditable and unfounded assertions as, not long ago, passed uncontradicted, at a meeting of an architectural society in London, that Stonehenge is made of statuary marble.

GEOLOGICAL COMMITTEE OF ENGLISH AGRICULTURAL SOCIETY.

The appointment of a Geological Committee, by the English Agricultural Society, at their meeting in Oxford, in July last, shows the sense entertained by that numerous body of landed proprietors, and cultivators of the soil of England, of the important services which may be rendered to them, by the application of geological knowledge to the improvement of the productive capabilities of the land.

It is well known to geologists that an almost unbounded supply of mineral manure may be found in the sub-strata, which in very many districts are composed of ingredients different from those of the surface. So constant are the characters of many of the beds of the geological groups which pass in long and narrow bands from one side of England to the other, that a single experiment, carefully conducted, on any one stratum of each formation, with a view to ameliorate its soil, by an admixture of the ingredients of some other adjacent stratum, will afford an example which may be followed with similar results in distant parts of the kingdom, through which this same stratum passes, in its course across the island.

Experiments, therefore, conducted by the owners and occupiers of land, under the advice of this Geological Committee, aided by the facilities for the analysis of soils now afforded by the laboratory of the Museum of Œconomic Geology, may shortly enable us to realize at least some share of the success that attended Lavoisier's application of chemistry to agriculture in France*.

* It was said of Lavoisier, that in ten years he doubled the produce of his land in grain, while he quintupled the number of his flocks. No doubt this report is much exaggerated.

SCHOOLS OF CIVIL AND MINING ENGINEERING IN THE UNIVERSITIES OF DURHAM AND LONDON.

The increasing demand for education in practical science has been recently provided for in the University of Durham, by the establishment of a course of instruction in Civil and Mining Engineering, with lectures in the Mathematical sciences, Chemistry, Metallurgy, Mineralogy, Geology, Surveying, Mapping, and Drawing, in addition to Ancient and Modern Languages. To theoretical instruction in such parts of these branches of knowledge as bear more especially on Practical Engineering, are added at Durham occasional surveying excursions, both in the field and underground, conducted by a practical civil engineer. More than thirty young men have, during the last year, been actively engaged in this new department of academical study.*

The locality of Durham, upon the margin of the great Newcastle coal field, and in the vicinity of the lead mines of Alston Moor, and Weardale, is in a peculiar degree favourable for a school of mining and civil engineering; enjoying advantages of position similar to those of the great Saxon school at Freyberg, near the mining districts of the Ertzgebirge and the Hartz.

The University of London also is taking measures to institute examinations of Candidates for certificates of proficiency in Civil Engineering, and the arts and sciences connected with Mining.

In University College, London, courses of preparatory experimental lectures and exercises in Natural Philosophy have, during the last year, been provided for the students in that establishment, who are destined for the Profession of Civil Engineers.

And in King's College, London, a course of lectures in Civil Engineering, and Sciences applied to Arts and Manufactures, is at this time attended by more than fifty students, who have the opportunity of adding practical to theoretical knowledge in a workshop and laboratory established for their use.

SCHOOL OF MINES IN CORNWALL.

Another proof of the direction of public attention to the collateral branches of our science has, within the last twelve months,

* See Durham University Calendar, 1839, p. 10.

been afforded by the establishment in Cornwall, of a school for the instruction in Sciences and Arts connected with Mining, of young men who are to be engaged in conducting the important subterranean operations of that county. The want of such a school had been pointed out by Mr. John Taylor, in his Prospectus of a School of Mines in Cornwall, February 7, 1825, and in his Records of Mining, published in 1829. It has at length been instituted chiefly through the exertions and at the expense of Sir Charles Lemon. This incipient school, and the University of Durham, form almost solitary examples in England, of such scientific establishments as are nearly universal in the mining districts of the Continent. The experiment has begun in Cornwall with Courses of Lectures in Mathematics, Mechanics, Chemistry, and Mineralogy, by three professors; and a course of instruction, by a practical surveyor, in Algebra, Drawing, and the Use of instruments: and during the next year, still further additions are contemplated.

POLYTECHNIC SOCIETY OF CORNWALL.

To the zealous exertions of Sir Charles Lemon, and of many intelligent and active individuals at Falmouth, the county of Cornwall is also indebted for the establishment of a Polytechnic Society, which, during the few years of its existence, has been attended with extraordinary success. One of its chief objects is to encourage, by rewards, the invention and improvement of machinery, of which so large an amount is essential to the working of the mines. Another object is to collect materials for expressing the quantity and value of the mineral and other produce of the county; and to construct tables indicating the diminished longevity, and diseases, which, in a peculiar degree, affect the Cornish miners, and do not prevail amongst those employed in Collieries. It appears, from a paper published in the Sixth Annual Report of this Society, (1839,) that the average duration of a miner's life is less, by many years, than that of the agricultural labourer in the same district; the apparent causes of this frightful evil being the inevitably imperfect ventilation of many of the veins or lodes in which the miner works; and, partly, the extreme fatigue of ascending from great depths by ladders, instead of being lifted by machinery, as the workmen are from coal pits: these pits also are usually susceptible of more perfect ventilation, than the metalliferous lodes in Cornwall.

The attention of this Society is strenuously directed to the discovery of remedies for these tremendous evils, which affect no fewer than a population of 28,000 persons; that being the proportion of the inhabitants of Cornwall, who are occupied in working the mines.

LOCAL MUSEUMS.

Another circumstance which marks the progressive advancement of public feeling as to the value of geology, is the increasing disposition to form local museums in our provincial towns.

At the meeting of the British Association, at BIRMINGHAM, in August last, after a strong expression of opinion, in the Section of Geology, as to the benefit likely to accrue to science from the establishment of Provincial Museums, for the local productions of each neighbourhood, the justness of the suggestion was so fully recognised, that, in the adjacent town of Dudley, before five days had passed, a public museum had arisen from contributions, out of the cabinets of private collectors in that town; presenting to the Association a more perfect assemblage than was ever seen, of the exquisite organic remains found in the limestone of that district, which has long been the classic type of a formation widely and abundantly distributed over the globe.

About this time also a provincial museum was formed at BRADFORD, in a district abounding in splendid examples of the vegetable remains which pervade the Yorkshire coal field; where the extensive collieries now wrought will furnish abundant materials for a collection, destined to illustrate the history of the extinct forms of vegetable life, which have produced the coal.

The museum at LEEDS, also, possesses a valuable collection of fossil vegetables from the coal field in its neighbourhood; and the WEST RIDING GEOLOGICAL SOCIETY, formed under the auspices of Earl Fitzwilliam, on the plan of holding quarterly meetings at different towns of the Riding in succession, is diffusing a taste for Geology, and affording ground for appreciating its practical importance, to numbers of intelligent persons, whose local occupations, and property in the coal and iron mines, will enable them to enlarge the fossil Flora and Fauna of our country.

ROYAL INSTITUTION OF SOUTH WALES.

From the first Annual Report of the Royal Institution of South Wales, published during the last year, we learn that the Swansea Literary and Philosophical Institution, hitherto supported by the town and neighbourhood, has been expanded, under Royal patronage, to the whole southern division of the Principality; and is now establishing its Museum and Lecture Rooms in a large and commodious edifice in the town of Swansea, under the presidentship of Lewis Weston Dillwyn, Esq.

The position of this Institution, in the midst of a great mining and manufacturing district, is peculiarly favourable for collecting facts illustrative of geological phenomena, more especially those of the Coal formation; and much has already been done by Mr. Logan, to develope, with extreme accuracy and minuteness of detail, the stratigraphical succession of the rocks composing this formation; and to show the number and nature of the events which attended their original deposition, as well as the subsequent derangements that have affected them. Mr. L. L. Dillwyn, also, is attempting a classification of the coal plants of the South Wales Bason; with a view to ascertain, by means of a comparative collection in the Swansea Museum, whether there exists any specific difference between those of the upper and lower beds of the carboniferous series.

BRITISH MUSEUM.

The accessions lately made to the British Museum form another subject, of high importance in our Review of the Geological Proceedings for the past year. At the head of these is the purchase, from Mr. T. Hawkins, of an additional series of the remains of fossil *Saurians* from the Lias formation; which, added to his former collection, already placed in this national repository, present an unrivalled series of species in the extinct families of *Ichthyosaurus* and *Plesiosaurus*, once inhabitants of Britain. Equally important was the acquisition, in a former year, of the unique collection of still more gigantic and not less monstrous Reptiles, from the Wealden formation of Kent and Sussex, obtained by purchase from Dr. Mantell. The possession of these several collections places the Museum, where it ought to stand, at the head of all existing repositories of organic remains, almost exclusively the productions of England; and it is due to his late exertions, whilst Chancellor of the Exchequer, that I should bear this public testimony to the services which Lord Monteagle has rendered to science, by supplying the means of placing these unrivalled collections in our national repository; where their constant presentation to the view of its thousands of daily visitors cannot fail to attract increasing attention to the wonderful discoveries of Palæontology.

These important public events, occurring beyond our walls, and having a direct and immediate tendency to enlarge the field of our labours, form an epoch in the history of our science, and place Geology before the country in a new and more widely popular aspect than it had occupied before. The past year has been also distinguished beyond all precedent, by the number and value of the GEOLOGICAL MAPS it has produced.

GEOLOGICAL MAP OF CORNWALL AND DEVON.

The first map which I shall mention, affords another example of the recognition by Government of the importance of our subject, by their having attached a geological department to the Ordnance Survey of England and Wales. The first fruits of this appointment are the splendid Maps of Devon and Cornwall, and a part of Somerset, coloured after the surveys of Mr. De la Beche; and it may be truly said of them, that they are more beautiful in their execution, more accurate in their details, and more instructive in the œconomical and scientific information they give respecting mines, than any maps yet published by any government in the world; affording documents to which we can at length with pride appeal, in reply to the reproach that has so long, with too much truth, been cast upon us, that England alone, of all the civilized nations, has abandoned to gratuitous individual exertions, and the liberality of amateurs in science, the great work of exploring and delineating the mineral structure of the country; and ascertaining the nature and extent of the subterraneous produce, which lies at the foundation of the industry of its manufacturing population, and to which the nation owes no small portion of its wealth.

The statistical importance of this first portion of the Ordnance Geological Map of England will be duly appreciated only by those, who know the extent of the property embarked in the mining interests of the Western counties, and are aware that the annual value of the mineral produce of Cornwall and Devon alone has recently amounted to 1,340,000*l*.

In the chapter on Œconomic Geology, which forms part of the Memoir connected with his Map of Cornwall and Devon, Mr. De la Beche has placed, in a more prominent light than has ever yet appeared, the bearing of geological researches and mineral statistics upon political œconomy; and proves, by tabular documents, the important fact, that the average value of the annual produce of the mines of the British Islands amounts to the enormous sum of 20,000,000*l*.*, of which about 8,000,000*l*. arise from iron, and 9,000,000*l* from coal.

Should this inquiry be extended through the endless departments of art, industry and commerce, which have their origin in the manufactories of metals, and in the power of steam, derived exclusively from the application of coal, the vast national importance of mineral statistics, and of models, maps and sections, on which alone their details can be effectually recorded, must be apparent to every one.

Still more extensive will be the statistical and political importance of the next portion of this great work, now in progress by the same highly accomplished geologist, which is to comprehend the coal and iron districts of Monmouthshire and South Wales.

GEOLOGICAL MAP OF ENGLAND.

You have this day the satisfaction to see suspended in your meeting room a new edition of Mr. Greenough's Geological Map of England, which has for many years formed the glory of this Society. It is truly gratifying to observe how small a change this new edition exhibits, either in the general dispositions, which it represented nearly a quarter of a century ago, or in the complicated details of the boundaries of the different formations. Some alterations appear in the Greensand series, the Wealden, the Lias, and the New red Sandstone. The principal additions are the introduction of the Si-

* See Geological Report on Devon and Cornwall, p. 624, and note, 1839. In this estimate the value of the copper is taken in the ore, before fusion; that of the iron, lead, zinc, tin and silver, after fusion, in their first marketable condition — as pigs, blocks and ingots. The coal is valued at the pit's mouth.

lurian divisions made in the slate rocks, by Mr. Murchison, in the border districts of England and Wales; and the new distribution very recently assigned to the slate rocks of Devonshire and Cornwall.

A great improvement also has been made by the substitution of an entirely new Map of Wales and Siluria, founded on the Ordnance surveys of those regions, of which no accurate physical map existed at the time of Mr. Greenough's first publication. Another improvement in the execution consists in the union of linear shadows with the colours representing the superficial extent of the strata. The combined effects of these *elements of expression*, judiciously employed, has been to exhibit, more distinctly, the subdivisions of formations, without destroying the unity of the general mass to which they belong. By the frequent introduction also of conventional signs, and figures of reference, Mr. Greenough has produced a more condensed assemblage of scientific information, of varied kinds, than has been put together in any map of equal extent yet published. Extreme attention has also been paid to the physical features of the country, and in the orographic details more than 500 heights are given. The hydrographic features also are delineated with scrupulous exactness.

GEOLOGICAL MAP OF IRELAND.

The last summer has witnessed the production of Mr. Griffith's large and splendid Geological Map of Ireland, containing the results of nearly thirty years' investigation, by that eminent geologist and civil engineer.

Mr. Griffith had supplied an outline of this map published in the Report of the Railway Commissioners for Ireland, 1838. It is obvious that the information thus conveyed, as to the nature of the materials of which the island is composed, affords the most solid basis for sound calculation as to the future improvement of Ireland by the application of its natural resources.

GEOLOGICAL MAP OF A LARGE PORTION OF EUROPE.

During the last year we have also witnessed the publication of a beautifully coloured general Geological Map of Germany, France, and England, and parts of the adjoining countries, compiled from the larger original maps of Von Buch, Elie de Beaumont, and Greenough, by Professor Von Dechen, in one large sheet, published at Berlin.* This map exhibits the geological details of a larger continuous portion of the surface of the earth than has ever before been put together with so much exactness, and set forth on such eminent authority. It also presents to the statesman and political œconomist the most important portions of central Europe, under the new aspect of the natural divisions of the mineral formations, of which each country is composed; showing that in every region the nature and disposition of the substrata lie at the foundation, not only of its agricultural productiveness, but also of its capability of supplying the materials, which form the basis of its industry and arts. As an historical document, this map demonstrates the rapid progress of our science, and the state of maturity which it has attained.

Thus far I have occupied your attention with external matters of extraordinary interest in the history of our science, which show that geological knowledge is spreading its salutary influence, more widely and rapidly than heretofore, over the practical business of the country. I now proceed to consider the communications made to the meetings of our Society during the past year.

POSITIVE GEOLOGY.—DEVONIAN SYSTEM.

In the Home Department of Positive Geology, the most striking circumstance has been an announcement by Professor Sedgwick and Mr. Murchison of the conclusion to which they were led by Mr. Lonsdale's suggestion in December 1837, founded on the intermediate character of the fossils in the Plymouth and Torbay limestone, —that the greater part of the slate rocks of the south of Devon and of Cornwall belong to the old red sandstone formation.

The order of the observations which have led to this important result, is nearly as follows:—

In a paper read at Cambridge, during the winter of 1836–37, Professor Sedgwick considered the fossiliferous slates on both sides of Cornwall to be of the same formation, and coeval, or nearly so, with the calcareous rocks that lie between the slates of South Devon.

* Schropp and Company, 1839.

In 1836 and 1837 also*, Messrs. Sedgwick and Murchison proposed to transfer the culmiferous or anthracitic shale and grits (Shillot and Dunstone) of *North* Devon to the carboniferous system; withdrawing them from the grauwacke in which they had before been included, and thus assigning a much more recent date than heretofore to the strata which occupy nearly one third part of the map of Devonshire.

But the relations of the slates and limestones of *South* Devon still remained to be determined; the mineral characters of the former being different from those of the old red sandstone beneath the carboniferous group, in many parts of South Wales and in Herefordshire, while the true position of the limestones (e. g. those of Plymouth, Torbay, and Newton Bushell,) was doubtful. At this period, (1837,) the fossils of this district were examined by Mr. Lonsdale and Mr. Sowerby, to whom the organic remains, both of the carboniferous and Silurian systems, were familiar. It was soon perceived, that while some of the South Devonshire fossils approached to those of the carboniferous strata, and others to those of Siluria, there were still many species which could not be assigned to either system; the whole, taken together, exhibiting a peculiar and intermediate palæontological character. Mr. Lonsdale therefore suggested, that the difficulties which had perplexed this inquiry could be removed by regarding the limestones of South Devon as subordinate to slaty rocks, which represent the old red sandstones of Hereford, Wales, Scotland, and Ireland,—their true place in the series of Devonshire being intermediate between the culmiferous basin of North Devon, and the Silurian strata,—if the latter exist in that county.

The value of this suggestion was not at first appreciated; but after the lapse of more than a year, Mr. Lonsdale's views were adopted (March 1839) by Messrs. Sedgwick and Murchison†, who

* In August 1836, at the Meeting of the British Association at Bristol; and in a paper read before the Geological Society, May and June, 1837, now published in the Geological Transactions, Second Series, vol. v., Part 3.

† It is to be observed here, that Mr. Murchison, having previously shown that the fossils of the Silurian æra are distinct from those of the carboniferous period, had also pointed out "the vast accumulations" (in which few fossils had at that time been discovered) "then known to separate the two systems." He mentions especially, that "the *fishes* of the old red

soon afterwards applied this new arrangement not only to the groups of Devonshire originally under review, but with a boldness which does credit to their sagacity, extended it to the whole of the slaty and calciferous strata of *Cornwall*, till then known only as grauwacke, clay-slate, or killas; assigning to those strata, likewise, the date of the old red sandstone, and resting this determination entirely on the character of the fossils. This change—the greatest ever made at one time in the classification of our English formations—was announced in a memoir read before the Geological Society in April 1839; the authors then also proposing for the whole series (including both the old red sandstones of Herefordshire, and the fossiliferous slates and limestones of South Devon and Cornwall,) the new name of "*the Devonian system*," and expressing their belief, that many of the groups hitherto called grauwacke, in other parts of the British Islands and on the continent, would ere long be referred to the same geological epoch.

The proposed alteration, therefore, will terminate the perplexity hitherto arising from the circumstance, that the *old* red sandstone of Werner has been frequently confounded with the *new* red sandstone formation of English geologists. It also explains the cause of the English old red sandstone having been rarely recognised on the continent:—for if the Devonian slates afford the normal type of this formation, whilst the marly sandstones and conglomerates of Herefordshire are abnormal exceptions in it, we see the reason why their slaty continental equivalents, like the greater part of the South Devon slates, have been referred to the undivided Wernerian formation of grauwacke.

Mr. Austen, in a communication relating to the structure of the south of Devon, has identified the calcareous slate and limestone of the south of Cornwall with the limestones of this district, and considers that of Torbay among the newest deposits in the latter series.

sandstone—entirely distinct as to form and species—are as unlike those of the Silurian system, as they are to those of the overlying carboniferous system:" adding, "that he has no doubt, although at present unprovided with geological links to connect the whole series, that such proofs will be hereafter discovered, and that we shall then see in them as perfect evidence of a transition between the old red sandstone and carboniferous rocks, as we now trace from the Cambrian, through the Silurian, into the old red system."—See Silurian System, p. 585, line 22, *et seq.*

The Rev. D. Williams also has communicated two papers respecting these disputed rocks, which he refers to the transition or grauwacke system, and endeavours to show that the strata of Devonshire can be distinguished into certain groups by their lithological characters.

Mr. De la Beche in his map of Devon and Cornwall, published in 1839, has adopted divisions of the strata, similar to those of Professor Sedgwick and Mr. Murchison, as to their order of sequence; applying, provisionally, to the culmiferous rocks the name of *Carbonaceous series*, and to the Devonian and Cornish slates the appellation of *Greywacke*.

We know also on the authority of Mr. De la Beche that tin mines are worked in carbonaceous rocks at Owlescomb near Ashburton, on the east side of the Dartmoor granite, and on its west side at Wheal Jewel near Tavistock. He further informs us that one of the richest tin mines now worked in Cornwall, namely the Charlestown mine, east of St. Austle, is in a fossiliferous rock containing Encrinites and corals, and that the same corals occur also near tin mines at St. Just; and in the neighbourhood of Liskeard the Rev. D. Williams has found slates which contain vegetable impressions, dipping under other slates which are intersected by lodes of tin and copper.

From these new facts, we learn that the killas and other slate rocks of Cornwall and the south of Devon do not possess the high antiquity which has till lately been imputed to them; and that tin occurs, as copper, lead and silver have long been known to do, not only in slate rocks that contain organic remains, but even in the coal formation.

Soon after the publication of the views of Messrs. Sedgwick and Murchison, a similar change was applied by Mr. Griffith to the south-west portion of his geological map of Ireland. In a paper that accompanied the presentation of this map to us on 22nd of May last, he states that he has now coloured, as old red sandstone and carboniferous limestone, extensive districts of the counties of Kerry, Cork, and Waterford, previously considered of higher antiquity; imputing his former erroneous opinion to the identity in lithological character of the shales and grits of the old red sandstone and carboniferous systems, with the older rocks in the transition series.

Mr. Griffith has also demonstrated by sections the unconformable position of the carboniferous and old red sandstone formations, which overlie older and more highly inclined slates in the counties of Kerry, Cork, Waterford, and Wexford.

Mr. Charles William Hamilton has likewise adopted similar changes; and believes that the slates which occupy a large space between the Mourne Mountains and Dublin are equivalent to those near Cork, which he now transfers to the old red sandstone.

Mr. Greenough, in the new edition of his map of England, represents nearly the same boundaries and order of succession in Devon and Cornwall as we find in the maps of Mr. De la Beche and Messrs. Sedgwick and Murchison; but in his memoir connected with the map, adopting the name of *Carbonaceous series* for the culmiferous rocks, he substitutes that of *Upper killas* for the Devonian system of Sedgwick and Murchison, (including under that term the old red sandstone of Herefordshire,) and *Lower killas* for the slates inferior to the Silurian system, which they have termed Cambrian.

Mr. Greenough, in his memoir, also shows by quotations from Dr. MacCulloch, that the undisputed old red sandstone of the north of Scotland exhibits, at intervals, the same great changes of mineral character, that occur in the strata intermediate between the Carbonaceous and Silurian systems in the west of England and on the borders of Wales; and justly infers the inadequacy of any one term to characterize formations which vary so much in lithological composition, that at one place they present the condition of a fine-grained silky slate, at another of sandstone, and at a third that of coarse gravel and conglomerate rock.

Thus, with respect to the slate rocks of Devon, Cornwall and Wales, the difficulties are reduced to those of an unsettled nomenclature; whilst nearly all parties are in unison as to the fundamental fact of referring the slates of South Devon and Cornwall to the epoch of the old red sandstone formation. The term grauwacke, however, I rejoice to think, will not be condemned to the extirpation which has been threatened from the nomenclature of geology; it may still retain its place as a generic appellative, comprehending the entire transition series of the school of Freyberg, and divisible into three great subordinate formations:—the Devonian system of Sedgwick and Murchison being equivalent to the upper grauwacke, the Silurian to the middle grauwacke, and the Cambrian system to the lower.

In this threefold distribution of the vast series of strata which have hitherto been indiscriminately designated by the common term grauwacke, we are, as it were, extending the progressive operations of a general inclosure act over the great common field of geology; we propose a division, founded on measurements, surveys, and the study of organic remains, analogous to that of the secondary strata, from the chalk downwards to the coal formation, established by William Smith, and to the separations of the once undivided territory of the great tertiary system, effected by Cuvier and Brongniart, Desnoyers, Lyell, and Deshayes.

To the uninitiated in geology, rectifications in the distribution of strata upon so large a scale may seem calculated to shake confidence in all the conclusions of our science; but a contrary inference will be drawn by those who know that these corrections have never been applied to conclusions established on the sure foundation of organic remains, but to those rocks only of which the arrangement had been founded on the uncertain character of mineral composition.

COAL FORMATION.

The Society has received from Professor Ansted a paper on the Carboniferous and Transition Rocks of Bohemia, a country which he visited last summer, directing especial attention to the district between Prague, Luditz and Pilsen, which he has illustrated by sections made from personal observation. Above the fundamental granite and gneiss he found extensive deposits of grauwacke, on which lie, in unconformable superposition, disconnected patches of the coal formation. The age of this coal is well known, from the fossil Flora of Count Sternberg, who resided in the midst of it near Swina, to be identical with that of the great Coal formation of England. Mr. Ansted gives information also as to the action of trap rocks in producing disturbances of the strata in this district; and respecting dislocations, by which the grauwacke is several times placed on a level with the coal measures, whilst in some cases the strata are inverted and the coal measures laid beneath the grauwacke.

We have received an interesting communication from Mr. Hawkshaw respecting a remarkable disclosure made in the Bolton Railway, six miles north of Manchester, of five fossil trees in a position vertical to the plane of the strata in which they stand. The roots are imbedded in a soft argillaceous shale immediately under a thin bed of coal. Near the base of one tree, and beneath the coal, more than a bushel of hard clay nodules was found, each inclosing a cone of *Lepidostrobus variabilis.* The bark of the trees was converted to coal, from one quarter to three quarters of an inch thick; the substance which has replaced the interior of the trees is shale; the circumference of the largest of them is $15\frac{1}{2}$ feet at the base, $7\frac{1}{2}$ at the top, and its height 11 feet. One tree has spreading roots, four feet in circumference, solid and strong. By the care of Mr. Hawkshaw these trees have been preserved, and a covering is erected over them. The attendant phænomena seem to show that they grew upon the strata that lie immediately beneath their roots.

Mr. Barber Beaumont, in a communication respecting these same trees, considers that no drifted plants occur in coal fields, and that all the vegetables which are now converted into coal, grew upon swampy islands covered with luxuriant vegetation, which accumulated in the manner of peat bogs; that these islands, having sunk beneath the sea, were there covered with sand, clay and shells, till they again became dry land, and that this operation was repeated in the formation of each bed of coal. In denying altogether the presence of drifted plants, the opinion of the author seems erroneous; universal negative propositions are in all cases dangerous, and more especially so in geology: that some of the trees which are found erect in the coal formation have not been drifted, is, I think, established on sufficient evidence; but there is equal evidence to show that other trees, and leaves innumerable which pervade the strata that alternate with the coal, have been removed by water to considerable distances from the spots on which they grew. Proofs are daily increasing in favour of both opinions: viz. that some of the vegetables which formed our beds of coal grew on the identical banks of sand and silt and mud, which being now indurated to stone and shale, form the strata that accompany the coal; whilst other portions of these plants have been drifted, to various distances, from the swamps, savannahs, and forests that gave them birth, particularly those that are dispersed through the sandstones, or mixed with fishes in the shale beds.

The cases are very few in which I have ever seen fossil trees, or any smaller vegetables erect and petrified in their native place. The Cycadites and stumps of large Coniferous trees on the surface of the oolite in Portland, and the stems of Equisetaceous plants described by Mr. Murchison in the inferior oolite formation near Whitby, and erect plants which I have found in sandy strata of the latter formation near Alencon, are examples of stems and roots overlaid by sediment and subsequently petrified without removal from the spots in which they grew. At Balgray, three miles north of Glasgow, I saw in the year 1824, as there still may be seen, an unequivocal example of the stumps of several stems of large trees standing close together in their native place in a quarry of sandstone of the coal formation.

In a paper on the sinking of the surface over coal mines, Mr. Buddle has shown that the depressions produced on the surface by the excavation of beds of coal near Newcastle-on-Tyne are regulated by the depth and thickness of the coal, the nature of the strata above it, and also the partial or total extraction of the beds of coal. The accumulation of water forming ponds in these superficial depressions, and the sinkings of a railway, have afforded accurate measures of the amount of the subsidences in question.

WEALDEN AND PORTLAND FORMATIONS.

In the north of Germany Mr. Roëmer, of Hildesheim, has identified beneath the Cretaceous system, the Purbeck stone and beds of the Wealden formation, with nearly all its characteristic shells, and three minute species of Cypris. He has also found the Portland sand and the upper and lower Green sand and the Gault clay, in the north of Germany. He has, moreover, found the Wealden formation near Bottingen in the High Alps.

CHALK FORMATION.

In extension of our knowledge of the Chalk formation, the Rev. J. Gunn has sent us a short communication, accompanied by a lithograph representing the columnar disposition of some Paramoudras to the height of many feet one above another in the chalk of Norfolk. The history of these enormous urn-shaped flints, which were first noticed by Professor Buckland in an early volume of our Transactions, 1st series, vol. iv. p. 413. pl. 24., is still involved in much obscurity. Their form is most probably due to siliceous matter collected around and penetrating throughout the substance of gigantic spongiform bodies; but we have yet to learn the reason why they are occasionally placed in single vertical rows, almost like the joints of a basaltic column, sometimes nearly touching, but not articulating with one another.

A paper has been read by Mr. Henry Lawes Long on the occurrence of numerous *subterraneous chasms* or *swallow-holes* in the chalk on the west of Farnham, with observations on the drainage of the country near the west extremity of the highly-inclined ridge of chalk, called the Hog's Back, between Guildford to Farnham. The land-springs immediately on the north of Farnham descend southwards in open gulleys over tertiary strata, until they arrive at the narrow band of chalk which passes under Farnham Park, where they are suddenly engulphed in transverse fissures or swallow-holes, through which they pass under ground to a considerable distance, and again break forth on the southern side of the chalk. Seven of these swallow-holes occur near Farnham, from some of which the water emerges in sufficient force to turn a mill. They are probably connected with subterranean faults and transverse fractures, the origin of which was coeval with the elevation of the narrow band of chalk, which forms the Hog's Back, and which, near Farnham, is inclined at a high angle to the north. The water that now passes through the Farnham swallow-holes may tend to enlarge the chasms through which it takes its subterraneous course, by dissolving slowly the chalk of their sides in the small quantities of carbonic acid which rain-water usually contains.

Similar transverse fractures, on a greater scale, have given origin to the chasms, which, being enlarged by denudation into transverse valleys, afford outlets through the high escarpment of the chalk to the rivers that, rising within the Weald, flow through the escarpment of the north Downs into the valley of the Thames, and through the escarpment of the south Downs into the sea, viz. to the Wey, the Mole, the Darent, the Medway, and the Stour, through chasms in the north Downs; and to the Arun, the Aduz, the Ouse, and the Cuckmere, through chasms in the south Downs.

Dr. Mitchell has communicated a paper on Artesian and other wells, in the gravel and London clay in Essex, showing that water occurs under the London clay at various depths; the deepest at Foulness Island, being 460 feet. He attributes this inequality in part to unevenness in the surface of the subjacent chalk. On reaching the chalk a large volume of water usually rushes up. Artesian wells are now general in Essex, where they are of the greatest utility in districts that have no natural springs. He also gives an interesting list of localities, both of constant and intermitting springs, some of them very powerful, that burst out from the chalk.

Dr. Mitchell has also communicated an account of deleterious gases that occur in wells in the chalk and strata above it near London. The most abundant of these, namely, carbonic acid gas, issues very partially and only from certain strata, and produces sometimes effects fatal to persons employed in digging wells. Sulphuretted hydrogen is occasionally met with in chalk; and both sulphuretted hydrogen and carburetted hydrogen occur in beds immediately above the chalk.

SUPERCRETACEOUS FORMATIONS.

In illustration of the history of the Eocene division of the tertiary strata, Mr. Bowerbank has concluded, from his personal observations at White cliff bay in the Isle of Wight, that there are no well-defined zoological distinctions between the London and plastic clays, but that in the cliffs of this bay the same shells are common to alternations of these clays with one another. At Alum bay also he found many London clay fossils in beds of greenish grey sand and clay below the variegated sands and clays referred by Mr. Webster to the plastic clay. A similar rectification was sometime ago proposed by Professor Sedgwick.

We have also witnessed during the past year the commencement of a valuable publication by Mr. Bowerbank on the fossil fruits and seeds of the London clay, illustrated with very numerous and accurate engravings by Mr. James Sowerby.

The great attention the author has long paid to the remains of fruits and seeds which occur in such vast abundance in the Isle of Sheppy, whence he has collected not less than 25,000 specimens, place him in a position peculiarly advantageous for the object before him. In this work drawings will be given of the anatomical structure of many of these fossils, as seen under the microscope. The simple expedient Mr. Bowerbank has adopted of preserving these fruits in jars of water, has kept him in the entire possession of every specimen ever placed in his collection; whilst of the thousands of similar fossils that have been deposited in other collections, including that at the British Museum, nearly all have perished from the decomposition of the iron pyrites with which they are always penetrated.

Mr. Lyell has communicated to us a paper full of elaborate detail of facts, and of ingenious speculations respecting the Boulder formation, or drift, associated with freshwater deposits, in the mud cliffs of Eastern Norfolk. These cliffs are in some places 400 feet high, and consist of chalk, crag, freshwater deposits, drift mud and sand, stratified and unstratified;—with superficial accumulations of flint gravel. The centre of his observations is the town of Cromer; he considers the Boulder formation to have been accumulated on land permanently submerged, and not, by one or many, transient advances of water over dry land, and therefore proposes, as Mr. Murchison and others have already done, to substitute the term of Drift for that of Diluvium, which many other writers have assigned to it. The Drift, or Diluvium, is of two kinds; one composed of sand, loam, clay, and gravel, all regularly stratified; the other consisting of clay, not divided into beds, and containing boulders of granite, trap and other rocks.

This clay is known on the east and north-east coast of Scotland by the name of Till. He considers the stratified Drift and Till to be contemporaneous formations, and compares the latter to moraines formed at the termination of glaciers. He imagines that drifted masses of ice, charged with earthy matter and fragments of rock, may have deposited the Till as they melted in still water, and the occasional intercalation or juxta-position of stratified materials is ascribed to the action of currents on materials also falling from melting icebergs.

Mr. Lyell refers the complicated bendings and tortuous foldings of many beds of this formation near Mundesley and Cromer to lateral pressure from drifting ice, especially where extremely contorted beds repose upon undisturbed and horizontal strata. But he admits that some of them may be due to landslips of ancient date, and which had no connection with the present line of cliffs. At the bottom of the boulder formation, and immediately above the chalk, extensive remains of a buried forest occur, the stools of the trees being imbedded in black vegetable earth. From the position of this forest a vertical subsidence of several hundred feet and a subsequent rise of the land to the same amount is inferred. This forest and a bed of lignite are connected with fluviatile or lacustrine deposits, which occur about the level of low water below the drift; but at Mundesley they are partly above it, and the freshwater shells which they inclose being nearly all of British species show that they, as well as the contemporaneous drift, all belong to the newer Pliocene period.

In an Address formerly delivered from this chair, in 1836, and in a subsequent edition of his "Principles of Geology," as well as in his "Elements" Mr. Lyell has called our attention to some differences of opinion which had been expressed by several eminent conchologists as to the number of fossil shells of the crag of Norfolk and Suffolk which could be identified with living species. So great was the discordance of the results at which M. Deshayes, Dr. Beck, and others seemed to have arrived, that their announcement was calculated materially to impair our confidence in the applicability of the chronological test so much relied on by Mr. Lyell for the classification of the tertiary formations; namely, that derived from the proportional number of recent and extinct species discoverable in each deposit. In the hope of arriving at some definite conclusion on this important point, Mr. Lyell visited Norfolk and Suffolk during the last year, and having obtained a considerable collection from the crag near Norwich and Southwold, he instituted, with the assistance of Mr. Searles Wood and Mr. George Sowerby, a thorough comparison between them and recent species. The fossil shells of this formation, which the author calls the Norwich crag, are partly marine, and partly freshwater, and indicate a fluvio-marine origin, and the proportion of living species was found to be between 50 and 60 per cent. This deposit, therefore, the author refers to the older Pliocene period. A similar examination was then made of 230 species of shells from the Red Crag in Mr. Wood's museum, and it was found that 69 agreed with living species, being in the proportion of about 30 per cent. This group therefore Mr. Lyell ascribes to the Miocene era. A collection of 345 species of Coralline Crag shells in Mr. Wood's cabinet was then compared in like manner, and sixty-seven were determined to be identical with recent species, being about 19 per cent. Mr. Lyell, therefore, considers that the Coralline Crag is also Miocene, although belonging to a more remote part of that period than the Red Crag. Having obtained from M. Dujardin a collection of 240 shells from the Faluns of Touraine, he found with Mr. George Sowerby's assistance that the recent shells were in the proportion of twenty-six per cent., so that he has now come round to the opinion long ago announced by M. Desnoyers, that upon the whole the Crag of Suffolk corresponds in age with the Faluns of Touraine, both being Miocene, although the species in the two countries are almost entirely distinct, those of England having a northern and those of France a sub-tropical character. I am also informed by Mr. Lyell, that out of 400 marine and freshwater species, from the Eocene strata of the London and Hampshire basins, Mr. G. Sowerby was scarcely able to identify two per cent. with living shells. It is satisfactory therefore to observe that the test of age derived from the relative approach to the recent Fauna is in perfect accordance with the independent evidence drawn from superposition. We ascertain for example by superposition that the freshwater strata of the mud cliffs of East Norfolk rest on Norwich crag, and are the newest formation of all. They are then followed in the descending series by, 1st, the Norwich, 2ndly, the Red, and 3rdly, the Coralline Crag, beneath which is the London Clay. The same order of sequence is indicated by the organic remains considered independently, and simply with reference to the degree of their correspondence with the existing Fauna.

It has been known for many years, that near Bridlington, in Yorkshire, sand and clay containing marine tertiary shells had been exposed on the coast. From an examination of the shells collected there by Mr. Bean, Mr. Lyell finds the deposit to agree in age with the Norwich Crag.

I cannot conclude these remarks without observing, that some part of the confusion and apparent inconsistency of the opinions of different conchologists, respecting the age of the Crag, must have arisen from the intermixture of fossils derived equally from the Norfolk and Suffolk beds, or from strata, some of which now turn out to be referable to the Older Pliocene, others to the Miocene period.

From an examination of some fossil shells, identical with recent species collected by Capt. Bayfield from the most modern deposit near the Gulf of St. Lawrence, and near Quebec, Mr. Lyell infers, that the climate of Canada was colder than now during the era immediately antecedent to our own times. The shells, which were determined by Dr. Beck, differ in great part from those now living in the Gulf of St. Lawrence, agree more nearly with arctic genera and species, and resemble those which Mr. Lyell collected at Uddevalla, in Sweden; whereas, if the living shells most abundant in the Swedish and Canadian seas are contrasted, they differ almost entirely. From notes sent by Capt. Bayfield, it appears that at different depths in the stratified sand and clay containing the fosils shells, near Quebec, insulated boulders are numerous, which, it is presumed, have been brought down at distant intervals by drift ice, and have dropped to the bottom of the sea as the ice melted.

While Mr. Lyell, by the aid of Dr. Beck's determination of fossils, had adopted these views respecting the climate of Canada, Mr. James Smith, of Jordan Hill, had been led by independent observations to a similar conclusion respecting the climate of Scotland during the Newer Pliocene era, arguing from the arctic character of the Testacea found in the raised beds of the valley of the Clyde, and other localities. In the first of two papers communicated by this author, he regarded all the deposits abounding in recent shells in Scotland and Ireland as belonging to one group; but in his second memoir he contends that there are two distinct formations on the Clyde, in the older of which there are from ten to fifteen per cent. of extinct or unknown species of shells, which he refers to the Newer Pliocene system of Lyell; whereas all the species found in the newer, which he calls Post-tertiary, exist also in the present seas. During this Post-tertiary period, which is considered to have been anterior to the human epoch, an elevation of at least forty feet took place on the shores of the Clyde. Mr. Smith affirms that the Till, or unstratified accumulation of clay and boulders, belongs not to the Post-tertiary, but to the older Pliocene division.

IGNEOUS ROCKS.

The principal communication we have received on rocks of igneous origin has been from our Secretary, Mr. W. I. Hamilton, who has read an interesting paper on the north-west part of Asia Minor, from the Peninsula of Cyzicus to Koola, with a description of the Katakekaumene. Between Cyzicus and Koola the principal stratified rocks are schist, with saccharine marble, compact limestone resembling the scaglia of Italy and Greece, tertiary sandstones, and tertiary limestones. The igneous rocks are granite, peperite, trachyte and basalt. The tertiary limestones are referred to the great lacustrine formation which occupies so large a part of Asia Minor. Hot springs burst forth near Singerli from a porphyritic trap rock. The Katakekaumene is a volcanic region, extending about seven miles from north to south, and from eighteen to nineteen east and west. It presents two systems of volcanic craters and coulées: the older of them are placed on parallel ridges of gneiss and mica slate, and the newer in the intervening valleys; hence he argues, that when the latter eruptions took place, the lines of least resistance to subterraneous expansion were in the valleys. The streams of lava from the more recent cones are bare and rugged, like the coulées in central France. Three periods of eruption are traced: the first, having produced basalt, which caps the plains of white limestone, and was ejected before the formation of the valleys; the second, marked by currents of lava from the more ancient system of volcanos in action since the formation of the valleys; the third resembling the coulées of Etna and Vesuvius, and mentioned by Strabo, but of which there is no historical tradition as to the period when they were in activity.

We have a notice by the Rev. W. B. Clarke of a shower of ashes that fell on board the Roxburgh off the Cape de Verd islands in February, 1839, the cause of which was not apparent. The sails were covered with a fine powder, resembling the ashes of Vesuvius, which was probably derived from an eruption in the Cape de Verd group.

PALÆONTOLOGY.

In the department of *Palæontology* Prof. Owen has, during the past year, contributed many papers, with his usual zeal and ability, to the elucidation of this most essential and perhaps most generally interesting branch of our subject. At the head of these we must place his determination of a tooth and part of a jaw of a fossil monkey, of the genus *macacus*, with part of the jaw of an opossum, and the tooth of a bat, in Eocene strata of the English tertiary formation. These remains were found at Kingston, near Woodbridge in Suffolk, by Mr. Colchester, in strata which Mr. Lyell has referred to the London clay; thus proving the existence of quadrumanous, marsupial, and cheiropterous animals in this country during the Eocene period. We have now evidence of fossil Quadrumana in the tertiary formations, not only of India and Brazil, but also of France and England; respecting which Mr. Owen has observed, that they appear under four of the existing modifications of the quadrumanous type: viz. the tailless ape (*Hylobates*), found fossil in the South of France; the gentle vegetable-feeding *Semnopithecus*, found fossil in India; the more petulant and omnivorous *Macacus*, found in Norfolk; and the platyrrhine *Callithrix*, found in Brazil. This genus is peculiar to America, and its extinct species is of more than double the stature of any that exists at the present day. This geographical distribution of Quadrumana adds further weight to the arguments derived from the tropical aspect of vegetable remains that abound in the London clay at Sheppy, showing that great heat prevailed in the European part of the world, as well as in India and South America, during the Eocene period.

The probability of high temperature is further corroborated by Mr. Owen's recent recognition of four petrified portions of a large serpent (*Palæophis Toliapicus*), eleven feet long, and in several points resembling a boa, or python; and also of a bird allied to the vultures (*Lithornis vulturinus*), all from the London clay of the Isle of Sheppy; wherein the occurrence of fossil Crocodilians and Testudinata, and of fossil fruits, having a tropical aspect allied to cocoa-nuts and many other fruits of palms, has been long known. Can we account for these curious facts without supposing that at the Eocene period of the tertiary epoch, the very clay on which London now stands was in the condition of a nascent spice-island, its shores covered with basking reptiles, and the adjacent lands waving with cardomums and palms, and thuias and cypresses, with monkeys vaulting and gamboling upon their branches, and gigantic serpents entwined around their trunks; the seas also swarming with sting-rays and saw-fishes, with chimæras and enormous sharks? for all these together with countless shells of pearly nautili occur among the fossil remains of the numerous extinct species of fishes, which, during the early ages of the tertiary period, crowded the tepid seas of our now humid and chilling climate.

Mr. Owen has also determined the character of a new genus of Pachydermatous animal (*Hyotherium*) intermediate between the Hyrax, hog, and Chæropotamus, found in the London clay at Herne Bay, near Margate, by Mr. Richardson.

Mr. Lyell having submitted to Mr. Owen some fossil teeth from the Red Crag of Newbourne in Suffolk, they proved to be referrible to the leopard, bear, hog, and a large kind of deer, and afford the first example of mammalian remains being found in England in any of those divisions of the Crag which Mr. Lyell, in a paper already alluded to, has ascribed to the Miocene period; these genera are known to occur in the Miocene formations of France and Germany. The numerous Mammalia in the fluvio-marine crag of Norwich, are decidedly of a later date; among these Mr. Lyell enumerates the teeth and jaw of *Mastodon longirostris*, a tusk of an elephant with serpulæ attached, and bones of a horse, hog, and field-mouse; there occur bones of birds, many fishes, and numerous shells, partly marine, and partly fresh-water and terrestrial.

The recent discoveries in Brazil by Dr. Lund of extinct Mammalia, that probably lived in some late portion of the tertiary epochs, form a new and important chapter in Palæontology. The largest of these are referrible to more gigantic forms than at present exist of families now peculiar to South America—*e. g.* to Sloths and Armadillos; just as most of the fossil mammalia of New Holland belong to families and genera which are still peculiar to that country. In a paper on one of these animals from Buenos Ayres, Mr. Owen has shown that the bony armour, which several authors have referred to the Megatherium, belongs to the Glyptodon, an animal allied to the Armadillo, and of which a head containing teeth, and attached to a tessellated bony covering of the body and tail, resembling those of an Armadillo, has been lately found near Buenos Ayres, and is figured by Sir Woodbine Parish in his interesting work on that country, 1838.

The Glyptodon differed from the Megatherium in the structure and number of the teeth, and from all known Armadillos in the form of the lower jaw, and the presence of a long process descending from the zygoma; and approached in both these respects to the Megatherium. The teeth differ from those of Armadillos, in having two deep grooves both on the outer and inner surface, are more complex than those of any known Edentate, and indicate a passage from that family into the Toxodon. The ungual phalanges are wholly unlike those of the Megatherium, and most nearly resemble those of Dasypus, but are short broad and flat, and seem to have been covered with hoof-like claws. The form of the foot most nearly resembled that of the fore foot of the Mole. Having appropriated to the Glyptodon the armour supposed to belong to the Megatherium, Mr. Owen next proves that the latter animal was unprovided with any such bony covering, arguing from a comparison of its vertebral column and pelvis with that of the Armadillo; and from the absence of the oblique processes, which in the loricated Edentata resemble as to form and use the *tie-bearers* in carpentry, that support the weight of a roof. The vertebral conditions of the Megatherium are nearer to those of the Sloths and Ant-eaters. We have accounts of twelve skeletons of Megatherium, not one of which was found to be accompanied by bony armour. Cuvier considered the Megatherium more nearly allied to the Ant-eaters and Sloths than to the Armadillos.

Captain Martin has found that many parts of the bottom of the English Channel and German Ocean contain in deep water the bones and tusks of Elephants. They have been dredged up between Boulogne and Dungeness, in the mid-sea between Dover and Calais, and at the back of the Goodwin Sands; also mid way between Yarmouth and the coast of Holland. In 1837 a fisherman enclosed in his net a vast mass of bones between the two shoals called Varn and Ridge, that form a line of submarine chalk-hills between Dover and Calais. Captain Martin says these bones do not occur on the top of banks or shoals, but in deep hollows or marine valleys. Sir John Trevelyan possesses the molars of a large Elephant from gravel in the bed of the Severn, near Watchet, and we have long known that the bones of Elephants occur in great abundance in the oyster grounds off Yarmouth.

In subterranean Ornithology three important discoveries have been made during the past year; the first in the Eocene formation by Professor Owen, who has recognised the fossil Vulture before alluded to in the London clay of Sheppy; the second, by Lord Cole and Sir P. Egerton, who have acquired from the chalk of Kent the humerus of a bird most like that of an Albatross, but of larger and longer dimensions; the third by Professor Agassiz, who has found in Switzerland, a nearly entire skeleton of a small bird (not unlike a Swallow), at Glaris, in the indurated blue slate beds of the lower region of the chalk formation. We know that the bones of a Wader, larger than a Heron, have been found by Mr. Mantell in the Wealden formation of Tilgate Forest; and that the Ornithichnites in the New Red Sandstone of Connecticut have been referred to seven species of birds.

We have an interesting accession to our knowledge of the anatomy of the Ichthyosaurus in Mr. Owen's description of the hinder fin of an *Ichthyosaurus communis*, discovered at Barrow-on-Soar by Sir Philip Egerton; this fin distinctly exhibits on its posterior margin the remains of cartilaginous rays that bifurcate as they approach the edge of the fin, showing in this respect a new approximation to the fin of a fish, and more fully justifying the propriety of the name Ichthyosaurus. Traces are also preserved of scutiform compartments on the integument of the fin. It is singular that this structure should never have been observed in any of the numerous specimens from Dorset and Somerset that have come under our notice; whilst at Barrow-on-Soar, from whence the paddle in question was derived, even the fibres of the skin and folds of the epidermis are sometimes accurately retained*.

Mr. Owen's first part of his report on fossil Saurians, read at the British Association at Birmingham in August last, forms the commencement of a most important addition to the history of extinct reptiles. His recent investigations in Odontography have also supplied to the geologist a new and most efficient instrument of investigation, enabling him to distinguish genera of extinct animals by the microscopic structure of their teeth; and as, of all fossil remains, the teeth are the parts most perfectly preserved, and in the case of cartilaginous fishes the teeth and spines are generally the only parts that

* See Buckland's Bridgewater Treatise, Pl. 10.

have escaped decomposition, this method assumes an especial importance in fossil Ichthyology, as affording exact characteristics of animals long swept from the surface of the earth, and whose very bones have been obliterated from among the fossil witnesses of the early conditions of life upon our planet. By this microscopic test applied to the family of Sharks, Mr. Owen has confirmed the views of Agassiz respecting the affinities between the living Cestracion and the extinct genera Acrodus, Ptychodus, Psammodus, Hybodus, Cochliodus; in the case of animals also of the higher orders, he has settled the much-disputed places of several extinct gigantic Mammalia by the same unerring test. Thus he has shown the supposed reptile Basilosaurus to be a Cetaceous mammifer, allied to the Dugong; the Megatherium to be, as Cuvier had considered it, more nearly allied to the Sloth than to the Armadillo; and the Saurocephalus to be, as Agassiz had supposed it, an osseous fish.

Dr. Malcolmson, in a memoir on the Old Red Sandstone of the north of Scotland, has done important service in showing that the rocks composing that group are divided into three formations, the two lower of which are clearly distinguished from each other by their fossil fishes. The cornstone or central formation is charged with numerous remains of Ichthyolites, including *Holoptychus nobilissimus*, a new species of Cephalaspis, and other forms not yet described. The lower division, consisting in this region of conglomerates, shales and sandstone, is characterized by the genera Dipterus, Diplopterus, Cheiracanthus, &c., of Agassiz, as well as by the occurrence of a singular Ichthyolite, which seems to offer close analogies to certain forms of Crustacea. By help of these Ichthyolites, the author has been enabled to connect certain strata of Orkney and Caithness, and determine their relations to the beds of Old Red Sandstone containing fossil fishes in the basin of the Tay, and in the border counties of England and Wales, where they had been described by Mr. Murchison.

Mr. Williamson, in a notice on the fossil fishes of the coal-fields of York and Lancaster, says that these coal measures are very rich in Ichthyolites, which abound so much at Middleton colliery, near Leeds, that the workmen have given to one bed the name of fish coal; they are usually in fine bituminous shale above and below the coal, and most frequent in the roof immediately above it, where, as at Burdie House, near Edinburgh, there is a thin seam of coprolitic matter; they are rarely mixed with any great quantity of vegetable remains. In the lower measures of Lancashire they are associated with Goniatites and Pectens, and in the higher measures of Lancashire and Yorkshire with freshwater shells allied to Unio, and with Entomostraca. Exact observations as to facts of this kind are of inestimable importance, for it is only by careful induction from a sufficient number of such-like phænomena, and from similar details as to the local distribution and condition of animal and vegetable remains in the marine and fluvio-marine and lacustrine deposits which compose the carboniferous series, that we shall arrive at a solution of the grand problem of the formation of coal.

CRUSTACEANS.

The Rev. T. B. Brodie has discovered in the Wealden formation near Dinton, in the vale of Wardour, the remains of Coleopterous and Hymenopterous insects, and a new genus of *Isopodous Crustacea* in the family Cymothoidæ. The Isopods are clustered densely together; the lenses in their eyes are sometimes preserved; there are also traces of legs, but of no antennæ. With them he has found a large species of Cypris. The insects are chiefly small Coleoptera; there are several species of Dipterous, and one Homopterous insect, and the wing of a Libellula. Mr. Brodie's discovery is the first yet made of insects in the Wealden formation, and also the first example in a secondary formation of Isopods that approximate in form to the Trilobites of the Transition series.

WORMS.

An addition has been made to fossil Helmintology by Mr. Atkinson of Newcastle-on-Tyne, who has found in slabs of micaceous slaty sandstone, from the carbonaceous series near Haltwhistle, tortuous casts of vermiform bodies of various sizes, some almost an inch in diameter, and several feet in length; the surface of many of these is thickly marked by transverse rings and a longitudinal groove, similar to those in the largest recent marine sand worms, *e.g.* the *Leodice gigantea.* The integument of some of these worms containing *chitine*, like the covering of insects, seems to have endured long enough to fix impressions of the transverse rings upon the sand; and the habit of swallowing large quantities of earth and sand, which we observe in many recent worms, may explain the presence of the large portion of sand, now indurated to stone, which occupies the interior of the impression of the skin. Since many casts are found upon the same slab, these worms must have been very numerous at the bottom of the sea, when the sandstone was in process of formation. Similar impressions of Annelids on the Cambrian rocks are figured by Mr. Murchison in Pl. 27 of his great work on the Silurian System.

ICHNOLOGY.

About twelve years ago we witnessed the creation of a new department in geological investigations, viz. the science of Ichnology, founded on the evidence of footsteps made by the feet of animals upon the ancient strata of the earth; this new method commenced with the recognition of the footmarks of reptiles on the New Red Sandstone near Dumfries, and not long after (1834) was followed by most curious and unexpected discoveries in Saxony and America. The Chirotherium of Hessberg and Ornithichnites of Connecticut were among its early results. Our own country has during the last two years been abundantly productive of similar appearances in many localities.

In recent excavations for making a dock at Pembray, near Llanelly, in Pembrokeshire, tracks of deer and of large oxen have been found on clay subjacent to a bed of peat, the lower peat being moulded into the footsteps; similar impressions were also found upon the upper surface of the peat beneath a bed of silt, and bones both of deer and oxen in the peat itself. Footmarks of deer have been also noticed in Mr. Talbot's excavations for a harbour near Margam burrows on the east of Neath.

Near Liverpool Mr. Cunningham has successfully continued his researches begun in 1838, respecting the footsteps of Chirotherium and other animals in the New Red Sandstone at Storeton Hill, on the west side of the Mersey. These footsteps occur on five consecutive beds of clay in the same quarry, the clay beds are very thin, and having received the impressions of the feet, afforded a series of moulds in which casts were taken by the succeeding deposits of sand, now converted into sandstone. The casts of the feet are salient in high relief on the lower surfaces of the beds of sandstone, giving exact models of the feet and toes and claws of these mysterious animals, of which scarcely a single bone or tooth has yet been found, although we are assured by the evidence before us of the certainty of their existence at the time when the New Red Sandstone was in process of deposition.

Further discoveries of the footsteps of Chirotherium and five or six smaller reptiles in the New Red Sandstone of Cheshire, Warwickshire and Salop, have been brought before us by Sir P. Egerton, Mr. I. Taylor, jun., Mr. Strickland, and Dr. Ward.

Mr. Cunningham, in a sequel to his paper on the footmarks at Storeton, has described impressions on the same slabs with them, derived from drops of rain that fell upon thin laminæ of clay interposed between the beds of sand. The clay impressed with these prints of rain drops acted as a mould, which transferred the form of every drop to the lower surface of the next bed of sand deposited upon it, so that entire surfaces of several strata in the same quarry are respectively covered with moulds and casts of drops of rain that fell whilst these strata were in process of formation.

On the surface of one stratum at Storeton, impressed with large footmarks of a Chirotherium, the depth of the holes formed by the rain drops on different parts of the same footstep has varied with the unequal amount of pressure on the clay and sand, by the salient cushions and retiring hollows of the creature's foot; and from the constancy of this phænomenon upon an entire series of footmarks in a long continuous track, we know that this rain fell after the animal had passed. The equable size of the casts of large drops that cover the entire surface of the slab, except in the parts impressed by the cushions of the feet, record the falling of a shower of heavy drops on the day in which this huge animal had marched along the ancient strand; hemispherical impressions of small drops, upon another stratum, show it to have been exposed to only a sprinkling of gentle rain that fell at a moment of calm.

In one small slab of New Red Sandstone found by Dr. Ward near Shrewsbury, we have a combination of proofs as to meteoric, hydrostatic, and locomotive phænomena, which occurred at a time incalculably remote, in the atmosphere, the water, and the movements of animals, and from which we infer with the certainty of cumulative circumstantial evidence, the direction of the wind, the depth and course of the water, and the quarter towards which the animals were passing; the latter is indicated by the direction of the footsteps which form their tracks; the size and curvatures of the ripple-marks on the sand, now converted to sandstone, show the depth and direction of the current; the oblique impressions of the rain drops register the point from which the wind was blowing, at or about the time when the animals were passing.

Demonstrations founded solely upon this kind of circumstantial evidence were duly appreciated, and are well exemplified, by the acute author of the story of Zadig; who from marks he had noticed on the sand, of its long ears, and teats, and tail, and from irregular impressions of the feet, declared the size and sex, recent parturition and lameness of a bitch he had never seen; and who from the sweeping of the sand, and marks of horse-shoe nails, and a streak of silver on a pebble that lay at the bottom of a single footstep, and of gold upon a rock against which the animal had struck its bridle, inferred that a horse, of whose existence he had no other evidence, had recently passed along the shore, having a long switch tail, and shod with silver, with one nail wanting upon one shoe, and having a bridle studded with gold of twenty carats value.

In addition to the commencement of Mr. Bowerbank's publication on the Fossil Fruits and Seeds of the London Clay, before alluded to, we have hailed with satisfaction the announcement, by Professor Henslow and Mr. Hutton, of their intended continuation of the Fossil Flora of Great Britain, conducted for some years by Dr. Lindley and Mr. Hutton, and lately suspended.

A Dictionary of the terms and language of geology has long been a desideratum to young students, to whose early progress the technical terms of the science have hitherto presented formidable impediments. This want has been recently supplied by two publications of this kind, one by Mr. George Roberts, author of the History of Lyme Regis; the other by Dr. Humble.

During the last year the Society has received no communication on Mineralogy; and almost the only volume that has been published in England on this much-neglected subject, has been a small but highly elaborate treatise on Crystallography by Professor Miller, of the University of Cambridge. In this treatise the author has adopted the crystallographic notation proposed by Professor Whewell in his paper on a General Method of calculating the Angles of Crystals, and the laws according to which they are formed, published in the Transactions of the Royal Society of London, 1825; and Professor Neuman's method of indicating the positions of the faces of a crystal by the points in which radii, drawn perpendicular to the faces, meet the surface of a sphere. The expressions which have been thus obtained are remarkable for their symmetry and simplicity, and are all adapted to logarithmic computation, and for the most part new.

NOTICE OF DECEASED MEMBERS.

In proceeding to speak of the losses which, during the past year, our science has sustained by death, I shall offer my first tribute of respect to the memory of one, whom a predecessor of mine in this chair has justly called the father of English geology; since to his discoveries we owe the first diffusion of exact knowledge as to the order of superposition of the secondary formations which occupy so large a portion of our island, and the first demonstration of that constancy of the organic remains, which he proved to be characteristic of the component strata of each different formation. It was the especial merit of Mr. William Smith to establish a series of types of these groups, many of which have been adopted as classical, in such a manner as will perpetuate his name among the original discoverers of the age in which he lived.

If, as it has been truly said, the honour of the first discoveries in tertiary geology belongs to France, where the labours of Cuvier and Brongniart gave to this great division of the strata of the earth a systematic arrangement before unknown, so the establishment of the types in secondary geology, from the chalk down to the new red sandstone, is due to England; and the discovery of the leading natural divisions of that important portion of them which constitutes the oolite formations, was almost exclusively the work of Mr. William Smith.

His earliest publication was a treatise on irrigation, 1806, a subject on which his experiments gained him a medal from the Society of Arts.

In 1801 he printed proposals for publishing accurate delineations and descriptions of the natural order of the various strata that are found in different parts of England and Wales, to be illustrated by a small geological map*. This work was never completed, but it led to the publication of his large map, in 1815, for which the Society of Arts awarded him their medal and a premium of £50. In the same year also his stratigraphical collection of organic remains was purchased for the British Museum; this collection having formed the basis of his two separate volumes, entitled "Strata identified by their Organized Fossils," 1815, and "a Stratigraphical System of Organized Fossils," 4to, 1817.

During the six years which followed the publication of his map of England, he put forth twenty geological maps of English counties on a larger scale, and several coloured sections across the south of England, and a general Geological Section of England and Wales, from London to Snowdon.

Among his unpublished papers were found unfinished and in part printed, an introductory work on geology, and preparations for a volume on Œconomic Geology, both illustrating the originality of his views.

Mr. William Smith entered on the field of his honourable exertions as a Civil Engineer and Mineral Surveyor at a time when his labours in geology were but little appreciated, and almost solitary. Amidst difficulties and discouragements, and at intervals snatched from the duties of a laborious profession, he accomplished the gigantic work of a general mineralogical survey of England, founded almost entirely on his own personal observations, which he ultimately recorded in a map of fifteen coloured sheets, published by subscription in 1815.

Inevitable delays retarded the appearance of this work nearly to the time when a more detailed and perfect map, by a distinguished president of this Society, eclipsed in some degree the fame which would have accrued to its author had it been published earlier, even in the less perfect form to which he had advanced it some years before. The sense entertained by this Society of the value of the scientific services of Mr. Smith, was marked by their award to him of their first Wollaston Medal, in 1831; and was accom-

* The original coloured copy of this map, dated 1801, was presented by Mr. Smith to our Society, and is now in the Museum.

panied by the just and eloquent eulogium pronounced on that occasion by Professor Sedgwick. In the same year also the British Association assembled at York made successful application to government for a pension, which was settled upon Mr. Smith for life; and at the meeting of this Association at Dublin, 1835, the University conferred on him the honorary degree of Doctor of Civil Law.

Mr. Smith was one of those remarkable persons whom strong natural sense and acute powers of observation occasionally enable to triumph over the disadvantages of a defective education. His attention was first called to physical inquiries, by the observing, when a boy, that a large stone which he was lifting under water in search of eels, could be moved with much more ease, than if the same stone had been on land. His juvenile curiosity was excited to learn the cause of an occurrence so surprising to him; and this first step led him, at the age of eighteen, to enter the profession of a surveyor and civil engineer. His early professional occupations from the year 1791 to 1799, whilst surveying collieries, constructing a part of the Somerset coal canal near Bath, and preparing reports respecting a supply of water for the Kennet and Avon Canal, and the trade it was likely to derive from carriage of stone and coal, &c., placed him in daily contact with geological phænomena especially calculated to illustrate the order of superposition of the English strata, and laid the foundation of his future discoveries.

By carefully noting the characters of the beds which he found in juxtaposition, and making comparative sections in various directions in the vicinity of Bath, he ascertained that an uniform order of succession pervades the groups exposed in the escarpments of the hills in that part of England, and that this uniformity is attended by a similarity in the organic remains of certain beds, which differ entirely from those of the groups above and below them; by diligently collecting and collating these remains, he drew the inference, that each group of strata contains extraneous fossils peculiar to itself.

His next step was to infer that the strata thus identified by himself in Somerset and Wiltshire were not of insulated and local occurrence, but formed parts of the great system of deposits extending over England; and thus, after many years of intense labour and continual travel, he succeeded in extending the principles first caught sight of in the neighbourhood of Bath, into that philosophical generalization which became the basis of his geological map of England.

Before Mr. Smith had quitted his occupations in Somerset and his residence at Bath, he indicated on a coloured map the geological structure of that neighbourhood. This document, dated 1799, is in the museum of our Society. He had also arranged his collections of rocks and their organic remains in the order of succession and continuity of the several strata; but neglecting to appropriate to himself the merit of these discoveries by immediate publication, he liberally imparted a knowledge of each, as it gradually arose, to his private friends, through whose oral communications they obtained such general currency, that their real author was frequently lost sight of or unknown. I was myself indebted to Mr. Smith, though at that time a stranger to me, for my first knowledge of the order of succession in the oolitic series. This I derived from information imparted to me by the late Rev. B. Richardson of Farley Castle, who had himself acquired it from Mr. Smith. A tabular view of the superposition of the English strata, written by Mr. Richardson, from the dictation of Smith in 1799, at the house of the Rev. Joseph Townsend, in Bath, and since also presented to this Society, forms a documentary proof of the extent of his discoveries before the conclusion of the last century.

In 1817 he planned the beautiful museum of Scarborough, in which he employed his original and instructive method of representing, by sloping shelves passing one beneath another, the inclined position of the strata; each shelf bearing the fossils that are respectively characteristic of the stratum it is intended to represent.

These works of William Smith undoubtedly place him in the position of an original discoverer, who was the first to establish, on an enlarged basis of evidence, the important facts of constancy in the order of superposition, and continuity in the horizontal extension of the strata of this island; and to prove that each of these strata is characterized by organic remains peculiar to itself. But it must not be forgotten, that both in this country and on the continent, other investigators, many of them no doubt unknown to him, were simultaneously collecting similar evidence in support of this great physical generalization. It only enhances the value and confirms the accuracy of Mr. Smith's conclusions, that the results of other independent inquiries were found to be in perfect harmony with his own. It is known to all who are acquainted with the productions of the school of Freyberg, that Werner had pointed out the importance of petrifactions as affording a basis for the arrangement of geological formations, the same in principle, though confirmed by less extensive details, than those which Mr. Smith elicited from the oolitic series in England. Professor Jameson has expressly stated that Werner was aware that petrifactions are comparatively rare in the transition rocks, increasing in number in the newer series of that division, and becoming still more numerous in the Floetz formations: he had further remarked, that the animals of the earliest periods are of the lowest and most imperfect class, namely zoophytes; that in ascending through newer and newer formations, we meet with shells and fishes and marine plants, all different from any living animals and vegetables of the present earth; that in the newest formations we find the remains of existing genera with those of land animals and land plants.

Werner had also noted, in some detail, the order of succession of the strata of the Muschel-kalk of Germany, founding his divisions upon the changes he observed in the petrifactions it contains; and thus announcing the principle of making distinctions in strata upon the nature of their organic remains.

The same principle had been previously caught sight of and partially elaborated by Lehman in Germany, and by other observers in France, where its application to tertiary strata received the fullest demonstration, in the great discoveries of Cuvier and Brongniart within the basin of Paris. In our just admiration of our countryman, therefore, we must not lose sight of the merits of his contemporary labourers on the continent; and whilst we honour him as the father of English Geology, let us also pay just homage to those who had started before him in the same course, wherein it was his undisputed merit to have arrived first at the goal.

Mr. W. Smith was born on the oolite formation at Churchill, in the county of Oxford, in 1769. When a child he was in the habit of collecting Terebratulæ from the oolite rocks in the fields of his native village, which he used as substitutes for marbles.

As an engineer he was employed in works of irrigation and drainage in many parts of England; as well as in stopping out the sea from breaches through which it had invaded the marshes of Norfolk, 1806, 1807, &c., and in the draining off the water of Mismer lake in Suffolk into the sea. He was the engineer also of the Ouse navigation in Sussex. In 1809 he was engaged in the restoration of the hot springs at Bath. In 1821 he recommended to Col. Braddyl to search for coal (beneath the magnesian limestone) on an estate in which is now situated the great South Hetton Colliery. No colliery in Northumberland had been worked, at that time, under the magnesian limestone.

Mr. Smith's principles of drainage have been applied with much advantage near Bath, Woburn, and in Norfolk. Finding the town of Scarborough to be very ill supplied with water, he excavated in the interior of the hill of Falsgrave Moor, two or three miles distant, a subterranean reservoir, in which he collected, from streamlets percolating that hill, sufficient water for the permanent supply of the town*.

From his early days to the latest period of his life he tells us that he had the habit of looking on the ground†.

Mr. Smith's last public employment was in conjunction with Mr. De la Beche and Mr. Barry, in the Commission for reporting on the best building-stone for the new House of Commons‡. During the later years of his life he resided near Scarborough superintending the estates of Sir John Johnson at Hackness; and dying at Northampton, in August 1839, aged seventy-one, after a few days' illness, at the house of his friend Mr. Baker, the historian of Northamptonshire, on his way to the Meeting of the British Association

* An account of this curious work is published by himself in the Philosophical Magazine for June 1827.

† See a paper by himself on Quartz in Soils, published in Charlesworth's Magazine for July 1837.

‡ For more detailed accounts of the life of Mr. Smith, and of the amount and value of the services he rendered to Geology in England, I must refer to Dr. Fitton's masterly and candid investigation of this question in the Edinburgh Review, Vol. XXIX, p. 310, &c.; to Mr. Conybeare's Introduction to his Outlines of the Geology of England and Wales, 1822, p. 45; to the Address of Professor Sedgwick to this Society, 1831; and to a biographical notice by his nephew Professor John Phillips, in the Magazine of Natural History, New Series, 1839, p. 213.

at Birmingham, was interred in the church-yard near the west end of the beautiful Norman church of St. Peter, in Northampton, which stands on the Oolite formation. He had often expressed a wish to be buried in this formation, on which he was born and educated, and the history of which he had so much elucidated. A monument will be erected to his memory in St. Peter's Church by subscription of members of the Geological Society of London.

It was not the least of the services which have been rendered to our science by Mr. Smith, that he was during many years the geological preceptor of his accomplished nephew Mr. John Phillips, in whom he has bequeathed to us a pupil, who has shown, by publications of the highest order in various departments of Geology, the soundness of the instructions received from his affectionate uncle.

Mr. Davies Gilbert was one of the earliest members elected into this Society, at its formation in 1808. During two years he served as a Vice-President, and for six years was a member of our Council; and though he communicated no papers, he took a lively interest in all our proceedings, and was ever prompt on all public occasions to promote the welfare and forward the great objects of our institution.

His paternal name was Giddy: he was descended in the line of both his parents from very respectable families in Cornwall, and on the maternal side of Davies, allied to the noble family of Sandys; in 1817 he assumed the name of Gilbert, on succeeding to the property of his wife's uncle, Mr. Charles Gilbert, of East Bourn, in Sussex.

Having been privately educated in Cornwall, he became, in 1785, at the age of eighteen, a gentleman-commoner of Pembroke College, Oxford, where, being of more studious habits and more mature attainments than is usual with students of his age, he associated chiefly with the senior members of his College. Dr. Parr, writing at this time to the late master of Pembroke, speaks of Mr. Giddy, then twenty-three years old, as "the Cornish philosopher," and adds, that "he deserves that name."

To this College, as well as to the University, his affectionate and devoted attachment endured to his latest hour, and he became on several occasions a liberal benefactor towards improvements in

Pembroke and its vicinity. During many years it was his great delight to pass a few days at Oxford, and he always considered the diploma Degree of Doctor of Laws, conferred on him by the University in 1832, as one of the most gratifying events of his life.

During his early residence his taste for chemistry and other branches of physical science had introduced him to the acquaintance of Dr. Beddoes, at that time a resident Member of Pembroke College, and who subsequently dedicated to him his pamphlet on mathematical evidence. This acquaintance was the remote cause of the first step in the public life of Sir Humphry Davy; when Mr. Giddy, who had discovered young Davy's genius for chemistry whilst yet a boy at Penzance, introduced him to Dr. Beddoes, to assist in his laboratory at Bristol, little dreaming that he should himself one day become the successor of this boy in the chair of the Royal Society.

Mr. Davies Giddy was elected a fellow of the Royal Society in 1791, and subsequently of the Antiquarian, Linnean, Geological, and Astronomical Societies of London. He was also an honorary member of the Royal Society of Edinburgh, the Royal Irish Academy, and of the New University of Durham. In 1814 he was elected first President of the Royal Geological Society of Cornwall and afterwards Vice-Patron of the Cornwall Royal Polytechnic Society, in both which offices he continued till the day of his death. He held the distinguished office of President of the Royal Society, during three years, from 1827 to 1830, and contributed several important papers to their Transactions; one upon the Mathematical Theory of Suspension Bridges (vol. 116, 1826, Part I., p. 202); also a Table for facilitating the Computations relative to Suspension Bridges (vol. 121, 1831, p. 341); a third paper, entitled Observations on Steam Engines (vol. 117, 1827, p. 25); and a fourth on the Efficacy of Steam Engines in Cornwall, with Investigations of the Methods best adapted for imparting great Angular Velocity (vol. 120, 1830, Part I., p. 121;) likewise a paper on the nature of Negative and Imaginary Quantities (vol. 121, 1831, p. 91). He also printed three Addresses as President of the Royal Society, 1828, 1829, 1830*.

* Mr. Gilbert was also the author of the following papers in the Quarterly Journal of Science and the Arts: Observations on the properties of

In 1804 he was returned to parliament for the borough of Helston; and in 1806 for Bodmin, which place he represented till 1832. During that time he was continually called on by the House of Commons to serve on committees of inquiry touching scientific and financial questions, on which latter subject he published a letter, entitled "A plain Statement of the Bullion Question." He was Chairman of the Committee for rebuilding London Bridge, which he caused to be widened ten feet. The rectification of the national standards of linear dimensions and capacities, was undertaken upon his motion for an address to the Crown.

In his native county also, his authority was continually appealed to on scientific questions, and calculations of practical importance in the machinery of mines and steam-engines; and he was ever ready on all occasions to devote his time and talents to the service of his friends and of the public. In 1792, on the occurrence of a riot in Cornwall, whilst he was a young man, holding the office of sheriff, there being no soldiers in the county, he performed, for the last time that such an event has occurred in England, the military duty of calling out the *posse-comitatus*.

Few persons excelled Mr. Gilbert in bringing the results of much contemplative study to bear on the business of life; his strong point lay in the application of high mathematical knowledge to practical purposes, and in calculating the amount of effective power to be derived from the use of mechanical forces, judiciously combined. For the exercise of this talent his beloved native county offered unusual opportunities; it also afforded him abundant materials for gratifying his taste for antiquarian researches; and the fruits of his labours as a biographer and local historian were presented to the public in 1838, in four 8vo vols; this work is entitled The Parochial History of Cornwall, founded on the manuscript histories of Mr. Hals and Mr. Tonkin, with additions and various

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the Catenarian Curve with reference to Bridges by Suspension, vol. x. p. 230; On the Ventilation of Rooms, and the Ascent of Heated Gases through Flues, vol. xiii. p. 113; Investigation of the Methods used for approximating to the Roots of Affected Equations, vol. xiv. p. 353; Researches on the Vibrations of Heavy Bodies in Cycloidal and Circular Arches, vol. xv. p. 90; On the General Nature and Advantages of Wheels and Springs for Carriages, the Draft of Cattle, and the Form of Roads, vol. xviii. p. 95; On the Vibration of Heavy Bodies, vol. xx. p. 69.

appendices by himself, and brings down the account of families and descent of property in that county from the death of those biographers, about the middle of the last century, to the present time. Mr. Gilbert's additions and criticisms form no small part of its value; he has introduced also copious scientific notices by Dr. Boase and other modern authors, relating to the geology of the county, a subject, he observes, of such recent origin, that the very word does not occur in Chambers's Encyclopædia printed in 1783. In acknowledgment of his indirect influence upon this science, I am bound to state with gratitude that my Bridgewater Treatise would never have existed, had not the appointment to write it been conferred upon me by Mr. Gilbert whilst President of the Royal Society.

Mr. Gilbert was an assiduous collector of ancient traditions, legendary tales, songs and carols, illustrating the manners, sports, and pastimes of the peasantry of Cornwall; and he was a writer of several anonymous letters and papers in the Gentleman's Magazine. He possessed great memory and powers of quotation and anecdote, enriched by vast stores of traditional information as to the personal history of many of the most distinguished individuals of his time, much of which will have perished with him. It has been truly said of him by a contemporary biographer, that "His most endearing talent was his power of conversation. It was not brilliant; it was something infinitely beyond and better than mere display; it was a continued stream of learning and philosophy, adapted with exquisite taste to the capacity of his auditory, and enlivened with anecdotes to which the most listless could not but listen and learn.

"His manners were most unaffected, child-like, gentle, and natural. As a friend, he was kind, considerate, forbearing, patient, and generous; and when the grave was closed over him, not one man, woman, or child, who was honoured with his acquaintance, but will feel that he has a friend less in the world. Enemies he can have left not a single one."

During the last twelve months his strength had been rapidly declining, but he retained full possession of his intellectual faculties till within a few hours of his death; he breathed his last in the bosom of his family at East Bourne, on the 24th of December last, in the seventy-third year of his age. An exact and admirable representation of his finely-formed head and intelligent countenance is preserved in a bust by Westmacott in the Hall of Pembroke College, Oxford.

Sir John St. Aubyn, who died during the last year, was one of the founders and early Vice-Presidents of the Geological Society, and was among its most firm and valuable friends and supporters at that perilous moment of its existence when the struggles and opposition which attended its first establishment had nearly crushed it in the bud; he was also a liberal contributor to the supplies at that time requisite for its advancement.

He subscribed largely also to the funds then raised for the publication of Count Bournon's crystallographic work on Carbonate of Lime, and for enabling Dr. Berger to undertake his tours in Cornwall, preparatory to his geological description of that county.

The meetings held for the purpose of forwarding Count Bournon's work by some of the most distinguished mineralogists of that day, when collections in geology were rare, was one of the steps that brought together our first founders: many of them were till then strangers to each other, and being thus accidentally introduced, they resolved from thenceforth to cooperate for the furtherance of objects in which they felt a common interest, and became the germ of the Geological Society.

Sir John St. Aubyn was at this time occupied, like his friends Sir Abraham Hume and Mr. Greville, in making large and costly additions to his cabinet of simple minerals, the nucleus of which consisted of the specimens he had purchased of Dr. Babington in the year 1799, and which are described by Babington in his catalogue (one vol. 4to) published in the same year. These specimens had previously been the property of Lord Bute.

The position of his seat at Clowance, in the centre of the greatest mining district of Cornwall, afforded facilities for acquiring the most choice productions of that great repository of mineralogical treasures, and of these facilities he assiduously availed himself during many years. His other seat on the picturesque granitic pinnacle of St. Michael's Mount in the bay of Penzance (the Ictis of Diodorus, from whence the Romans exported tin to Gaul), placed him in another position of high geological and mineralogical advantages; the granite veins that intersect the killas at the base of this classic mountain being among the first described and most instructive instances which Cornwall affords, of the important phænomena of the injection of granite into slate, and the metamorphic condition of the slate thence resulting; whilst a well-exposed tin vein at the base of the ancient fortress and monastery that crown this insulated mountain, affords specimens of Apatite, and is more richly studded with minute but perfect crystals of topaz than any other vein known to exist in this country. These easily accessible examples of phænomena, most highly interesting to the mineralogist and geologist, he carefully preserved for the inspection of the numerous visitors that are continually attracted to this spot—of threefold interest, to the antiquary, the artist, and the mineral philosopher.

A similar zeal for the preservation of interesting scientific objects induced Dr. Jenner to preserve, for the benefit of geological visitors, a rock which presented the rare phænomenon of organic remains intermixed with toad-stone, on the side of a trap dyke intersecting old red sandstone at Newport, near his residence at Berkeley.

To the nucleus formed by Dr. Babington's collection, Sir John St. Aubyn made large additions, not only from the productions of Cornwall, but also from foreign countries, particularly the mines of Germany and Hungary, many of which are no longer wrought. This collection was very rich in the ores of gold, silver, copper, and other metals, and particularly in native diamonds and gems. The arrangement of it was begun by Count Bournon, but subsequently completed after the system of Mohs.

In 1834 he presented the bulk of his collection to the Devonport Civil and Military Library, of which he had been annually appointed President from its formation in 1827 until his death; and a collection of Duplicates to the museum of Saffron Walden, near which place he then resided. He was an active member of the Geological Society of Cornwall, and of many scientific institutions in London; had a knowledge of Chemistry, Conchology, and Botany; and was a patron of the fine arts and a collector during his whole life.

In Brigadier Charles Silvertop the Society has lost the author of many interesting communications to our Evening Meetings on the Geology of Spain, the mineral structure of which, notwithstanding its proximity to France and England, and the long-continued military operations of both these nations upon its territory, is less known than that of any other portion of civilized Europe.

The unhappy circumstances of the country have long abstracted the attention of the Spaniard from researches of science, and the difficulties of travelling in the midst of civil commotions have deterred even the enterprising spirit of neighbouring geologists from endeavouring to fill up the lamentable blank which Spain still presents upon the scientific map of Europe.

Brigadier Silvertop, though occupied in the professional engagement of arms, was not forgetful of the pursuits of science. He published the substance of his communications to this Society in a small volume, 1836, wherein he gives a sketch of the widely-disseminated deposits of tertiary beds in the provinces of Granada and Murcia, accompanied by a general view of the volcanic and other rocks of the same district, illustrated by sections, which represent the configuration of the ground, the relative height of the ridges, and the superposition of the strata. He died at Rennes, in June last, on his way to the Pyrenees and Italy.

Mr. Louis Hunton was the author of a paper printed in our Transactions on the Upper Lias and Marl-stone of Yorkshire, showing the limited vertical range of the species of Ammonites and other Testacea, and illustrating their value as geological tests. His observations are founded on the details of the section of Easington height, near Whitby.

Jens Esmark, Professor of Mineralogy in the University of Christiania, was one of the many disciples of the school of Freyberg, who imbibed from their master an enthusiastic devotion to his theories, which largely contributed to stimulate into activity that general spirit of geological inquiry, the expansion of which, during the present century, has produced such unexpected and extensive discoveries in the development of the structure of the earth.

In 1794, deeply imbued with the doctrines of Werner, he went to Vienna to prepare himself for a tour through Hungary; after this he remained some months at Chemnitz, and visited the other chief mining districts of Hungary, Transylvania, and the Bannat, and crossing the Carpathians to Wielitzka and Cracow, returned to Saxony by the mines of Tarnovitz in Silesia.

In 1798 he published, at Freyberg, the result of his observations, in a small octavo volume, giving descriptions of the mines he visited, and their respective productions, and expressing his conviction of the truth of Werner's opinion as to the Neptunian origin of the pumice and obsidian (even that of the Lipari Island), as well as of trap and granite. A translation of his remarks on the Geological History of the Globe was published in the Edinburgh New Philosophical Journal, (1827) vol. vi. p. 107. The most important portion of this paper consists in its bearing his evidence to show that the greater part of Norway has, at some period, been covered with ice, and that the granite blocks, so abundant in that country, have been brought to their present place by glaciers.

In 1829 Professor Esmark published a Tour in Norway*, containing many measurements of heights, and he was the first to measure the lofty mountain of Schneehätten. He also published various detached Memoirs on Mineralogy†.

He is said by Otte to have been the first discoverer of chromate of iron in Norway; and the Norwegian datolite, which was also discovered by him in 1806, was at that time named Esmarkite. He published a short notice on tellurium, in the 3rd vol., 1st series, of our Transactions.

His residence at Christiania, in the vicinity of iron, copper, and silver mines, and of the School of Mines and Agriculture at Konigsberg, gave full scope to his taste and talents, and also afforded occasion for the exercise of those courteous attentions which have, during many years, been gratefully acknowledged by scientific travellers in Norway.

He once came to England, and was a member of the Wernerian Natural History Society of Edinburgh.

He was an excellent chess-player; and in appearance, countenance, and the fine form of his head, resembled Mr. Davies Gilbert, whom it has been my painful duty to associate with him in the catalogue of the losses we have sustained during the last year.

Don Carlos de Gimbernat, Member of the Royal Academy of Sciences at Munich, was the son of a physician of Barcelona, and, from political motives left his native country at the commencement of the French Revolution for Paris, where he passed many years. He had previously studied at Freyberg under Werner, and visited England, where he became acquainted with Townsend, our Spanish

* Reis von Christiania nach Drontheim.

† In the Magazin for Naturnidenskaberne.

traveller, and with Dr. Hope, of Edinburgh; giving to the physical sciences the attention usually required of students for the medical profession, and continuing to cultivate them in his later years. He was more particularly attached to Chemistry, Geology and Mineralogy, and analysed the waters of many hot mineral springs, and found azote in all. The medical virtues which he ascribed to these springs, raised him high in the estimation of the Swiss.

M. Gimbernat published accounts of his discovery in the thermal waters of Aix in Savoy, Baden, and other warm springs in Switzerland, of a mucous organic substance, (formed, as he fancied, by chemical precipitation, from azote and carbonic acid,) which he thought was more nearly allied to animal than vegetable matter, and to which he gave the name of Zoogene; and he also supposed that he found the same substance in the thermal waters of Ischia, and in waters produced by the condensation of the steam disengaged from Vesuvius. A similar mucous substance, in the thermal sulphureous waters of Roussillon, was supposed by Professor Anglada, of Montpelier, to be a chemical product, from elements held in solution by the waters at the time they issued from the earth, and deposited by them in a flocculent form when they come in contact with the air. De Saussure, however, Decandolle, Dillwyn, and Daubeny*, founding their opinions on the structure it exhibits under the microscope, refer this gelatinous substance to minute Confervæ; but the more recent discovery, by Ehrenberg, of infusorial animals in the warm springs of Bohemia, gives some probability to the supposition that these may be mixed with Confervæ in the so-called zoogene of Gimbernat. The decomposition either of Confervæ or of Infusoria would afford the azote found in zoogene; but their presence would transfer the origin of this organic substance from simple chemical agency to the instrumentality of organic life. On quitting Naples, in 1820, he retired to Switzerland, where he fell into bad health and reduced circumstances, and died at Geneva in 1839†.

Frederick Mohs, Professor of Mineralogy in Vienna, was born at Gernrode, in the Harz Mountains, about 1770. He lost his

* On Organic Matter in Sulphureous Springs, Linn. Trans., London, vol. xvi. 1833.

† A short notice on Sulphate of Soda is published by Gimbernat in our Transactions, vol. ii., second series, p. 331.

father, a merchant, very early, and was expected to succeed him in the business; but his predilections for science, particularly for mathematics, had marked him out for higher destinies.

He began his studies, 1796-98, at Halle, and continued them in the mining institution at Freyberg.

We find him in 1802 at Vienna, occupied in describing the mineral cabinet of the banker Von der Nüll, where he first conceived those views which he afterwards developed in his system of mineralogy.

His fondness for geology and the art of mining induced him to visit Styria, Saltzburg, Carinthia, Carniola, Hungary and Transylvania, &c., and he received from the Austrian Government, in 1810, a commission to examine those parts of Passau, Austria, and Bohemia, where porcelain clay is found.

Having thus attracted the notice of the Archduke John, and undertaken a journey to Styria in 1811, he was nominated Professor of Mineralogy in the Johanneum, at Gratz.

In 1818 he visited England with Count Breüner, who had been his pupil at Gratz; his conferences at Edinburgh with Jameson, whom he had known at Freyberg, made a strong impression on the Professor, in favour of what he called the "natural-history-system" of mineralogy, which he in part adopted, and first made known to British mineralogists in 1820*, and afterwards more fully explained in 1821† and 1822‡.

On the death of Werner, in 1817, he was called to the chair of Mineralogy in the Mining Academy of Freyberg; but in 1826 went to reside at Vienna, as Professor of Mineralogy, and Superintendent of the Imperial Cabinet. In 1804 he published a volume of practical importance, containing "A Detailed Account, illustrated with a Ground Plan, of the Mines and Mining Operations at Himmelsfürst, near Freyberg." In this work he describes, not only the geological relations and mineral products of these mines, but gives full details as to the methods of working them; their buildings and machinery, ventilation and drainages, preparation of the ores, receipts, expenditure, &c.

His great work on Mineralogy, or "the Natural History of the

* Third edition of his System of Mineralogy.

† Manual of Mineralogy. ‡ Encyclopædia Britannica.

Mineral Kingdom," is best known in this country by its translation, published at Edinburgh, with considerable additions, by his pupil, Mr. William Haidenger, in 1825, 3 vols. 8vo. In the method of arrangement proposed by Mohs in this work, he founds his classification solely on external resemblances and differences, and displays a most profound knowledge of all the productions of the mineral kingdom.

This devoted pupil, friend, and successor of Werner died in Italy, 20th September, 1839, at Agardo, near Belluno, having undertaken a tour into that country for the purpose of studying the phænomena of volcanos*. He was an honorary member of the Royal and Wernerian Societies of Edinburgh.

It has been said of Mohs, and may be said of many distinguished cultivators of this department of natural science, that he was too consummate a mineralogist to be a good geologist. The sustained attention to minute details, which is indispensable to the recognition of individual minerals, gives such a habit to the mind, that it cannot easily recoil from the state of tension, which is induced by the continual study of minutiæ, to that expanded condition which is essential to apprehend the magnificent generalizations of geology. For similar reasons, an extremely skilful delineator of botanic details would probably be incapable of expressing the grand and general features and effects of forest scenery, or landscape, from his habits of overstrained attention to the details of individual trees and plants that occupy the foreground of his picture.

Captain Alexander Gerard, of the Bengal Native Infantry, was one of three brothers, all distinguished by their enterprising spirit, and zealous scientific researches in the Himalaya Mountains, the sons of Dr. Gilbert Gerard, who wrote the well-known "Institutes of Biblical Criticism," and grandsons of Dr. Alexander Gerard, author of works which have been translated into various European languages, and of a standard "Essay on Taste."

Having been born at the University of Old Aberdeen, in which his father was Theological Professor, he had early imbibed a thirst for knowledge and for scientific pursuits; and at the age of sixteen

* His funeral was celebrated with much ceremony expressive of public respect, and attended by a long procession of miners, each bearing in his hand a burning torch.

he entered the military service of the East India Company. Having considerable abilities as a surveyor, and being desirous of travelling, he soon got an appointment, and was sent to survey the province of Malwa, where he prosecuted his instructions under a burning sun, with great accuracy and constancy of purpose. He procured at his own expense the most costly instruments, and undertook several surveys in the Himalaya Mountains, suffering every vicissitude of heat, cold, hunger, and all the ills which could beset a traveller, with a degree of cheerfulness which was remarkable; but a residence of thirty years in India, passed chiefly in the endurance of these hardships, laid the foundation of that decay of health, which has lately brought him to a premature grave.

Captain Alexander Gerard was well known in the East as a scientific traveller, having, in company with his brother, the late Dr. James Gerard, penetrated the Himalaya Mountains through several passes before unknown to Europeans. While contributing, by his maps, to benefit geographical science, he never lost sight of what was novel and interesting in the geology, botany, and zoology of these stupendous regions, and various occasional papers have appeared from his pen, comprising valuable information on these subjects. We owe to this enterprising officer and indefatigable barometrical observer, our first knowledge of the structure of that portion of the Himalaya Mountains which forms the upper region of the Valley of the Sutlej, and is chiefly primitive. In this north-west extremity of India, on the frontier of China, he ascended to the astonishing height of 19,411 feet, on the mountain Tahigang, the summit of which he estimated at 22,000 feet above the sea.

A small collection of geological specimens made by him has been recently laid before this Society; it was formed in the district of Speetee, in Chinese Tartary, at the elevation of from 12,000 to 19,000 feet above the level of the sea, and between the latitudes 31° 30″ and 32° 30″ north, and longitude 77° and 79° east. On the confines of Chinese Tartary, at the height of 16,200 feet, he found a region of limestone containing Ammonites. The same shells occur nearly at the same height near the Niti and Manná Passes. In Thibet he observed millions of organic remains, lying at extraordinary altitudes, and forming vast and rocky cliffs. At the elevation of 17,000 feet were seen detached fragments of rocks, bearing the impression of shells, which must have been derived from still higher peaks; one cliff was a mile in perpendicular height above the nearest level.

He first appears as the companion of Herbert in his survey of the course of the Sutlej, 1819. (Asiatic Researches, vol. xv. p. 339.) In the same vol. p. 469, he published observations on the climate of Subathu and Kotgerh. His labours in completing a geographical survey of the valley of the Sutlej are the subject of a paper by the late Mr. H. T. Colebrooke in the Transactions of the Asiatic Society of London, vol. i. p. 343. From the diary of this survey, Mr. Colebrooke selected notes of Geological observations; and from specimens then collected, duplicates were sent to our Society. Upon these notes, and on Captain Gerard's letters, written during his survey in the middle valley of the Sutlej, a sketch of the Geology of the Himalaya was prepared by Mr. Colebrooke and published in the Geological Transactions of London*.

The second volume of Sir W. Lloyd's recent narrative of a journey in the Himalaya, contains an account of Captain Gerard's attempt to penetrate on the north side of the Himalaya by Bekhur, to Garoo and the lake Manasarowara, near the source of the Sutlej. These letters are interspersed with many interesting geological observations respecting the mineral productions and nature of the rocks of the country over which he travelled. He found the inclination of the strata to be usually perpendicular to the direction of the range, presenting long continuous slopes on the side towards which they dip, and terminating abruptly in rugged precipices towards the axis of the mountain chain. Near Bekhur, at the north side of the Himalaya, on the margin of the great table land of Tartary, elevated 15,786 feet above the sea, he mentions the occurrence of gravel studded with Ammonites, not far from the Hookeo Pass, which presents mural precipices of limestone.

In one excursion in the Himalaya he fell in with the late Bishop Heber, who devotes a long and eloquent passage in his journal to the expression of his praise and admiration of the scientific talent and enterprising spirit of Captain Gerard. He was an excellent Persian scholar, and acquainted with several other oriental languages.

* Vol. i., second series, p. 124.

He performed many of his surveys under a burning sun, the thermometer ranging from 100 to upwards of 112 degrees. As many of his observations were required to be taken at mid-day, the consequences were frequent suffering and illness from strokes of the sun; but he continued his labours until his health totally failed. He died at Aberdeen in December last, at the age of forty-seven, having apparently sacrificed his life to the promotion of science, stimulated in his labours by the wish to benefit mankind, without the hope of worldly remuneration.

To his late equally zealous and indefatigable brother, Dr. James Gilbert Gerard, surgeon of the Hill corps stationed at Subathu, and the companion of Captain, now Sir Alexander, Burnes, in his perilous journey through Central Asia, we owe the discovery of extensive collections of fossil shells in the Himalaya mountains, at the height of 17,000 feet. The greater part of these closely resemble shells that occur in the Oolite formation of Europe, particularly Ammonites and Belemnites; whilst a few, *e. g.* Orthoceratites and Spirifers, are similar to shells we find in rocks of our Transition Series. The Rev. R. Everest has described and figured some of these in the eighteenth volume of the Asiatic Researches.

His third brother, Captain Patrick Gerard, is remarkable as the author of a Meteorological Journal, kept in 1819–20 at Kotgerh, Subathu, and the intermediate places in the Himalaya mountains, and recording hourly observations during nearly two years*.

* See Journal of Asiatic Society of Bengal, vol. ii. p. 615.

After the Reports had been read,

It was then Resolved:—

1. That the thanks of the Society be given to Charles Lyell, Esq. and the Rev. Adam Sedgwick, retiring from the office of Vice-President.

2. That the thanks of the Society be given to Professor Daubeny, M.D.; Sir Philip Egerton, Bart. M.P.; Dr. Grant; Rev. Professor Henslow; Sir Charles Lemon, Bart. M.P.; and Richard Owen, Esq. retiring from the Council.

After the Balloting Lists had been duly closed and the lists examined by the Scrutineers, the following Fellows were declared to have been elected the Officers and Council for the ensuing years.

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PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. III. 1840. No. 69.

Feb. 26.—A paper was first read, entitled "Further observations on the fossil trees found on the Manchester and Bolton railway;" by John Hawkshaw, Esq., F.G.S.

Since Mr. Hawkshaw's former communication,* another fossil tree has been found on the opposite side of the railway. It is about three feet in height, and three feet in circumference, and stands on the same thin stratum of coal as those first discovered, and perpendicularly to the surface of the bed. Mr. Hawkshaw is, therefore, strengthened in his belief, that the trees grew in the position in which they are found.

After this notice of the recent discovery, he proceeds to describe the effects produced in hot and moist climates on felled or prostrated solid dicotyledonous trees. The tropical forests with which he is acquainted from personal examination, are situated in Venezuela on the shore of the Carribean sea, and between the 8th and 10th degrees of north latitude, and the 65th and 70th of west longitude. In these forests a few months are sufficient to destroy the interior of the largest tree, little more being left than an outer shell, consisting chiefly of the bark. Mr. Hawkshaw noticed this peculiarity more frequently in dicotyledonous trees, having a proper bark, than in monocotyledonous vegetation, excluding necessarily those always hollow; and he does not remember to have seen a single instance of a palm similarly acted upon. Sometimes the portion of the dicotyledonous tree remaining on the ground, presented very much the appearance of the founder's mould, when the pattern has been withdrawn from the sand, and before the metal has been run in; and by this kind of decay, a cavity is formed from which a fac simile of the tree might be cast. In other cases, prostrated trunks having the appearance of being solid, have yielded to the pressure of his feet, and proved to be only hollow tubes. Dangerous accidents have also occurred from temporary bridges constructed of dicotyledonous trees having given way beneath the passenger, though there was no outward indication of decay. The bark of these trees had changed but little, though nothing of the interior remained but dust, and a few remnants which crumbled beneath the slightest touch.

* Ante, p. 139.

The low and flat tracts in which this destructive operation goes on most rapidly, are those in which, from the deep rich soil and excessive moisture, all below the tall forest trees and larger palms is occupied by canes, bamboos, and minor palms. Such tracts would be most easily submerged; and in Mr. Hawkshaw's opinion they might hereafter present a seam of coal, which would afford but few distinct traces of palms and forest trees. These phænomena, he says, may explain in part, why so few distinct forms remain of the numberless forest trees, which must have formed a portion of the vegetable kingdom, at the time of the accumulation of our coal deposits.

Mr. Hawkshaw does not attempt to explain the process by which dicotyledonous trees are rendered hollow in tropical forests. He expresses doubts respecting the probable nature of the Calamites of the coal measures, and offers no explanation of the means by which they have been preserved in so great abundance. If the coal be considered as the debris of a forest, he says, it is difficult to account for not finding more trunks of trees than have been discovered in our coal basins; and he observes, it is only perhaps by allowing the original of our coal seams to have been a combination of vegetable matter, analogous to peat, that the difficulty can be solved. In this case, he is of opinion, but a few isolated trees might be expected to be found, and that the remains of vegetable forms most frequently discovered, would only be confirmative of the antiseptic qualities of their original nature, as previously advanced by Professor Lindley, and not of the number or importance of their particular genera at the time of their deposit.

In conclusion, Mr. Hawkshaw says, that whatever opinion may be drawn from what is conjectural in his paper, it will be obvious, that though fossil remains may be found filled with a mechanical deposit, and containing traces of other vegetables, yet that this condition does not prove, that the plants were originally hollow, nor even render it the most likely hypothesis, as they may have been hard wood-trees, the centre of which had been removed by natural processes.

A paper was then read, "On the characters of the fossil trees lately discovered near Manchester, on the line of the Manchester and Bolton railway; and on the formation of Coal by gradual subsidence;" by John Eddowes Bowman, Esq., F.L.S. communicated by the President.

The paper commences with a few preliminary remarks on the theory of repeated subsidences of the land during the carboniferous æra; and on the drift theory, the author being of opinion that the former receives much support from the phænomena presented by the fossil trees found near Manchester, and that it affords in return great assistance in explaining the peculiarities of their position. Mr. Bowman does not deny that plants may have been carried into the water from neighbouring lands, as in the instances of fern-fronds and other remains scattered through the sandstones and shales; but he conceives it is difficult to understand whence the vast masses of vegetables necessary to form thick seams of coal could have been derived, if drifted; and how they could have been sunk to the bottom, without being intermixed with the earthy sediment which was slowly deposited upon them. He is of opinion also, that without a superincumbent layer of mud or sand, to retain the hydrogen during the process of bituminization, ordinary caking coal could not have been formed. Another difficulty, connected with the drift theory, Mr. Bowman says, is the uniformity of the distribution of the vegetable matter, throughout such great areas as those occupied by the seams of coal, extending in the instance of the lower main seam of the great northern coal field, over at least 200 square miles; and in that of a thin seam below the gannister, or rabbit coal, in a linear direction of thirty-five miles from Whaley Bridge to Blackburn. On the contrary, he believes, that it is much more rational to suppose, that the coal has been formed from plants, which grew on the areas now occupied by the seams,—that each successive race of vegetation was gradually submerged beneath the level of the water, and covered up by sediment, which accumulated till it formed another dry surface for the growth of another series of trees and plants,—and that these submergences and accumulations took place as many times as there are seams of coal. He also explains the thinning out of the seams and other strata of the coal measures, by irregularities in the mode or extent of the depressions.

Mr. Bowman then proceeds to the examination of the phænomena presented by the fossil trees discovered on the line of the Manchester and Bolton railway, and described by Mr. Hawkshaw in his paper read on the 5th of June 1839, (see p. 139.) and in the preceding communication (see p. 269.): it will be necessary to notice therefore only those points which did not claim that gentleman's more particular attention. Mr. Hawkshaw describes generally the markings on the internal casts of the trees; but as it is difficult to convey a correct notion of their waved and anastomosing characters either verbally or by reduced drawings, Mr. Bowman applied paper to the surface of the stems and carefully traced the grooves or furrows by following them exactly with an instrument. The only indications of scars, which he could find after a long and close search, were at one point near the base of the largest tree, and though indistinct, his practised eye recognised them to be those of a Sigillaria. He detected also in some parts, on the ribs of the same tree, the fine wavy lines so often visible on decorticated specimens of that family. In describing the second tree, he alludes to a deep wedge-shaped rift on the south-east side, which had been coated with coal, and is strongly marked with wavy lines, like those on the surface of thè alburnum of a gnarled oak. On the fifth tree, he discovered a longitudinal concavity on the north side, and he states that it resembles the impression which would be left in a dicotyledonous tree, by the pressure of a parasitic plant. The characters of the roots are also detailed at considerable length, paricularly their mode of bifurcation, and position with respect to the horizon.

From a careful consideration of the phænomena presented by the fossils, Mr. Bowman is convinced that they stand where they originally flourished; that they were not succulent, but dicotyledonous, hard-wooded forest trees; and that their gigantic roots were manifestly adapted for taking firm hold of the soil, and in conjunction with the swollen base of the trunks to support a solid tree of large dimensions with a spreading top.

Towards the close of 1838, in forming the railway tunnel at Claycross, five miles south of Chesterfield, a number of fossil trees were found, standing at right angles to the plane of the strata. The tunnel passes through the middle portion of the Derbyshire coal measures, which there dip about 8° to a little north of east. The bases of the trees rested upon a seam of coal fifteen inches thick. The exterior of the stems consisted of a thin film of bright coal, furrowed and marked like the *Sigillaria reniformis*; and the interior consisted of a fine-grained sandstone. Mr. Conway, who supplied Mr. Bowman with an account of the discovery, infers, from the information which he obtained, that there must have been at least forty trees found, and judging by the area excavated, he is of opinion that they could not have stood more than three or four feet apart. There were no traces of roots, the stems disappearing at the point of contact with the coal. Several specimens of *Stigmaria ficoides* were also noticed by Mr. Conway, lying horizontally and about three feet in length.

With reference to fossil trees in general, and especially to those near Manchester, Mr. Bowman proceeds to show still further; 1st, that they were solid, hard-wooded, timber trees, in opposition to the common opinion that they were soft or hollow; 2nd, that they originally grew and died where they have been found, and consequently were not drifted from distant lands; and, 3rd, that they became hollow, by the decay of their wood, from natural causes, similar to those still in operation in tropical climates, and were afterwards filled with inorganic matter, precipitated from water.

1. In stating his reasons for believing that the coal measures' casts were solid timber trees, Mr. Bowman alludes to the rifting of the bark of modern forest trees, in consequence of the expansion caused by the annual addition of a layer of wood between the bark and the alburnum; and to the thickening or swelling of the base of the trunk and main roots, and the apparent lifting up of the latter out of the soil, in old trees, by the greater annual increase of the upper part or that nearest to light and heat. These phænomena in vegetation were illustrated by a diagram, which exhibited the form of the base of the stem and the root of a sapling, and of a full-grown tree. The author, in applying these characters to the fossils of the Manchester and Bolton railway, alludes to the irregular, longitudinal and discontinuous or anastomosing furrows on their surface, to the swelling out at the base of their stems, and to the divergence as well as the angle of dip or downward direction of their roots. These characters, he says, are not observable in soft monocotyledonous trees, their stems never expanding laterally, and being as thick when only a few years old and a foot high, as when they attain the height of 60 or 100 feet. Their roots also, instead of being massive and forking, generally pre-

sent a dense assemblage of straight succulent fibres, like those of an onion or hyacinth. Analogy, therefore, as far as outward shape and habit are concerned, he adds, is strongly in favour of the fossils having been solid timber trees.

Mr. Bowman then combats the view, generally entertained, that fossil stems with perpendicular furrows, as in the Sigillaria, were succulent or hollow plants*. He states, that good specimens of decorticated Sigillariæ exhibit fine straight, and curled or gnarled striæ, similar to those on the alburnum of many modern forest trees ; and that this character, in conjunction with others, renders it almost certain, that the fossils had a separate back,—a feature which is considered in vegetable physiology to be a proof of a woody structure. He also alludes to the existence in many of the decorticated parts of their fossil trees of little prominences like those in barked timber; likewise to the scars left by the disarticulation of leaves; and he accounts for the general absence of the latter on large and old trunks, by their having been obliterated, in consequence of irregular expansion from the deposition of new layers of wood: he notices moreover the absence in small Sigillariæ of the irregular furrows observed on large specimens, and due in his opinion to the unequal expansion by the addition of new layers of wood. In support of these proofs of the original solid nature of the trees, Mr. Bowman exhibited polished slices mounted upon glass of portions of a similar fossil tree discovered in sinking a shaft 300 or 400 yards N.W. of those found on the line of the railway. The slices were made from a portion which exhibited within the carbonized bark, a patch browner, heavier, and more compact than the rest. In these slices, made under Mr. R. Brown's direction, that gentleman discovered in the transverse section, the uniformity of vascularity which is evidence of coniferous structure; and in the longitudinal section parallel to the medullary rays, the existence of these rays. The slices therefore exhibit proofs of dicotyledonous structure, and considerable probability of that structure being coniferous. The important evidence however of coniferous structure deducible from discs in sections parallel to the rays, was not obtained, the vessels having apparently undergone some alteration.

2. With respect to the second point, that the trees grew and died on the spots where they are now found, and that they were not drifted from distant lands, Mr. Bowman says, the arguments in favour of the formation of beds of coal by a series of subsidences of the surface on which the vegetables that produced the coal grew, naturally lead to the inference that the trees associated with the coal also flourished on the same spots. In opposition to the opinion that trees would naturally float in an upright position in consequence of the greater specific gravity of the base and roots, he asserts, that the

* Specimens of recent dicotyledonous wood from New Zealand, lent to the author by Mr. R. Brown, were exhibited on the table of the Meeting Room. They displayed both upon the bark and the naked wood, longitudinal ribs and intermediate furrows as regular as those on Sigillariæ; and therefore prove that these characters are not incompatible with a dicotyledonous structure.

trees would maintain that position only as long as they floated, and that they would fall and lie prostrate when grounded on shoals or cast ashore. He agrees with Mr. Hawkshaw in the opinion, that it is more difficult to account for a number of great trunks being deposited in the position of the fossils in the Manchester railway, than to imagine that they grew on the surface of the bed on which they now stand. Their position on a bed of coal is another proof, Mr. Bowman conceives, that the trees were not drifted, for if they had been transported by currents of water they might equally have been imbedded in the alternating shales or sandstones. If beds of coal are the accumulated remains of many generations of a luxuriant vegetation, the rich compost thus formed, Mr. Bowman argues, would be well suited for the growth of trees. Again, the angle at which the roots of the fossil trees, particularly of that distinguished by him as No. 2, dip towards the bed of coal, is considered by the author evidence of the trees being in their original position, because, had they been drifted, the roots would have been bent upwards, by the downward pressure of the trunk, when the water had left them. The appearance of the roots being cut off, where in contact with the coal, he is of opinion, may be explained by the fermentative process having dissolved the vegetable texture below the surface. The stems and upper portions of the roots standing above the coal, he explains by reference to similar phænomena in peat marshes, in which the bases of the trunks of ancient forest trees stand with the roots exposed, owing to the shrinking of the surrounding peat.

3. In discussing the third point, that the trees became hollow from the decay of their wood, and were filled with sedimentary matter after their immersion, Mr. Bowman refers to the facts recorded in the preceding paper by Mr. Hawkshaw (see *ante*, p. 269.); and in confirmation of them states, that Mr. Schomburgk during his four years' travels in Surinam repeatedly observed similar phænomena. Mr. Bowman then proceeds to explain the processes by which he conceives the fossil trees were gradually submerged—their upper branches torn off—their interior removed by natural decay,—their bark converted into coal,—their central cavities filled with sediment; and the whole buried beneath the stratum of shale or sandstone in which the trees were discovered. He afterwards applies the phænomena which he believes these processes produced to the condition and position of the trees and the arrangement of the surrounding sedimentary matter. The author then enters into the inquiries, 1st, the time which the trees may have required to attain their dimensions; and consequently the minimum of years requisite for the accumulation of the vegetable matter; and, 2ndly, what thickness of vegetable matter was necessary to form the stratum of coal nine inches thick, over which the trees stand. Mr. Schomburgk is of opinion that a dicotyledonous tree which would require in temperate climates one hundred years to attain a certain diameter, would arrive at the same dimensions within the tropics in sixty or eighty years. The largest of the fossil trees forming the immediate subject of the paper is equal in circumference to an oak of 130 years growth in

this climate, or about 100 for a climate equal in temperature to that of the tropics. Allowing therefore that some time elapsed after the commencement of vegetation on the surface of the then dry land before the trees began to grow, Mr. Bowman infers, that 100 years must be the minimum of time which would be required for the production of the vegetable matter out of which the nine inches of coal were produced. With respect to the depth of the stratum of vegetable matter from which it was formed, Mr. Bowman takes for his data, the thickness of the bed of coal, nine inches; the distance between the top of the seam and the bottom of the trunk under the arch formed by the roots, fifteen inches; and for the distance to the surface of the ground, four inches, or in all twenty-eight inches; whereby he infers that the thickness of the solid coal is equal to about one-third that of the vegetable matter out of which it was produced.

A paper was lastly read, "On the character of the beds of clay lying immediately below the coal seams of South Wales; and on the occurrence of coal-boulders in the Pennant grit of that district;" by William Edmond Logan, Esq., F.G.S.

Immediately below every regular seam of coal, in South Wales, (and nearly 100 are known to exist) is constantly found a bed of clay, varying in thickness from six inches to more than ten feet, and called the underclay, undercliff, understone, pouncer, or bottom stone. It is so well known to the collier, that he considers it an essential accompaniment of the coal; and only where it ceases, does he give up his expectation of finding coal. Seams which have thinned out in one portion of a work, have been recovered in another by following this bed.

The underclay is always more or less argillaceous, but it is never without a considerable admixture of sand; and in most cases it yields a very good fire-clay; which, though generally tough when freshly cut, yet crumbles on exposure into a mass of a grey colour. Occasionally it is quite black, in consequence of the presence of carbonaceous matter, and it then sometimes resists the effects of the weather. Under a part of the lowest seams of coal between Swansea and the Bury river, it is a hard, durable, finely grained, siliceous stone. It is however by containing innumerable specimens of *Stigmaria ficoides*, that these beds are most strongly marked, other portions of the coal measures presenting the same mineral composition. The stems of the Stigmaria, which are usually of considerable length, always lie parallel to the plane of the bed, and nearer to the top than the bottom; and they are occasionally compressed, their diameter varying from two to six inches. Their long slender processes, covered with a pellicle of carbonaceous matter, form an entangled mass, and traverse the beds in every direction, vertically, horizontally, and obliquely; but Mr. Logan has never been able to trace them to their termination, though he has followed single processes for considerable distances. Portions of the stem of the Stigmaria are found in other parts of the coal measures, but it is only in the underclay that the fibrous processes are attached to the stem or associated with it. Mr. Logan, however, states, that if such specimens exist in other strata, they are not so likely to be exposed, as those beds are less worked than the underclay.

In some instances, the Stigmaria, with its processes, is found equally abundant in the roof as in the floor of a coal pit, but in such cases the roof has been ascertained to be the underclay of an immediately overlying bed of coal.

Mr. Logan then quotes at length, Steinhauer's account of the Stigmaria, as it gives the best explanation he has seen of the external botanical character of the plant, as well as of its position in the beds in which it occurs; the only point in which his experience induces him to differ from Steinhauer, being the vertical extent to which the fibres range. Mr. Logan has never traced them in that direction more than seven or eight feet from the stem, though he admits they may have an horizontal range of twenty or more feet. (American Phil. Trans. New Series, vol. i. p. 265, 1818.)

When it is considered, that over so considerable an area as the coal field of South Wales, not a seam has been discovered without an underclay, abounding in Stigmaria, Mr. Logan says, it is impossible to avoid the inference, that there is some essential and necessary connexion between the existence of the Stigmaria and the production of the coal. To account for their unfailing combination by drift, seems to him unsatisfactory; but whatever may be the mutual dependence of the phænomena, he is of opinion, that it affords reasonable grounds to suppose, that the *Stigmaria ficoides* is the plant to which may be mainly ascribed the vast stores of fossil fuel.

In the second part of the paper, Mr. Logan gives an account of boulders or rounded fragments of coal, contained in the coal measures themselves.

The thickness of the coal deposit of South Wales, he says is equal in the deepest part to 12,000 feet, and that consequently a long period must have been required for the accumulation of the materials, and that any fact which may assist in ascertaining its length, cannot fail to possess some interest. The occurrence of these boulders he is of opinion bears upon the subject.

From a layer of indurated clay, two inches thick, lying on the top of a seam of common bituminous coal, and covered by hard sandstone, at Penclawdd on the Bury river, he obtained. in the spring of 1839, a worn, rounded mass of cannel coal, six inches long, four inches wide, and two inches thick. The discovery of this singular specimen having excited attention to the subject, it was ascertained that in the quarries of the enormous mass of sandstone forming Cilfay hill and the Town-hill range from Swansea to the Bury river, there occur many irregular conglomerate beds, formed of innumerable pebbles and small boulders of coal, sometimes four inches in diameter, mingled with sand and pebbles of ironstone; and there have been also found in them small boulders of granite and mica-slate. Many impressions, coated with coal, of Sigillariæ and other plants, occur in the mass; and the difference of age between this coal and that of pebbles, he says, is beautifully illustrated in numerous cases, where the softer coal of the plants has been pressed down upon the harder coal of a layer of the pebbles, by the cleavage of the former, however distorted the plant may be, presenting an uniform parallelism, while the cleavage of the coal forming the pebbles is parallel with the sides of the pebbles, which are inclined in all possible directions.

The pebbles consist principally of the common bituminous coal of the neighbourhood, but two have been found composed of cannel coal, the only seams of which, existing in the lower measures, occur about 2000 feet below the conglomerate bed.

The Cilfay sandstones and the measures at Penclawdd, in which the first-mentioned pebble was found, form part of the Pennant grit; and there is reason to believe, that throughout the whole of this great mass of sandstone, about 3000 feet thick, occasional beds of coal pebbles are to be met with: but Mr. Logan has not seen any associated with the lower measures.

March 11.—Rev. Richard Taylor, M.A. of the Bay of Islands, New Zealand; Graham Francis Moore, Esq. Brick Court, Temple; and Samuel Smith, Esq. of Combe Hurst, Kingston, Surrey, were elected Fellows of this Society.

A paper was first read, "On the Rocks which form the West shore of the Bay of Loch Ryan in Wigtonshire, N. B." by John Carrick Moore, Esq. F.G.S.

The peninsula of the Ryans extends about thirty miles from N. to S., and is about seven miles across at its greatest breadth, or from Stranraer to Port Patrick. In the geological maps of M. Necker, Dr. Macculloch, and Mr. John Phillips, it is coloured as part of the great graywacke chain, stretching from the Irish sea to St. Abb's Head, and the chief part of the rocks composing the peninsula, Mr. Moore says, undoubtedly belongs to that epoch; but he has ascertained from an examination of the district during the summer of 1839, that others of a more recent date also exist.

The portion of the peninsula particularly described by the author, extends about eleven miles from north to south, and about five from east to west; and is bounded on the W. and N. by the Irish sea, and on the E. by the Bay of Loch Ryan. The formations of which it consists are—1. Graywacke, 2. Trap rocks, 3. Coal measures, and, 4. a red breccia.

1. The graywacke constitutes the greater part of the district, the beds being nearly vertical and the prevailing strike E. by N. At the northern extremity, near the Corsewall Lighthouse, are beds of conglomerate composed of rounded masses of granite, with pebbles of serpentine and other rocks. In the little bay of Sloughnagarry, at the most southern point, where the graywacke shows itself, Mr. Moore found in a slaty rock alternating with compact beds, an abundance of fossils, determined by Mr. Lyell to be graptolites.

2. The trap rocks occur at two points, one near the northern extremity of the peninsula, on the farm of Balscallock, constituting a

dyke of amygdaloid greenstone which cuts through the graywacke and is lost in the sea; and the other is near Loch Connell, where a mass of greenstone extends in a westerly direction for nearly two miles. At both localities, the trap intersects the graywacke; but at neither point could the author find it in contact with the coal or overlying breccia.

3. Coal Measures. A deposit consisting of beds of red and white sandstones, clays and micaceous shale, similar to those of the coal-field of Ayr, has been long known to exist in the district, and has led to several fruitless researches for coal. The deposit may be traced for about nine miles, forming a narrow band parallel to Loch Ryan. The beds are in general moderately inclined to the E. or S.E. In a quarry on the farm of Clachan, Mr. Moore found remains of *Stigmaria ficoides*, and in another, on the farm of Challock, an abundance of Calamites.

4. Red Breccia. This rock extends from the bay of Sloughnagarry to the farm of Dumlae, a distance of eight miles, forming a ridge from 200 to 300 feet high, between the coal measures and the shore of Loch Ryan. It consists entirely of irregular fragments of graywack cemented by a red clayey sand, but in some places it passes into laminæ of red sandstone. The beds are nearly horizontal or dip slightly to the S.E., and rest on the coal measures. As Mr. Moore did not detect any organic remains in the breccia, nor find any rock overlying it, he does not offer an opinion respecting the period of its formation.

A paper was afterwards read, "On the Siliceous Bodies of the Chalk, Greensand and Oolites;" by Mr. Bowerbank, F.G.S.

The author commences by stating, that naturalists and geologists have long considered the form of tuberous masses of flint found in the upper chalk to be due to alcyonia or sponges, but that he is not aware of this opinion having been proved to be correct. It was Professor Ehrenberg's observations on siliceous bodies which first induced him to obtain thin slices of flint with the intention of procuring specimens of Xanthidium. In the examination of these slices, he was struck with the frequent occurrence of patches of brown, reticulated tissue, spicula and foraminifera, and he was induced to infer, that the patches of tissue were the remains of the organized body, possibly a sponge, to which the flint owed its form. With this belief, he commenced his inquiries by examining thin slices of flints obtained from various localities, and he found in all of them, a perfect accordance in the structure and proportion of reticulated tissue, in the number of spicula, and in the occurrence of Xanthidia and Foraminifera. The following are the general appearances which the slices of flint exhibit when mounted upon glass.

With a power of about 120 linear, the slice presents the appearance of a stratum of a turbid solution of decomposed vegetable or animal matter containing foraminifera, spicula, Xanthidia, and frequently fragments of the brown tissue. In a specimen from Northfleet the mass of the spongeous portion exhibited numerous cylindrical contorted canals, which from their uniformity and minuteness of diameter, Mr. Bowerbank considered to be the incurrent canals of the sponge; and other orifices of greater diameter, to be the excurrent. Very frequently, when little of the reticulated substance of the sponge remains, its former presence, the author says, is indicated by the siliceous matter resembling a congeries of gelatinous globules, moulded by the tissue amid which it was deposited; and the globules, when traced to the edges of the patches of spongeous texture, were found to agree in size and form with the orifices of the supposed incurrent canals. In cases where no traces of the sponge can be detected, Mr. Bowerbank thinks, that the mode in which the spicula, foraminifera and other extraneous matters are dispersed equally in all parts, and not precipitated to one portion of the flint, indicates that the organized tissue in which they were entangled, retained its form and texture sufficiently long to allow of the fossilization of these remains in their original places; and that the nature and position of these bodies strongly indicated the former spongeous nature of the flint.

When the chalk is carefully washed from the exterior of a flint, and a portion examined as an opake object with a power of about fifty linear, it exhibits a peculiar saccharine appearance, with deep circular excavations, having fragments of extraneous matters partly imbedded or adhering to them. If the surface be further cleansed by immersion in diluted muriatic acid, till effervescence ceases, spicula may be detected on the sides of the deep circular cavities; and if, again, a piece a quarter of an inch in diameter, presenting the roughest aspect, be examined under a power of 120 linear, illuminated by a Leiberkuhn, the surface, under favourable circumstances, will present a complex mass of small, contorted tubuli, occasionally furnished at the apex with a minute perforation.

The structure and other characters of the tabular flints are stated to accord perfectly with those of the nodular masses, except that the under surface has a still more marked spongeous aspect, and that spicula and foraminifera are more abundant. The absence of any apparent base or point of attachment in the great mass of nodular chalk flints, the author says (considering them undoubtedly of spongeous origin) may be accounted for by supposing that the gemmule was originally attached to some minute fragment of a shell or other substance, and that its further development took place while recumbent on the mud or silt.

The perpendicular and oblique veins of flint between Brighton and Rottingdean, are reported to present exactly the same internal characters as the tabular and nodular flints, and to agree externally with the former. The occasional existence of a fissure filled with chalk, in the centre of the vertical layers, Mr. Bowerbank conceives, may indicate that the sponge had grown from the two sides of the crevices, but had not in all places been able to unite. The sides of these flint veins are not studded with foraminifera in a manner similar to that of the tabular horizontal layers.

Mr. Bowerbank next examined the flint with which Echinites and shells of the chalk are often entirely or partially filled and enveloped, and he states, that the results were the same, both with reference to the exterior and the interior of the flint. In those cases in which the Echinite is only partially filled, he infers that the portion so occupied was originally a sponge, because its surface is uneven; for had the flint been deposited in an empty shell or Echinite, it would present an uniformly flat surface. Again, he states, that the projecting of the flint through the two openings of the Echinite, with an extension to a greater or less distance, is owing to the sponge having grown outwards through these orifices; and the envelopment of an organic body by a tubular mass of flint, he explains by reference to the habit of recent sponges to invest testacea or other marine bodies. In some cases, he has found minute but deep depressions on the surface of flints filling Galerites, and immediately opposite to the ambulacral pores; and he ascribes the origin of the depressions to streams of water drawn in through the orifices to supply the wants of the living sponge.

Mr. Bowerbank was afterwards induced to extend his examination to the flints which invest the zoophytic bodies of the Wiltshire chalk. By carefully cleaning the interior of some of these flints, he discovered spicula projecting from all parts, however different the character of the inclosed body; and the spicula appeared to have no reference to it, none of them being found on its surface. Under the microscope, the investing flint presented in every respect the same appearance as that exhibited on the lower surface of the tabular flints, having fragments of minute corals and small shells attached to the inner surface. A thin slice exhibited the usual organic contents of the common flint. He, therefore, infers that the tubular flint which incloses the zoophtyes, owed its origin also to a sponge which invested the organic nucleus.

A comparison of the characters presented by the spongeous remains of the flint, with a collection of recent sponges, has induced Mr. Bowerbank to conclude that the fossils cannot be referred to any of the established divisions of existing sponges.

On examining the cherts of the greensand of Fovant in Wiltshire in the same manner, he found that the only differences between them and chalk flints, existed in the coarser texture of the spongeous fibre, the greater size of the interstices of the network, and the larger dimensions of the imbedded extraneous bodies. The cherty nodules of the upper greensand of Shaftesbury afforded similar appearances. A black, semi-transparent nodule, with an outer coat resembling agglutinated sand, was found under the microscope to contain numerous contorted canals of various sizes, and a considerable number of beautiful green spicula. Two chert casts of Spatangi from Shaftesbury afforded results analogous to those obtained from chalk Echinites.

Slices from a great variety of the greensand cherts of Lyme Regis presented characters which agreed with the cherts of Fovant. A specimen of flint from the Portland stone of Tisbury, and another from Portland, gave a greater quantity of cellular structure than any of the previously noticed cases, and the texture bore a greater affinity to that of the freshwater sponge, than is exhibited in the flints of the chalk or the cherts of the green sand.

With respect to the causes of the deposition of the flint, Mr. Bowerbank objects to the supposition, that it was influenced by the siliceous spicula of the sponges, because the flint is in no case limited or determined by their immediate presence, but is, in all instances, bounded by the extent of the animal matter of the sponge. He has frequently observed that the large excurrent canals in the chalk-flint spongites are not filled with silex, and that the spicula projecting into them have not the slightest incrustation of siliceous matter upon their surface ; while on the contrary, wherever a single tube or a thin layer of tubes has been projected from the mass into the chalk, the silex has been attracted to it. He conceives also, that the retention of the spicula and extraneous matters in all parts of the flint, may be accounted for, by supposing that the animal matter was the attractive agent, acting equally throughout the whole body of the sponge. In support of his argument he adduces the siliceous shells of Blackdown, and the siliceous corals of the Tisbury oolite and the mountain limestone, which contain no spicula, and in which it cannot be supposed that previously existing siliceous matter was the attractive agent. Lastly, the pyritous fossils of the London, Kimmeridge, Oxford and other clays, are also mentioned as examples of animal and vegetable substances having exercised an attractive influence.

March 25.—Morgan John O'Connell, Esq., M.P ; John Samuel Enys, Esq., of Enys, in the county of Cornwall ; Thomas Joyce, Esq., of Trinity College, Cambridge, and Bath ; John Eddowes Bowman, Esq., F.L.S., Hulme, near Manchester ; and Viscount Valentia, of Arley Hall, Staffordshire, were elected Fellows of this Society.

A paper was first read " On the Age of the Limestones of South Devon ;" by W. Lonsdale, F.G.S.

The object of this communication is to show the nature and limits of the author's claim to having been the first to infer from zoological evidence that the limestones of South Devon would prove to be of the age of the old red sandstone; and it was drawn up at the request of Mr. Murchison, in consequence of the subsequent adoption and extension of the proposed classification by Professor Sedgwick and that gentleman ; and at the request likewise of Dr. Fitton, in consequence of the same views having been applied to some of the infra-carboniferous formations of Belgium and the Boulonnais. The paper commences with a summary of the opinions previously entertained respecting the age of the limestones. The authors quoted are, Woodward, 1722 ; Da Costa, Maton, Playfair, Berger, L. A. Necker, De Luc, T. Thomson, Kidd, W. Smith, Brande, W. Phillips, Hennah, Greenough, Sedgwick, W. Conybeare, J. J. Conybeare, Buckland, Dufrénoy, Elie de Beaumont, De la Beche, Prideaux, Boase, J. Phillips, Austen, Murchison, Bakewell and J. de Carle Sowerby.

By these geologists the limestones are placed in the primary, transition or graywacke and carboniferous series; Mr. Prideaux being the only author who ascribes them in part, and on mineral characters, to the old red sandstone; and Mr. J. Phillips, in his article on geology in the Encyclopædia Metropolitana, hesitating to place them in a definite position, in consequence of the resemblance of many of the shells to species found in the mountain limestone. Mr. De la Beche, in his memoir on Tor and Babacomb Bays, also states that the limestones of that district rest on old red sandstone; and in his Report on Cornwall and Devonshire (1839), he says, "that those who rely very exclusively on the character of organic remains would probably feel disposed to consider the Torbay and Plymouth beds as equivalent to some such rock as the old red sandstone." The author of the paper refrains from all reference to the memoirs of the Rev. David Williams and Mr. Weaver, because his attention is more particularly confined to the limestones of South Devon. In allusion to the diversity of opinions which have been entertained respecting these rocks, even on some occasions by the same geologist, he is of opinion that it must be ascribed to the want, at the time the memoirs were written, of that preponderating weight of evidence which enables the mind to rest steadily on its own decisions; and that if a better result be now attainable, it must be ascribed to the mass of evidence, which has been recently accumulated in various parts of the kingdom. Until the organic remains of the mountain limestone and Silurian system had been determined, the former overlying and the latter underlying the old red sandstone, and shown by Mr. Murchison to graduate regularly into that formation, and to contain perfectly distinct suites of fossils, it was impossible to determine the age of a series of beds, the fossils of which were in part new, and in part closely allied to carboniferous shells; and procured from a region but partially examined, without a base line, beset with faults, and traversed by igneous rocks.

Mr. Lonsdale then proceeds to show, what was the zoological evidence on which he ventured in December, 1837, to conclude that the South Devon limestones would prove to be of the age of the old red sandstone. Previously, he had examined in part the corals of the Silurian region and South Devon, and ascertained that some of the species are common to both; he had also examined with Mr. J. Sowerby, Mr. Hennah's valuable collection of fossils from the neighbourhood of Plymouth, and had become aware, from the decisions of Mr. Sowerby, that certain of the shells could with difficulty, if at all, be distinguished from mountain-limestone species; and that some were distinct. In December, 1837, he examined with Mr. Austen a portion of that gentleman's collection of Newton Bushel fossils, and though he ventured to differ from some of the identifications with mountain-limestone species pointed out to him, yet these shells, agreed so much in aspect with testacea of the carboniferous fauna, that he could not doubt there was a connexion between the beds from which they had been obtained and the mountain limestone system: the same collection also proved that, associated with these shells, were corals of Silurian species. He had also been informed by Mr. Austen, that in beds connected with the limestone, the *Calceola sandalina* had been found. It was therefore by combining the amount of the above evidence, the presence in the same strata of shells, identical, or nearly identical, with mountain-limestone species, of Silurian corals, the *Calceola sandalina*, and a numerous distinct testacea, that he suggested the South Devon limestones would prove to be of an age intermediate between the carboniferous and Silurian systems, and consequently of that of the old red sandstone. In alluding to Professor Sedgwick and Mr. Murchison's adoption of the suggestion in 1839, and their bold application of it to all the older sedimentary rocks of Devon and Cornwall, the author states, that the fullest testimony is borne in the papers, containing their present views of the structure of those counties, of the source whence the suggestion was derived.

Appended to the notice was a list of fossils, necessarily very incomplete, from the limited nature of the materials at the author's command. It consisted of sixty-three species; twelve considered common to the Carboniferous and Devonian limestones, forty-two peculiar to the Devonian strata; and nine, seven of which are corals, common to the Devonian and Silurian formations; doubts were, however, entertained respecting the identification of the two species of shells. The author then observes,—should it be urged that it was unjustifiable to assume, from organic remains alone, the age of the Devonshire limestone, it may be replied, that in a district of which little in 1837 was positively known, which is cut off by the granite of Dartmoor from the only base line of the country, the culm measures of central Devon, proved in 1836 by Prof. Sedgwick and Mr. Murchison to be the representative of the true coal measures, organic remains were the only test by which the age of strata so situated could be determined; and in support of his argument, he advanced the recent establishment in Cutch and the Desert to the east of it, from the examination of suites of fossils brought to England by Capt. Smee and Capt. Grant, and others procured by Colonel Pottinger at the request of Colonel Sykes, of a series of beds unquestionably of the age of the oolites of England, the fossils agreeing in their general characters with those of that geological epoch in this country, and being in many instances specifically undistinguishable. In this case, mineral characters and order of superposition would have been valueless guides, for the rocks are totally different in character from those of the same age in England; and there was no predetermined series of beds from which an order of superposition could be derived. Another instance was noticed of the value of organic remains, if rightly applied, in determining the relative age of a distant region, and in this case of one inaccessible to Europeans, in the Ammonites obtained from the Tartar side of the Himalayan mountains. These fossils prove the existence in that unexplored country, of rocks of the secondary epoch, by possessing that peculiar character in the sutures, which is not found in Ammonites of any other epoch; they are moreover accompanied by Belemnites.

In advocating the value of fossils, the author, however, begs it may be clearly understood, that he would not expunge from the geologist's consideration, the aid to be derived from order of superposition, and under a right control, from the use of mineral composition and lithological structure; and he would advise the observer not to depend upon his own limited sources of knowledge, but to seek the aid of the philosophical zoologist, who can teach him to reason justly on the distribution of animal life,—the accidents to which it is liable,—the changes which such accidents may produce, or the means provided by nature to resist them,—and on the effects which a permanent alteration in the inhabiting medium may work in the form and size of a shell or coral.

Of the importance of organic remains in identifying districts less widely separated, the two following instances were noticed. In M. Dumont's work on the geology of the province of Liege, published in 1832, and justly valued for unravelling the structure of a most intricate country, the strata immediately beneath the mountain limestone are divided into three systems, but without any definite comparison with the formations which underlie that deposit in England. At the meeting of the Geological Society of France, at Mezieres, in September, 1835, Dr. Buckland proposed the following first comparison between the systems of M. Dumont and the subdivisions of the Silurian system established by Mr. Murchison:—

Système calcareux supérieur...... Mountain limestone.
(Old red sandstone wanting.)
Syst. quartzo-schisteux supérieur.. The Ludlow rocks.
Syst. calcareux inférieur........ The Dudley and Plymouth limestone.
Syst. quartzo-schisteux inférieur.. The Caradoc sandstone.
(Builth and Llandeilo flags wanting.)
Terrain Ardoisier.

This comparison was principally founded on the resemblance of the corals with those obtained at Dudley and Wenlock. M. Constant Prevost pointed out the resemblance of the *calcaire bleu* of the *système calcareux inférieur* of M. Dumont with the Plymouth limestone, and of the marble of Heer, subordinate to the *système quartzo-schisteux supérieur*, with the limestones of Babacombe. Mr. Greenough, however, doubted the identity of the Plymouth and Dudley limestones, and he stated that he had remarked the total absence of the Dudley Trilobites in the *système calcareux inférieur*. During the Mezieres meeting, Dr. Buckland identified certain beds beneath the mountain limestone near Namur, Dinant, and Huy, and at Engis, with the old red sandstone*; and at an ordinary meeting of the Geological Society of France, in December, 1837, M. Rozet repeated his belief, that the old red sandstone is well developed between Dinant and Namur; and M.

* In the "Outlines of England and Wales" (1822), the Rev. W. D. Conybeare places all the Belgian beds between the carboniferous limestone and the transition slates in the old red sandstone.—Note, 468.

Constant Prevost stated, that he had also during the Mezieres meeting, determined its existence in those districts. In 1838, M. Dumont visited England for the purpose of examining the Silurian region; and on his return to Belgium, he laid before the Royal Academy of Bruxelles a table, differing from that of Dr. Buckland only in drawing more closely the terms of comparison, and in identifying the two upper divisions of the Terrain Ardoisier with the Cambrian system. He stated also, in a report which accompanied the table, that the old red sandstone was most probably wanting in Belgium, or, if it exist, that it must be considered as a great development of the superior part of the Upper Ludlow Rock. In M. Dumont's work, before mentioned, lists are given of the fossils from each system; and on examining them, for the purpose of determining how far the comparison of the Belgian and Silurian systems could be established by organic remains, the author of this notice ascertained, that out of twenty-two species, only four could be considered as peculiar to the Silurian system; and of these he believes two may be erroneous identifications; that five species are common to the Belgian beds and the mountain limestone, and thirteen to the Belgian and Devonian systems. These lists, Mr. Lonsdale states, are small, but, he adds, they bear internal evidence of having been carefully drawn up without any preconceived theory; and he conceives that they afford sufficient proof that the beds from which they were obtained do not belong to the Silurian system, but partake of the same intermediate character as the Devonian limestones. The other case, alluded to in the paper, refers to the older beds of the Bas Boulonnais. These strata were identified by M. de Verneuil in 1838, with the Silurian series of England, particularly a bed of limestone containing corals and other fossils with the Wenlock limestone; and M. Dumont, who examined the country with M. de Verneuil, states in his report to the Bruxelles Academy, that his four systems occur in the Boulonnais. The above bed of limestone, M. Rozet had also, in 1828, placed below the old red sandstone; but in a subsequent memoir, published in the *Annales des Sciences Naturelles* (xix. p. 145. 1830), he assigns it to the old red sandstone. At the Meeting of the Geological Society of France at Boulogne, in Sept. 1839, and at which some of the Fellows of the Geological Society of London assisted, the identification of the Boulonnais beds with the Silurian system was fully admitted. When, however, doubts were recently thrown out respecting the age of the formations in the Liege districts on account of the nature of their fossils, Mr. Murchison, who was present at the Boulogne Meeting, stated to the author of this notice, that if the Liege country had been wrongly identified, the older beds of the Boulonnais had been wrongly identified also. To determine the question, as far as fossils would assist, Mr. Murchison procured, by the kind assistance of M. Dutertre Yvart, a collection of specimens in the Museum at Boulogne. An examination of these specimens with published lists, proved that the inference was just, and that there exists in the Bas Boulonnais, the same mixed assemblage of mountain limestone, Silurian and Devonian, or peculiar fossils, as in the province of Liege and in Devonshire.

A note "On the Bone Caves of Devonshire," by R. A. C. Austen, Esq., F.G.S., was then read.

Mr. Austen commences by noticing the two theories which have been proposed to account for the introduction of the bones of animals into caves—one, which accounts for their presence on the belief that they were dragged in by hyænas or bears inhabiting the caves; the other, which supposes that the bones were drifted in by diluvial waters. He then proceeds to give his own explanation of the phænomena presented by Kent's Cave and Yealmpton Cavern; but he says it is not his intention, by doing so, to propose a general theory for ossiferous caves.

In the Devonshire caverns, mentioned above, remains of the Elephant, Hog, Rhinoceros, Horse, Ox, Bear, Hyæna, and Cat, generally bearing marks of teeth, are intermingled. With reference to the means by which they were collected, Mr. Austen observes, the habits of the Hyæna are now better known than formerly, and there is little in them to warrant the conclusion that the fossil bones were collected by that animal. He says, on the authority of Cuvier, that hyænas "se tiennent solitaires dans les parties montagneuses," (last Edit. Oss. Foss.) least of all do they inhabit caves; that they have not the courage to attack any formidable animal, preferring the putrid flesh and bones, which they find in their nightly prowlings: that they never drag away their prey, but devour it greedily on the spot: and he adds, on the authority of M. Marcel de Serres, who has observed the habits of the Hyæna in Africa, "that its gluttony is equalled only by its cowardice."

The Lion, on the other hand, seeks solely for living prey, which it prostrates at one spring, and then conveys to its lair. The African lion has been known to carry off a bullock, and its constant abode is in chasms, caves, or on overhanging ledges of rock.

Mr. Austen is therefore induced to believe that the cavern bones were in the first instance the prey of the larger feline animals, and that during their absence the hyænas visited the caves to feed upon the fragments of the partially consumed prey; and in support of this view he quotes the passage from Johnson's Field Sports, given in the *Reliquiæ Diluvianæ* (p. 22): "they feed on small animals and carrion, and often come in for the prey left by tigers and leopards after their appetites have been satiated."

What the large feline animals were, Mr. Austen says, is not important, as they resemble each other in their habits. The remains of a Felis as large or larger than any now known, have been found in the Plymouth and Hutton caves, and the canine and molar figured by Dr. Buckland from Kirkdale, are said by Cuvier to differ in no respect from those of a lion. (Oss. Foss. IV. 151.)

The remains of a fossil lion have been also found in the caves of Gailenreuth, the province of Liege, Mialet and Jobertas (Dép. du

Gard), Lunel-Viel, Joyeuse, Ardeche, Fouvent, Fausan (Dép. de l'Herault), and in Kent's Cavern.

It is known that the Lions of the present day will attack every one of the animals, the remains of which are found in Kent's Hole, and other caves; and if it should be urged that the most powerful lion could not carry off the bodies of the great pachyderms, Mr. Austen says, that an examination of a very large proportion of the remains taken from Kent's Hole has proved that the bones and teeth of the Elephant belonged to young animals; and he quotes Dr. Buckland's statement, that the ten elephants' teeth discovered in Kirkdale cave belonged to extremely young animals. (Rel. Dil. p. 18.)

The conclusions, therefore, which Mr. Austen wishes to draw are, 1st, that the carcases were dragged into the bone caves by powerful feline animals; and 2ndly, that hyænas picked and gnawed the bones after those animals had satisfied their hunger, and while they were absent. He also objects to the belief that some of the German caves are filled with the animal matter of countless generations of bears, as the decomposition of one carcase, he says, would have driven the living bears from the cave; but he believes the prevailing fossil remains in each locality indicate only what animals were most abundant in the district, and consequently most frequently fell a prey to the powerful Felidæ: thus in the low grounds about Yealmpton, Kent's Hole or Kirkdale, herbivora may have been most abundant, and bears in the region of the Hartz.

April 8th.—Richard Vaughan Barnewell, Esq., Queen's Bench Walk, Temple, was elected a Fellow of this Society.

A paper was first read, "On the Great Fault, called the Horse, in the Forest of Dean Coal Field;" by John Buddle, Esq., F.G.S.

The term fault is used in this paper in the miner's signification, or for any interruption in the regular deposition or range of a bed. The Horse Fault, therefore, is not a displacement of one part of the stratum by a dislocation, but a local thinning out of a bed of coal, and a substitution of sandstone for it.

The Horse has been traced in the Coleford High Delf seam, the 23rd in the descending series, or the 3rd from the bottom, and the only one in which it is clearly developed, for about two miles; and its known breadth varies from 170 to 340 yards. The only point at which it has been tunneled through in a transverse direction, is under Barn Hill enclosure, between Brixslade and Howler's Slade valleys, and its width is there about 200 yards. The upper surface of the seam of coal, to a considerable distance on each side of the Horse, undulates considerably, producing depressions called "lows," and great varieties in the thickness of the bed; but the pavement composed of the ordinary argillaceous deposits, which accompany the seam throughout the basin, preserves nearly its ordinary regularity.

The roof of the seam consists of the strong sandstone which usually reposes upon the Coleford High Delf, but a layer of black slaty substance is sometimes interposed between it and the coal.

This sandstone extends to the surface, varying in thickness according to the undulations of the ground, but at one point over the Horse, the thickness is 94 yards. The sandstone sometimes passes into a conglomerate, containing fragments of coal, ironstone, and vegetable remains; also quartz pebbles, similar to those which abound in "the pudding-stone," a deposit between the carboniferous limestone and the old red sandstone, and which attains a considerable elevation in the adjoining hills. The sandstone also encloses concretions of highly indurated, ferruginous sandstone, scattered irregularly throughout its mass; and angular fragments of obliterated casts of vegetable remains, formed likewise of highly indurated sandstone.

The coal under the lows is generally mixed with particles of the sandstone of the roof; but it contains no boulders, angular fragments, or pebbles, as asserted by some observers; the supposed boulders and fragments being, Mr. Buddle observes, the concretions and vegetable remains of the roof, alluded to in the preceding paragraph.

The fall of the Horse conforms to that of the strata or S. 31° E., but whether the "fault" rises with the seam of coal to the outcrop on the S.E. side of the basin, remains to be proved. In the transverse section, the bed of the Horse is nearly horizontal.

There are no indications on the surface by which the Horse can be traced beyond the limits explored under ground; and whether it produces any change in the overlying seams, can be determined only by future works. Mr. Buddle infers, that it does not descend any lower than the Coleford High Delf seam, in consequence of the evenness of the floor, and the entire absence in it of sandstone.

In its underground characters, the Horse is similar to the "washes" or aqueous deposits in many coal-fields, but it differs in not underlying a river bed, or being in the bottom of a valley, and in not extending to the surface. In the Newcastle coal-field all the "washes" cut through the whole of the strata, from the surface to that on which the wash reposes.

In the workings of the Park End Colliery in Park End High Delf seam, which is situated 50 fathoms higher in the series than the Coleford High Delf, and two miles to the S.E. of the point to which the Horse has been traced, a great succession of "lows" has been found in crossing the line of the Horse, but no fault corresponding with the Horse. The coal is deteriorated in the same manner as in the Coleford seam. This colliery is situated beyond the centre of the basin, and where the strata rise in the opposite direction. Future workings alone can determine if there be any connexion between the Horse and these "lows."

In the direction of the Horse there is also an extraordinary oval depression of the Coleford High Delf, the centre of the seam being 20 feet below the ordinary level; and it remains to be proved if the Horse presents the same characters under the depression as elsewhere.

From the phænomena exhibited by the Horse and the adjacent coal-seam, Mr. Buddle is of opinion, that the fault and seam occupy the site of a lake, which existed during the deposition of the latter, and that the carbonaceous matter, which forms the seam, was accumulated while the water was deep and tranquil; that the undulations on the surface of the coal were occasioned by the action of the water when the lake was discharged; and that the Horse occupies the bed of the stream by which the complete drainage of the lake was effected. The sandstone of the roof, and that which fills the lows, he conceives, on account of the fineness of the grain, were tranquilly deposited.

A paper was then read, entitled, "Remarks on the Structure of the Royal George, and on the Condition of the Timber, Iron, Copper, &c., recovered during the operations of Col. Pasley, in the Summer of 1839;" by Mr. Creuze, of Her Majesty's Dock Yard, Portsmouth, and communicated by Captain Basil Hall, R.N., F.G.S.

The Royal George was accidentally sunk at Spithead on the 29th of August, 1782, and as the specimens described in the paper were recovered during the summer of 1839, they had consequently been immersed in a tide-way of salt water fifty-seven years. She was the first ship of war built on the principles recommended by the committee appointed to inquire into the superiority of the vessels in the Spanish and French navies; and was commenced at Woolwich in 1746, and launched the 1st of February, 1756. The Royal George was consequently, when sunk (1782), twenty-six years old.

The great agent in the work of destruction of the timbers had been "the worm". This insect had gradually, by its innumerable perforations on every exposed portion of the wreck, destroyed the fibrous tenacity of the wood, and reduced it to such a state as to permit the wash of the tide to remove the surface layer by layer. The quantity which had been thus destroyed, Mr. Creuze considers, from the parts recovered, to have been almost the whole of the upper portion of the ship, including the topsides above the line of the middle deck ports; and he is of opinion, that in another half century the same agents might have destroyed every part of the hull above the surface of the mud, if Col. Pasley's operations had not been undertaken.

The timbers which had been protected by the mud, were found to be solid and firm; but the only exposed wood which has escaped the ravages of "the worm" is the ash of which the dead-eyes were made. A portion of one of these timbers, which accompanied the paper, and had formed a part of the exterior surface covered with mud, bore no marks of "the worm." The copper sheathing appears to have suffered very slightly, several whole sheets having been found to be of the average weight per square foot of that now used. This state of preservation Mr. Creuze assigns to galvanic action. The copper nails are also nearly perfect. The cast-iron guns which have been recovered, were so soft when first brought to the surface, that they were easily abraded by the finger nail to the depth of at least $\frac{1}{16}$th, and in some parts of $\frac{1}{8}$th of an inch; but they have gradually hardened on exposure to the atmosphere. The brass guns were apparently as sharp in their ornamental castings, and as sound, as at the period of their immersion. A fragment of tarred rope-yarn exhibited a remarkable instance of durability. It is supposed to have formed part of the sea-store, of the Royal George, or of one of the cables used by Mr. Tracey in an attempt to raise the ship soon after she was lost. A piece of $2\frac{1}{2}$-inch cable-laid cordage, made from the yarns of this junk, bore 21 cwt. 3 qrs. 7 lbs.; a piece of similar cable, from yarn spun in 1830, bore only 20 cwt. 1 qr. 7 lbs.; but another manufactured from yarn spun in 1838, bore 23 cwt. 1 qr. 7 lbs.

The paper contained various details respecting the construction and measurement of the Royal George, and of the different descriptions of timber used in building the ship. Appended to the Memoir was also a catalogue of twenty-three specimens sent for exhibition, a portion of each of which was presented to the Society's Museum.

A letter, dated November, 1839, was afterwards read, addressed to Dr. Mantell by Mr. C. Hullmandel, "On the Subsidence of the Coast near Puzzuoli."

In 1813, Mr. Hullmandel resided during four months in the Capuchin Convent, which is situated at the entrance of Puzzuoli, and on the seaward side of the road towards Naples. The oldest friar, styled *il molto reverende*, then ninety-three years of age, informed Mr. Hullmandel, that when he was a young man, the road towards Naples passed between the convent and the sea, but that from the gradual subsiding of the soil it had been obliged to be changed to its present course. During Mr. Hullmandel's residence, the refectory and the entrance-gate were from six to twelve inches under water, whenever strong westerly winds prevailed. Thirty years previously such an occurrence never took place. The small wharf at Puzzuoli was also constantly under water during westerly winds. Mr. Hullmandel therefore infers, that as it is not probable the architect of the convent would have so placed the ground-floor as to expose it to inundations, or the builder of the wharf would have so constructed a landing-place as to render it liable to be overflowed; —a gradual subsidence of the soil has been going on for many years, and that this change tends to corroborate the opinion respecting the differences of relative level which have taken place in the Temple of Jupiter Serapis.

A notice was next read, "On part of Borneo Proper;" by G. Tradescant Lay, Esq. Communicated by the President.

The country visible in the background, on approaching the estuary into which the river of Borneo flows, is of variable, though nowhere of considerable elevation. Towards the east, however, is a remarkable range of mountainous ridges, rising one above another like steps, and trending, the author supposes, towards Kinibalu, the most lofty point in the island.

Borneo Proper consists, as far as Mr. Lay's observations extended, of sandstone; but near the mouth of the river is a little island on which coal is found, and called by the natives Pulu-cheomin, or Mirror island, in allusion, it is supposed, to the brightness of the coal. Mr. Lay says, if he understood his informant rightly, a large supply of fuel might be obtained from the island. Lignite is also found by the natives in sandstone in a deep valley or ravine, not far from Borneo city, and believed by the author to be that called Kianggi. The bed extends obliquely from one side of the ravine to the other, forming an angle of about 45°, with the direction of a rivulet, which flows through the valley; and it is stated to be more than two yards in breadth. The valley is accessible by a path called Jalan-subrek, and conspicuous from the palace of the Sultan, but it is steep, rugged, and narrow. The distance from the water-edge is less than two miles. The whole of the peninsula lying on one side of the river is formed of very steep hills, which gradually become more lofty towards the south-west. Upon the main land, or opposite side of the river, the ridges are supposed to range at right angles to the mountains. They are composed, generally, of a soft sandstone, alternating with clay; but on the summit of one of the hills, Mr. Lay noticed the outcrop of a hard red sandstone, formed of round and angular masses of quartz, particles of black mica, and a ferruginous cement.

A paper was last read, "On some Geological Specimens from Syria;" by Mr. W. C. Williamson.

The specimens were sent to England by Mr. Heugh, to whom the author states, he is indebted for a few notes respecting the localities, whence they were obtained. The chief districts are the vicinity of Beyroot, especially Mount Gebeel Suneen, which forms the part of the Lebanon range immediately above Beyroot. The triangular tongue of land, on which that town is built, is about four miles in extent from the mountains to the coast, and it presents an undulating surface, some of the higher points attaining 500 feet above the level of the sea. The formation of which it is composed, is a hard cream-coloured limestone, which exhibits in the cliffs along the sea-shore numerous veins of flint; and it is in one part of the coast overlaid by a soft calcareous rock, occasionally 100 feet thick. The latter stone is easily wrought, and is employed as a building material, being better able to resist the effects of the earthquakes than the harder and more compact rock.

On ascending Gebeel Suneen from the flat plain, which extends along its foot, and is 400 feet above the level of the sea, the following rocks are passed over:—

Compact limestone	1200 to 1500 feet.
Coarse siliceous conglomerate, containing thin seams of lignite, and fragments of siliceous wood	800
Compact limestone	2000

A very ferruginous rock, composed of minute grains of sand, thickly coated with hydrated oxide of iron	50 feet.
A seam of oysters, which may be traced completely around the mountain	
Compact limestone, forming the summit of the mountain, about	100

In a break in the side of Gebeel Suneen, and extending for some distance along the upper part of the lower conglomerate, is a basaltic dyke, which shoots upwards into the compact limestone. It is about 100 yards wide, and begins, as well as terminates, very abruptly. Except a small hillock near the sea of Tiberias, this is stated to be the only trap seen by Mr. Heugh or his friends throughout the whole of Syria.

The fossils from the middle bed of limestone are generally casts, but are assigned by the author to the genera *Dolium*, *Buccinum*, *Nerinæa*, *Turritella*, *Venus*, *Crassatella ?*, *Hippurites*, *Trigonia*, *Cardium*, *Lucina*, *Nucula*, and *Spatangus*.

In a soft limestone at the village of Ba-abda, and also on the banks of the Zamies, are found large drusy geodes of quartz, and sometimes of chalcedony.

Among the other fossils contained in the collection, are specimens of *Clupea brevissima* (Agassiz, Tab. LXI., f. 6–9.). They occur in great numbers a little above Tripoli, on the way to the Cedars, and about thirty miles north of Beyroot.

None of the fossils, except the fishes, having been identified with described species, Mr. Williamson does not venture to determine the precise age of the beds from which they were obtained; but he is of opinion that the fossils are more nearly allied to the organic remains of the cretaceous series than to any other. The *Dolium*, he says, bears a strong resemblance to the *D. nodosum* of the English chalk, and a species of *Venus* to the *V. angulata* of the green sand. *Nerinæa*, he states, on the authority of Mr. Daniel Sharpe, are found near Lisbon associated with *Hippurites*.

PROCEEDINGS

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April 29.—Abraham Gesner, Esq., residing in Nova Scotia; the Rev. James Cartmell, M.A., Christ Church, Cambridge; and Algernon Sydney Aspland, Esq., Lamb's Buildings, Temple, were elected Fellows of this Society.

A paper was first read, "On a few detached places along the coast of Ionia and Caria; and on the island of Rhodes;" by William John Hamilton, Esq., Sec. G.S.

The localities described in this paper are, 1. Fouges (anc. Phocæa); 2. Ritri (anc. Erythræ); 3. Sighajik (anc. Teos); 4. Scalanuova, near Ephesus; 5. Boodroom (anc. Halicarnassus); 6. Cnidus; 7. Island and shores of the Gulf of Syme; and 8. Rhodes.

1. *Fouges* is situated in a small bay at the northern extremity of the Gulf of Smyrna, and all the formations in its neighbourhood examined by Mr. Hamilton are volcanic. On the north side of the bay, a range of hills, from 300 to 400 feet high, extends several miles to the eastward, and consists in the uppermost part, of beds of smooth semivitrified red and gray trachyte, containing numerous cavities lined with mammillated chalcedony. The trachyte passes downwards into a soft, white, pumiceous sandy rock. The greater part of the hills to the north of the bay are composed of the same formation, traversed, in several places by north and east, narrow trap-dykes, which have altered the adjacent rocks into an imperfectly banded jasper. About one mile to the north-east of Fouges, Mr. Hamilton noticed a mass of black hornstone, and to the west and north-west, near the water's edge, trappean and amygdaloidal rocks, overlaid by the pumiceous sandstone.

2. *Ritri* is situated on the shores of the bay of Erythræ, opposite the island of Scio; and the geological structure of the neighbouring district consists of red crystalline, apparently stratified trachyte, and of blue or gray, more or less, crystalline limestone, with associated sandstone. The two latter rocks are of anterior date to the trachyte, but Mr. Hamilton could not determine their relative geological age, as they appear to be destitute of organic remains. The beds of limestone are sometimes vertical. On the shore near the Acropolis the author noticed also vertical strata of indurated shale and jasper, and near the juncture of the trachyte and limestone, to the north of the Acropolis, that the calcareous beds were much shattered. The two

long islands which form the anchorage, are also composed of blue semi-crystalline limestone, without traces of bedding.

3. *Sighajik.*—A rich alluvial plain, connecting the harbours of Sighajik and Teos, gradually rises to the eastward, towards the mountainous district, which extends to Smyrna. To the west the plain is separated from the sea by a range of hills composed of thickly-bedded, white, cretaceous limestone, resembling closely the limestone near Smyrna, described by Mr. Strickland*. In some places it is underlaid by beds of sandstone, and sand containing cal careous concretions. Just above the ruins of Teos, the limestone is very thinly bedded, with slightly micaceous marly way-boards, the inclination of the strata being 15° to the west; and near the ancient harbour the white limestone is underlaid by a hard, brown, micaceous sandstone, associated with beds of hard nodular limestone, evidently belonging to a much older formation. Low undulating hills of this sandstone bound the plain to the north-west. One of the two insulated remarkable hills, seen from the anchorage, also consists of it, the other being composed of vertical beds of blue marble, probably belonging to the same formation. To the north-west of the plain, this marble passes into a beautiful breccia, associated with strata of brown sandstone. Mr. Hamilton saw no igneous rocks *in situ*, but numerous blocks of greenstone are scattered about the country.

4. *Scalanuova.*—This town stands upon an insulated hill of blue semi-crystalline limestone, part of the western chain of Mount Messogis. The limestone is similar to that which occurs near Ephesus and Mount Prion, where it is associated with beds of yellow micaceous sandstone.

5. *Boodroom.*—The castle is built upon an insulated rock of similar limestone, connected with beds of argillaceous shale, of various colours. The hills to the north of the town, and on which are traceable the walls of the Acropolis of Halicarnassus, consist of the same formation, interstratified at one point with thin projecting bands of siliceous limestone. The low hills near the shore, and on which the ruins of Halicarnassus stand, are composed of horizontal beds of volcanic sand and trachytic conglomerate, formed chiefly of angular fragments of brown porphyritic trachyte. Five or six miles to the south-west of Boodroom is the conical hill of Chifoot-Kaleh, 1000 feet high. It consists entirely of reddish trachyte; and all the country between it and Boodroom is composed of trachyte or trachytic conglomerates. The hills to the west of Chifoot-Kaleh are also trachytic, with indications of columnar structure. Trachyte likewise forms part, if not all, the promontory of Karabaghla, and the islets to the westward of it. The north-east dip of the limestone of Boodroom, Mr. Hamilton thinks, may be owing to the protrusion of the igneous rocks of Karabaghla and Chifoot-Kaleh. The shore abounded in one place with pebbles of pumice.

6. *Cnidus* is situated near the extremity of Cape Krio, the western end of the south shore of the Gulf of Cos. The whole peninsula is formed of blue semi-crystalline limestone, shale and sandstone,

* Geol. Proceedings, vol. ii. p. 538; Geol. Trans., 2nd Series, vol. v. p. 393.

the strata dipping near the extremity of the promontory 45° to the south-west, but increasing to a higher angle towards the east-north-east.

The following is given by Mr. Hamilton as the general structure of the country:—

Summit of the peninsula towards the west, thin-bedded calcareous shale and blue limestone, thickly bedded and cavernous. Eastward of the ruins, it is in some places interstratified with a hard greenish sandstone, resembling graywacke. The sides of the hills are occasionally obscured, by a loose limestone breccia of more modern origin.

The hills rise rapidly towards the east and north-east, and at the distance of two miles exceed 2000 feet in height. Their summit is a narrow ridge, a quarter of a mile in length from north-west to south-east, and consists of laminated calcareous shales, dipping 45° to the south-west. These shales present a very steep escarpment towards the north-east, but are overlaid towards the south-west by the blue limestone.

7. *Island and shores of the Gulf of Syme.*—The Gulf of Syme is separated from that of Cos by a narrow isthmus. The island is an uniform mass of grayish-white compact scaglia, with occasional bands and nodules of siliceous limestone. In some places the limestone is thickly bedded, but in others thinly, with way-boards of marl; and in one locality it was observed to rest on greenish sandstone. The thinner-bedded variety is sometimes reddish, and resembles the limestone of Mount Atairo, in the island of Rhodes. The strata are occasionally horizontal, but on the brow of the high table-land above the town of Syme and in other districts they are inclined from 30° to 35° to the north and north-north-west; and beyond the harbour of Panermiotis 20° to the south and south-south-east. Mr. Hamilton found no organic remains in the island.

The southern shore of the gulf consists of the same whitish compact scaglia, with nodules of flint and jasper. Some portions of it are a breccia, composed of fragments of white limestone in a pale red paste, or of red limestone in a white paste. At the eastern extremity of the gulf, a thinly bedded limestone alternates with bands of pale red jasper, the strata dipping 50° north-west; but in some places they are curiously contorted. The jasper increases in quantity towards the north-west, the limestone becoming less prominent. Mr. Hamilton did not land on the north side of the gulf, but several points appeared to him, viewed from the sea, to consist of a brown arenaceous conglomerate.

8. *Rhodes.*—The northern half of the island, the portion visited by the author, consists chiefly of tertiary marine deposits, of secondary limestone and of scaglia, with sandstones and conglomerates. No igneous rocks were observed *in situ*, but numerous pebbles of greenstone and other traps were noticed in the conglomerates near the centre of the island.

Tertiary Strata.—These consist of a shelly testaceous limestone, sandstone, and conglomerates, and extend in a zone of variable breadth, having a quâquâversal dip, along those parts of the island visited by the author. At the north-east end, the tertiary strata rise into high and considerable hills, which stretch across the island from east to west.

The following is the order of succession :—

1. Summit of the hills three miles, south-south-west of the town of Rhodes.

	Feet.
Sandy gravel and conglomerate consisting of pebbles of scaglia	10 to 13
Fine sand, with indications of false stratifications, true dip 5° north-east	10 to 15
Gravel	8
Sand, with perpendicular veins of marl	10 to 12
Sand, with concretions of marl	
Sand, with bands of marl	

2. These beds repose on an extensive formation (considered to be from 200 to 300 feet thick) of yellow, calcareous, shelly conglomerate, the beds of which dip 10° to north-east. It contains numerous shells of the genera Pecten, Cardium and Venus, and it is the stone principally used in masonry. It extends to the town of Rhodes, and re-appears to the south of the table-land in nearly horizontal beds, some of which are very arenaceous. It is extensively developed in several places along the coast, as far as Lindo, where it rests unconformably against the secondary limestone.

3. A bed of sandy marl, containing thin bands of calcareous marl. Thickness not great.

4. A thick bed of conglomerate and gravel, extending a considerable distance to the south and south-west, and rising into lofty hills, which form steep and broken cliffs on the western coast of the island, several miles from Rhodes. It thins out gradually further south, resting at the entrance of a deep valley, upon upraised beds of blue and white scaglia and sand.

Near Archangelo, half-way between the town of Rhodes and Lindo, a similar system of tertiary rocks is extensively developed.

About one mile north of Lindo Mr. Hamilton noticed between the tertiary and secondary series a thick bed of large limestone pebbles, with sometimes quartz pebbles and boulders, cemented by a hard calcareous paste. This conglomerate rests immediately on the blue limestone, filling up its interstices ; and it is considered by Mr. Hamilton to be the lowest tertiary deposit.

Secondary Rocks.—The greater part of Rhodes consists of scaglia, generally considered to be the equivalent of the cretaceous sytem of Europe. It is composed, (1.) of red and brown sandstones with conglomerates ; (2.) of whitish gray and red scaglia limestone ; and (3.) of blue limestone; but the last deposit Mr. Hamilton considers to belong to a different epoch.

1. The sandstones and conglomerates occur near the centre of the island, and apparently form the upper division of the deposit. A red conglomerate, which is found between Apollona and Embona, dips 50° to the south-south-west, and rests conformably upon whitish-

gray scaglia. At the same locality exist indurated red marls and sandstone grits; and at the north-north-west foot of Mount Atairo is another bed of conglomerate, containing chiefly boulders of greenstone, and a greenish granular rock, but inclosing also rounded masses and pebbles of the gray scaglia of the neighbouring hills. The greenstone was not seen by Mr. Hamilton *in situ*.

2. The scaglia limestone is chiefly developed in the lofty ridge of Mount Atairo (anc. Mons Atabyrius), which is from 3500 to 4000 feet in height. The summit is a narrow ridge about two miles long, extending from north-east to south-west, or nearly in the direction of the axis of the island. The bed dips from 15° to 20° to the south-east. The upper portion consists of thick-bedded gray scaglia, without flints; lower down occurs a thinly-laminated limestone, with tabular masses or beds of flint; and still lower, the beds are again thicker and the flints are nodular. The total vertical dimensions of these deposits is from 800 to 900 feet. Beneath them, the scaglia is interstratified with a red marly limestone, and further down the hill are thick beds of scaglia without flints. Below the village of Embona, situated to the north-west of the mountain, a greenish compact sandstone crops out from beneath the limestone of Mount Atairo, and dips to the south-east. The range of hills to the north-north-east consists also chiefly of the gray limestone, which rests on the red and brown sandstones. Mr. Hamilton did not ascertain how far the formation ranges to the north-west.

The Acropolis of Camiro, on the east coast of the island, and six miles north of Lindo, stands upon an insulated table-rock of whitish compact scaglia, encircled at its base with tertiary strata.

3. The blue limestone is classed provisionally by Mr. Hamilton with the secondary rocks; but he is of opinion it may be of the same age as the limestone of Halicarnassus, and belong to a much older system. It occurs extensively along the east coast, particularly near Lindo, where it forms high and steep hills, against which remnants of horizontal strata of tertiary limestone rest at a considerable height. The Acropolis of Lindo is situated upon beds of it, having an inclination of 20° to 25° to the north-west. It occurs likewise further north, between Rhodes and Archangelo, where it forms the high ridge of hills about two miles from the shore, and the low ridge of rocky islets in the middle of the plain, and parallel to the coast.

Older Rocks.—The only locality at which these are satisfactorily shown, is half-way between Archangelo and Lindo, and close to the shore at the bottom of a deep bay. At this point the blue limestone, which in its lowest beds is hard and siliceous, and dips between 60° and 70° to the north-west, is underlaid constantly by a hard, black, schistose, crystalline rock, like the limestone of the Bosphorus.

In conclusion, Mr. Hamilton gives the following general statements: 1. The scaglia is more abundant in Rhodes and the south of Asia Minor than further north, and is apparently a prolongation of the scaglia which constitutes the mass of Mount Taurus. Nummulites have been found in it near Adalia, and Mr. Hamilton obtained near Deenair a species resembling one found in the scaglia of the Ionian Islands. 2. Igneous rocks are much more rare towards the south, and do not appear so often associated with the scaglia as with the older limestones. 3. Trachyte and other igneous products almost constantly accompany the blue semi-crystalline limestone, as at Erythræa and Boodroom. 4. In the absence of organic remains, Mr. Hamilton hesitates to state positively whether the blue limestone is an altered rock, or is an older formation which has been raised to the surface; but he is inclined to adopt the latter opinion, in consequence of the resemblance of the limestone to that near Constantinople, which is associated with schists, containing transition fossils.

A letter from Mr. Ottley, of Exeter, was then read, "On some specimens from the new red sandstone," considered by the writer to be casts of Alcyonia.

The specimens alluded to in this letter were found by Mr. Parker in a quarry about two miles from Exeter, in the road towards Bath. In the lower part of the quarry coarse sandstones and fine conglomerates occur, and in the upper a flat, flaggy sandstone. The beds dip 10° or 12° to the south-east. Interstratified with the conglomerate is a looser red sandstone, in which the branched concretions, considered to be of alcyonic origin by Mr. Ottley, principally occur; but they have been found also in the conglomerates, and the sandstone of the upper part of the quarry.

A paper was afterwards read, entitled, "Description of the remains of a Bird, Tortoise, and Lacertian Saurian, from the chalk;" by Richard Owen, Esq., F.G.S.

Bird.—The three portions of Ornitholite were obtained by Lord Enniskillen from the chalk near Maidstone, and were recognized by him and Dr. Buckland as belonging to some large bird. One of the bones is nine inches in length, and has one extremity nearly entire, though mutilated, but the other is completely broken off. The extremity, partially preserved, is expanded. The rest of the shaft of the bone has a pretty uniform size, but is irregularly three-sided, with the sides flat and the angles rounded: its circumference is two inches and a quarter. The whole bone is slightly bent. The specimen differs from the femur of any known bird, in the proportion of its length to its breadth; and from the tibia or metatarsal bone, in its triedral figure, and the flatness of the sides, none of which are longitudinally grooved. It resembles most the humerus of the Albatross in its form, proportions and size, but it differs in the more marked angles bounding the three sides. The expanded extremity likewise resembles the distal end of the humerus of the Albatross, but it is too mutilated to allow the exact amount of similarity to be determined.

On the supposition that this fragment is really a part of the humerus, Mr. Owen says, its length and comparative straightness would prove it to have belonged to a longipennate natatorial bird, equalling in size the Albatross.

The two other portions of bone have been crushed, but Mr. Owen states that they belong to the distal end of the tibia, the peculiar strongly-marked trochlear extremity of which is well preserved. Their relative size to the preceding bone, supposing that specimen to be part of a humerus, is nearly the same as in the skeleton of the Albatross. There is no bird now known north of the Equator with which the fossils can be compared.

Tortoise.—The remains of the Chelonian Reptile consist of four marginal plates of the carapace, and some small fragments of the expanded ribs. The marginal plates are united by the usual finely-indented sutures, and each is impressed along the middle of its upper surface with a line corresponding to the margin of the horny plate which originally defended it. The external edge of each plate is slightly emarginated in the middle. These plates are narrower in proportion to their length than in any of the existing marine Chelonia; and they deviate still more in the character of their internal articular margin, from the corresponding plates of terrestrial Chelonia; but they sufficiently agree with the marginal plates of the carapace of the Emydes, to render it most probable that these cretaceous remains are referable to that family of Chelonia which live in fresh water or estuaries.

Lacertian Saurian.—This fossil belongs to the collection of Sir Philip Egerton; and it consists of a chain of small vertebræ in their natural relative position, with fragments of ribs and portions of an ischium and a pubis.

The bodies of the vertebræ are united by ball and socket-joints, the socket being on the anterior and the ball on the posterior part of the vertebra; and they are further proved to belong to the Saurian class of reptiles by the presence of many long and slender ribs, as well as by the conversion of two vertebræ into a sacrum, in consequence of the length and strength of their transverse processes. The remains of the ischium and the pubis are connected with the left side of the sacrum, proving incontestably that this reptile had hinder extremities as well developed as in the generality of Saurians. Of these extremities, as well as of the anterior and of the head, there are no traces.

Mr. Owen then proceeds to determine to which division of Saurians, having ball and socket vertebral joints, the fossil should be referred. In the crocodilian or Loricate group, the transverse costigerous processes are elongated, and three, four, or five of the vertebræ which precede the sacrum are ribless, and consequently reckoned as lumbar vertebræ: in the lacertian Sauriæ there are never more than two lumbar vertebræ, and those which have ribs support them on short convex processes or tubercles.

In the fossil from the chalk, the ribs are articulated with short processes of the kind just mentioned, resembling tubercles, and they are attached to the sides of the anterior part of all the vertebræ, except the one immediately preceding the sacrum. These characters, Mr. Owen says, in conjunction with the slenderness and uniform length of the ribs, and the degree of convexity in the articular ball of the vertebræ, prove incontestably, that the fossil is part of a Saurian, appertaining to the inferior or lacertian group.

The under surface of the vertebræ is smooth, concave in the axis of the spine, and convex transversely. As there are twenty-one costal vertebræ anterior to the sacrum, including the single lumbar, the fossil, Mr. Owen observes, cannot be referred to the genera *Stellio*, *Leiolepis*, *Basiliscus*, *Agama*, *Lyriocephalus*, *Anolis*, or *Chamæleon*, but that a comparison may be instituted between it and the *Monitors*, *Iguanas*, and *Scinks*. In conclusion, he states, that in the absence of the cranium, teeth, and extremities, any further approximation of the fossil would be hazardous, and too conjectural to yield any good scientific result.

May 13.—John Ruskin, Esq., of Christ Church, Oxford; W. J. West, Esq., of Tunbridge Wells; and Frederick Dixon, Esq., of Worthing, were elected Fellows of this Society.

A memoir was commenced "On the Classification and Distribution of the Older or Palæozoic Rocks of the North of Germany and of Belgium, as compared with formations of the same age in the British Isles;" by the Rev. Prof. Sedgwick, F.G.S., and Roderick Impey Murchison, Esq., F.G.S.

May 27.—William Humble, M.D., of Worthing, was elected a Fellow.

The memoir "On the Classification and Distribution of the Older Rocks of the North of Germany," &c., by Prof. Sedgwick and Mr. Murchison, commenced at the previous meeting, was concluded.

In an introduction of considerable length, the authors enter on a historical review of the different steps by which they had been led, during the former year, to place nearly all the older slates of Devonshire, and a considerable part of the slate rocks of Cornwall, in a group intermediate between the carboniferous and Silurian systems, and therefore coeval with the old red sandstone of Herefordshire. To the vast group of slate rocks, so defined, they proposed the name of Devonian System; and their leading object in visiting Belgium, the Rhenish provinces, the Hartz, &c., was to ascertain whether in any of those countries there was a group of strata (no matter of what mineralogical character) with Devonian fossils, and in a position intermediate between the carboniferous and Silurian systems. Should such a group exist on the continent, then would the Devonian system be established, not merely on plausible arguments derived from its suite of fossils, but also on the more direct evidence of natural sections.

With these views the authors endeavoured (1.) to ascertain the natural descending order of the formations on the right bank of the Rhine, between the Westphalian coal-field and the chain of the Taunus. (2.). To ascertain the same order in Belgium, and among the ancient rocks on the left bank of the Rhine, north of the Hundsruck.

In the course of the summer they also made (with similar objects) several traverses through the Hartz, and one long traverse from the Thuringerwald to the north flank of the Fichtelgebirge, in the hope of bringing into relation with their previous observations, the country which has become so celebrated from the labours of Count Munster.

The authors follow this order in the descriptive parts of their paper. But before commencing their detailed sections, they explain at some length the method of determining the order of superposition among rocks, like those of Belgium and the Rhenish provinces, which are not only much contorted, but often in a reversed position. This order of superposition can be made out only by sections, which are of two kinds, *vertical* and *horizontal*. *Vertical sections*, where the strata are not inverted, not only indicate the natural group of strata, but their true order of superposition, both of which may often be ascertained on a single line of traverse. But *horizontal sections*, showing the intersection of successive groups of strata with the actual surface of the country (and represented by the colours of a geological map), can only be examined by following the lines of strike. The colours of such a section (if derived from strata originally conformable) must show the masses, however contorted, in their true juxtaposition. Hence we may define from the horizontal sections of a country a true consecutive geological series; and if the relative age of any two contiguous terms be known, the relative age of all the other members of the section may be inferred with certainty, though the formations be in an inverted position, as seen on the line of any one vertical section. It was by this laborious method of "horizontal sections," or, to use his language, by determining the symmetry of position of the several formations, that Professor Dumont first disentangled the perplexing phænomena of the Belgian provinces. The authors, after acknowledging the great value of this principle, state that they endeavoured never to lose sight of it in estimating the value and interpreting the meaning of the many vertical sections they examined in their long traverses through the provinces they describe.

§ 1. *Coal-fields of Westphalia, &c.*—The authors commence their descending sections, on the right bank of the Rhine, with the productive coal-field, which occupies an irregular triangular area, bounded towards the north by greensand and cretaceous deposits, towards the south-east by older formations, afterwards to be described, and towards the south-west by an irregular line, skirting the low country near the Rhine, and passing near Mulheim, Ketwick, Werder, and thence to a point a few miles north-east of Elberfeldt. In its lithological character and fossil contents it is not to be distinguished from the coal-fields of England. It is affected by many anticlinal and synclinal lines, which have brought a lower and unproductive portion to the surface, and thrown the productive portions into a number of irregular troughs, ranging in the direction of the strike, east-north-east.

The lower and unproductive coal-field is composed in part of coarse grits, well exposed on the banks of the Ruhr, between Herdecke and Schwerte, and of yellowish and light-coloured sandstones and grits, with thin seams of coal and impressions of plants; and the strata are underlaid by dark gray micaceous slates and thin-bedded hard sandstones, of great thickness, marked by many obscure impressions of small plants. The lowest member of this series contains much dark pyritous shale (*Alaun Schiefer* of the Germans), and reposes on the upper calcareous zone of Westphalia (mountain limestone). Several sections are described which confirm this order of superposition. The authors then state that this lower division of the coal-field is greatly expanded towards the north-east; that it is lithologically almost identical with the great *culm-field* of Devon, and resemble it also in its numerous impressions of small plants. It is the *Flötzlehrer Sandstein* of the German geologists, and had been regarded by them as the highest member of the graywacke series; but in the recently published map of Von Dechen, it is placed on the parallel of the millstone grit of England.

§ 2. *Carboniferous limestone of Westphalia (Berg-Kalk), Kiesel Schiefer, and bituminous limestone, &c.*—The authors next describe the limestone which commences at Cromford, near Ratingen, and ranges east-north-east to Velbert. Thence deflecting to the valley of Regrath, north of Tonnesheide, it is cut off, and does not form a continuous band (as represented in all the German maps), with a lower limestone, which commences a few miles further south, and ranges through Metman to Elberfeldt. Near Cromford the limestone is thick-bedded, and in its structure and fossils resembles the great scar-limestone of England. For proofs the authors give several detailed sections, and quote published lists of fossils. In its range to the east it becomes more cherty, and abounds in casts of the stems of Encrinites, so as to resemble the screw-stones of Derbyshire. At several places (*e. g.* Isenbugel, Velbert, &c.) the connexion of the limestone with the upper series is well exposed. The upper beds of limestone pass into dark flat-bedded flinty slate, which is overlaid by psammite and shale, with thin courses of flinty slate, and these dip under the lower members of the coal-field. Again, there is at Velbert a clear proof that the limestones, screw-stones, and flinty slate, dip under the alum-slates of the neighbourhood.

Following the strike of the county still further to the east, the limestone range loses its mineral character; but a large group of strata (dipping under the alum-slates above-mentioned, and resting on dark shales, like those which form the base of the limestone) occupy the exact place of the carboniferous limestone in the transverse sections. The group is characterized by dark flinty slate (*Kiesel Schiefer*) and dark and often fetid thin-bedded limestone, and so closely resembles the culm-limestone series of Devonshire, that the description of one formation might almost serve for the other. Like the culm-limestone, it also contains many Goniatites and Possidoniæ; and among the latter, the *Possidonia Becheri* of Devon. It wants, however, the numerous species of mountain limestone fossils of the beds above-noticed, a fact which the authors explain by a reference to a change in all the physical conditions of the deposit. This group, following all the sinuosities of a most contorted country, and sometimes doubled back upon itself for many miles together, may be traced by its *Kiesel Schiefer* and Possidonia schists, and sometimes by its black fetid limestones, to the eastern limit of the chain of older rocks near Bleiwasche and Stadtberge.

§ 3. *Devonian System.*—The authors next describe the rocks immediately inferior to the carboniferous groups. The mountain limestone of Cromfort, above-described, rests on dark-coloured shale, but the descending section is much obscured by overlying deposit. In the long range of the same series, from Elberfeldt to Menden, there are many clear transverse sections, exhibiting in greater or less perfection the following *descending order.*—(1.) Immediately under the lower limestone shales are many reddish bands, with calcareous concretions, in which the Possidonia and some of the species of the superior groups are still found. (2ndly.) These are succeeded by a well-marked range of psammites and coarse flagstone. (3rdly.) From beneath the psammites rise a series of shales, and bands of psammite of dark colour, with here and there thin courses of inferior limestone, in which we find flattened Goniatites, and shells of a species different from those of the overlying formations, among which especially is noticed the *Terebratula aspera* of Schlotheim. These are, therefore, considered as forming a part of an inferior system, and the first and second groups of the section may be regarded as made up of beds of passage between the carboniferous system and that which is below it. The sequence here given is compared with the highest beds of the Devonian series, immediately under the culm measures, and with the yellow sandstones of Ireland described by Mr. Griffith.

3 *a*. *Lower Limestone of Westphalia, &c.*—This limestone rises immediately from below the third group of the preceding section. Its range (from the neighbourhood of Ratingen, in the valley of the Rhine, to the confines of Hessia) is described in detail. Its changes of mineral structure—its separation here and there into two zones—its contraction in one place and its great expansion in another—its enormous flexures and occasional inversions of position—its re-appearance at Warstein and Attendorn, in consequence of such flexures,—all these phænomena are noticed in their turn. As a whole, it has so great a resemblance to the limestone of South Devon, that through large tracts of Westphalia the two could not, by a series of land specimens, be distinguished from one another. The fossils of this limestone are very abundant, and several sections are given in detail, to show their local distribution. Among the most characteristic and abundant in these sections the following are enumerated: *Stromatopora polymorpha, S. concentrica, Favosites ramosa, Favosites polymorpha, F. spongites, F. Gothlandica, Strygocephalus Burtim, Gypidium, Terebratula aspera, Turritella coronata, T. bilineata* (Schlotheim), *Buccinum spinosum* (Sowerby), &c. &c. From all these facts, it is inferred, that this lower limestone of Westphalia is a true Devonian limestone, exactly or very nearly on a parallel with the great limestone of South Devon.

Local and detailed lists are added, and detailed sections are given, connecting the whole series both with the upper and lower formations, especially one from the Possidonia schists and black limestones, near Schelke, through the Devonian limestone, and to the lower formations exposed on the banks of the Lenne, towards Altena. In this section there is no ambiguity, and the defective evidence in the sections of Devonshire, when we endeavour to connect the culm-measures with the South Devon limestone, is here amply supplied.

The authors then describe in detail the sections at Paffrath, near Bensberg, on the right bank of the Rhine, near Cologne, where the same Devonian limestone occurs, with a magnificent series of fossils; its position is, however, reversed, as it seems to dip under the limestone near Bensberg, which is referred to the upper part of the Silurian system.

To the same geological epoch the authors also refer the complicated metalliferous deposit of Dillenburgh, and the limestones of the Lahn in the country of Nassau. At the former place the great contortions and the extraordinary intrusions of trappean rocks make the relations difficult; but, considered on a great scale, the vast fossiliferous and calcareous group reposes on rocks considered of the Silurian age: it contains a true Devonian group of fossils, and its upper portion at Herbon is surmounted by a Possidonia schist, perfectly identical with that of Westphalia. The limestones of the Lahn at Dietz, Weolburg, Wetzlar, &c., are still more unequivocally Devonian; and though the alternating masses of limestone and schist are of enormous thickness (rivalling in that respect the whole series of limestones and slates in South Devon), and the sections often obscure, yet in descending the Lahn from Dietz to Nassau and Bad Ems, they had a proof that the calcareous system is underlaid by Silurian rocks. The appearance of these Devonian deposits near the eastern limit of the old rocks, on the right bank of the Rhine, is accounted for by enormous undulations, which have repeated over again, in three or four great parallel troughs, the formations which appear in their true place in Westphalia, on the northern limit of the same ancient formations.

§ 4. *Silurian System.*—The authors next describe the great series of rocks which rise from beneath the lower Westphalia limestone, and state that in the long range from Elberfeldt to Iserlohn the descending order is unequivocal. The passage downwards is sometimes effected by flagstones, with bands of shale, containing thin calcareous courses. In other places, the shales are more abundant, occasionally becoming much indurated; and in the range towards the north-east (for example, near Meschede) this group becomes greatly expanded, and contains many quarries of roofing-slate, with a true oblique cleavage. This part of the series is compared with the shales under the Eifel limestone, and with the Wissenbach slates, which underlie the Devonian limestone series of Dillenburg. The great difference in the development of this group produces a great difference in the fossils, but on the whole, they are regarded as forming a passage between the Devonian and Silurian types. A list of fossils is subjoined, and the authors regard the numerous Goniatites as rather connecting the group with the overlying Devonian rocks; while the trilobites and orthoceratites, &c., some of which cannot perhaps be distinguished from known Silurian fossils, seem to link it to the Silurian system.

Below the preceding comes a group of vast thickness, composed of earthy schistose beds, passing on one hand into shale, on the other into coarse slate, and alternating indefinitely with bands of psammite, sometimes passing into coarse arenaceous flagstone, sometimes into thick beds of sandstone. Nearly throughout are occasional obscure vegetable impressions, and in the upper part are courses of limestone and calcareous bands, with innumerable impressions of fossils. In the lower part, the limestone bands seem gradually to disappear, and the whole passes into a formation of graywacke and graywacke slate, in some rare instances producing a good roofing-slate. For many miles south of the undisturbed range of the lower Westphalia limestone, the prevailing dip is about north-north-west. The country round Siegen is regarded as a kind of dome of elevation, composed of the lower part of this series; for still further south the dip is reversed to the south-south-east; and in a traverse from Siegen to the Taunus, across the strike (a distance of about fifty miles), the same dip is continued, with very few interruptions. Considering their high inclination, this fact seems to give an almost incredible thickness to the deposits in question. But the vertical sections do not give the order of superposition; for at Dillenburg, and on the Lahn, two great Devonian troughs are brought in among the older strata, without any general change of dip; and if we accepted the vertical sections as the sole proofs of superposition, we must place the Devonian and a part of the carboniferous series under the chain of the Taunus. The authors therefore endeavoured to apply the method of Professor Dumont, and found their results confirmed by the sections of the lower Lahn.

Many other local details are given, and the authors having determined the geometrical position of the great mineral masses, next attempt to define their age from their fossils. In the arenaceous and calcareous group under the lower Westphalia limestone, many species of the genus Pterinea (Goldfuss), Homalonotus, Orthis, &c. &c., begin to prevail. Along with these are forms at present unknown in England, *e. g.* Hysterolites of Schlotheim, and two species of Delthyris,—*D. macroptera* and *D. microptera* (Goldfuss). The same groups of fossils are found on the banks of the Rhine; and in a quarry near Unkel are many fossils of the genus Orthis, among which were *O. pecten*, *O. flabellula*, *O. rugosa*. Along with them was *Terebratula Stricklandii*, and the group was considered characteristic of the lower Silurian rocks of England.

On a review of the whole evidence, the authors place this vast succession of strata in the Silurian system, without professing to separate the several parts into distinct groups, on a parallel with the several groups of the Silurian system of England. This is forbidden by the absence of distinct calcareous bands, and also by the great vertical range of some of the fossil species, which are found almost from the highest beds to the lowest of the whole series. Several lists of fossils are then given, in confirmation of these general views; and it is thence concluded, that the great sequence of coarse earthy schists, calcareous bands, arenaceous flagstones, psammites, &c., are the representatives of the upper Silurian system, and that the lowest quartzose, graywacke, flagstone, roofing-slate, &c., which in some places have no fossils, and in others have numerous repetitions of a few species of the genus Orthis, belong to the lower Silurian, or upper part of the Cambrian Systems.

Part II. *Older formations on the left bank of the Rhine.—The Hartz.—Upper Franconia, &c.*

§ 1. The authors commence with a short description of the physical region extending from the coal-field of Belgium to the south-eastern flank of the Ardennes, and then in like manner describe the country between the same coal-field and the limestone of the Eifel. They afterwards discuss, at some length, the methods used by Professor Dumont to determine the superposition of the natural groups; and partly from considerations derived from the symmetrical arrangement of the mineral masses, and partly from the direct evidence of sections, especially in the Eifel country, show that the geological sequence has been correctly determined. So far adopting the views of Professor Dumont, the descending order in the provinces above-mentioned is as follows:—

(1.) Coal country.......... *Terrain Houillier.*
(2.) Anthraxiferous country. *Terrain Anthraxifera.*
(3.) Slate country......... *Terrain Ardoisier.*

The second of these divisions is subdivided into four natural groups or systems, viz. Upper calcareous system; Upper quartzo-schistose system; Lower calcareous system; Lower quartzose-schistose system.

The slate country is also divided into three groups,—Upper, Middle, and Lower.

The order being assumed as fixed, the next question is as to the British equivalents of the successive divisions or subordinate systems.

Respecting the Belgian coal-field, there is no doubt: it is on the same horizon with the great coal-fields of England. Through a considerable part of its south-eastern boundary it is inverted, so as to dip under the older formations; but on a part of its northern boundary the older formations emerge in their regular order.

The upper limestone of the second division is undoubted mountain limestone. The only question, then, is respecting the equivalents of the three lower divisions of the *Terrain Anthraxifera*, which are, by Professor Dumont, respectively classed with the Ludlow rock, Wenlock limestone, and Caradoc sandstone formations. This classification is not accepted by the authors, for reasons stated in detail.

The *upper quartzo-schistose system* is separable at two parts very different from one another: the higher, often characterized by an open-grained yellowish psammite; the lower (with many variations of structure, and with occasional subordinate calcareous bands) abounding in a dull greenish-gray earthy schist, not unlike the "mudstone" of the Ludlow rocks. But the higher grits and psammites pass insensibly into the bottom beds of the upper limestone (mountain limestone), and contain a series of fossils so near the carboniferous type, that it is difficult to draw a line between the two deposits; and the lower earthy schists do not contain (among the specimens brought away by the authors) one single species found in the Ludlow rock.

The *lower limestone* of the second division is then described in detail, both as seen in Belgium and the Eifel. The authors dwell some time on the remarkable association of the Eifel dolomites with volcanic rocks of different ages: but they contend that the dislocation and contortions of the older strata, and their changes of mineral structure, are not generally due to the more recent igneous eruptions. A comparison of the lists of fossils from the Eifel and lower Belgian limestone, show that they belong to a group identical with that of the lower limestone of Westphalia and the limestone of Paffrath, and that they present the closest analogies with the fossils derived from the limestones of South Devon; some of the most abundant species, both of shells and corals, being identical in all the localities. Hence the authors conclude, that the second and third members of the *Terrrain anthraxifera* of Professor Dumont form a part of the Devonian system, and not a part of the Silurian system.

Lower quartzo-schistose system.—In Belgium it is harder and more quartzose than the upper division, and also of more varied mineral structure; and in its upper portion contains some thick beds of conglomerate, which, from their mineral structure and the supposed analogies of the lower limestone with the mountain limestone of England, have been classed with the old red sandstone. Without attributing any value whatever to these conglomerates, as terms of comparison with English formations, and regarding them only as mineral accidents, the authors place them near the base of the Devonian system, and consequently near the lower limit of the old red sandstone.

In the Eifel, the system is better developed and more fossiliferous, and exhibits the following descending order: (1.) Calcareous shales, forming the base of and passing into, the limestone; (2.) Indurated shales, alternating with sandstone and flagstone, occasionally of a reddish colour; (3.) Sandstone, flagstone, arenaceous slate, quartzite, &c., gradually passing into a slate formation. The authors refer to various lists of fossils, and conclude that, though several species are in common with those of the overlying Devonian system, yet that as a group they are distinct: 1st. Because the carboniferous species disappear; 2ndly. Because some of the most characteristic species of the lower limestone (such as the *Strygocephalus Burtini*, &c.) are wanting; 3rdly. Because new (and Silurian) types begin to abound; more especially shales of the genus *Pterinea*, several species of *Orthis*, the *Homalonotus Knightii*, *Calymene Blumenbachii*, &c. They further remark, that the species of Silurian fossils which appear in the Eifel lists are mostly derived from the lower shales, which are regarded as beds of passage. Along with known Silurian fossils there occur also (as remarked in deposits under the Westphalian limestone, Part I.) many other fossils, *Delthyris microptera* and *D. macroptera*, &c., in great abundance. The lower quartzo-schistose rocks of Professor Dumont are therefore placed in the Silurian system, but without any attempt to subdivide it into distinct portions analogous to those of England. And as there is no well-defined separation between this system and the overlying Devonian, still less is there any well-defined separation between its lower limits and the central slate rocks of the Ardennes.

The slate country of the Ardennes is subdivided into three groups of slate rocks,—Upper, Middle, and Lower. All the fossils obtained by the authors from the upper group are of Silurian types. From the middle and lower groups they obtained no fossils: but as all the groups are linked together, and the upper is placed by its fossils in the lower part of the Silurian system, they assign the two lower groups to the upper Cambrian system. They then enter on some mineralogical details connected with the structure of the slates of the Ardennes; and among the crystalline beds of the lowest group (which they regard as only an altered portion of that which is next superior), point out some examples of slates derived from a cleavage transverse to the beds, and intersected by a true second cleavage plane, a rare phænomenon among the slates of England; but noticed by the authors among some rocks on the south coast of Devon and the north coast of Cornwall.

§ 2. *Formations between the Eifel and the Hundsruck.—Left bank of the Rhine, &c.*—Crossing the strike of the beds from the Eifel to the Moselle, by several distinct traverses, the authors met with the same series of deposits in descending order: viz. 1st. Calcareous shales; 2nd. Arenaceous flagstones and shale; the upper part frequently exhibiting a reddish tinge, and with portions more or less calcareous, and the lower part passing into a great formation of arenaceous flagstone, indurated slate and coarse slate, and occasionally of fine quartzite. The series is here and there highly fossiliferous, containing several species of Pterinæa, Delthyris, Orthis, &c., occasionally presenting obscure impressions of plants, and casts of a large Homalonotus, of a Silurian species. The sequence, determined more by the symmetrical position of the great mineral masses than by direct superposition, as seen in vertical sections, gradually passes into rocks of a more decidedly slaty structure, and almost without fossils. Passing to the right bank of the Moselle, and in the same way making traverses through the chain of the Hundsruck (which is elevated on the line of strike, *i. e.* east-north-east), they again had an ascending series, and thence concluded that the whole chain was only a portion of the great system under the Eifel limestone in an altered form. The Silurian fossils discovered among the crystalline quartzites and schists of the chain (*e. g.* one or two species of Orthis, a large winged Delthyris, &c.), confirmed this view. Hence also the chain of the Taunus, which is the physical prolongation of the Hundsruck, must be referred to a similar place in the general series; a conclusion at which the authors also arrived from an examination of the sections on the right bank of the Rhine, though obscured by the enormous development of masses of contemporaneous trap (*Schaalstein*).

The authors then give some details respecting the trappean and volcanic rocks on both banks of the Rhine, and conclude, that the quartzite and chlorite slates, &c. of the Hundsruck and Taunus are but altered forms of a great Silurian group under the Eifel limestone; and that the causes which at an ancient epoch dislocated, contorted, and mineralized the strata, have perhaps not yet entirely ceased, and that the hot springs of Wisbaden and bubbling fountains of Nassau, may be referred to their last expiring efforts.

On a review of all the facts stated in this and the preceding Part of their communication, the authors conclude, (1.) That from the carboniferous deposits of Westphalia and Belgium, to the lowest fossiliferous deposits of the Rhenish provinces, there is a great and uninterrupted series of formations, which are in general accordance with the British series, though the subordinate groups do not admit of direct comparison; (2.) That, considered in a broad point of view, the natural successive groups of strata and the natural successive groups of fossils, are in general accordance; but as the boundaries of the physical groups are ill defined, so also the boundaries of the fossil groups are ill defined, and pass into or overlap one another; (3.) That as there are no great mineralogical interruptions, producing a discontinuity and a want of conformity among the deposits, so also there seems to be no want of continuity among the groups of the great palæozoic series of animal forms. If the extreme terms be compared together, all the objects are dissimilar; but if the proximate fossil groups be put side by side, there are many points of resemblance, and many of specific agreement; (4.) That the Devonian system is, therefore, a natural system, not merely made out, as in England, by a plausible interpretation of fossil evidence, but defined, in the Rhenish provinces, both by its group of fossils and its place in a true descending section. And as the old red sandstone of Herefordshire passes on the one hand into the carboniferous limestone, and on the other into the upper Silurian rocks, without interruption, it follows, that the Devonian system, as above defined, is contemporaneous with, and the representative of, this old red sandstone.

§ 3. *Chain of the Hartz.—Fichtelgebirge, &c.*—The general strike of this chain is nearly the same as in the provinces before described (*i. e.* east-north-east), and therefore almost at right angles to the prevailing direction of the chain, as laid down on a geological map. The mineral structure and the fossils are also nearly the same, and the numerous contortions throw the same difficulties in the way of determining the true order of superposition; and these difficulties are greatly increased by protruding masses of granite, which have not only altered the structure of all the neighbouring rocks, but literally broken the chain into fragments, several of which are thrown into a reversed position.

The igneous rocks of the region are stated to be of four kinds: (1.) Trappean rocks in beds and protruding masses, nearly on the line of strike; (2.) Granite, sending veins into the older slates and trappean rocks; (3.) Quartziferous porphyry in masses and dykes, identical in structure, and apparently in relation with the Elvans of Cornwall; (4.) Trappean rocks (*melaphyre*, &c.), associated with the *rothe todte liegende* and coal-measures on the south-eastern skirts of the chain.

Silurian fossils are found in several parts of the Hartz, but the authors saw no rocks which they could compare with the central slates of the Ardennes, or the oldest slates of the Rhine; but they give two sections which ascend into a higher system. The first is from Huligenstein to the neighbourhood of Clausthal, and appears to give the following ascending order:

(1.) Devonian limestone, well characterized by its fossils.

(2.) A series of psammites and shales, with one or two species of Possidonia.

(3.) A series of coarse sandstones and grits, surmounted by shales and psammites highly charged with plants, and mineralogically resembling the Devon culm-beds.

Plants are, however, found below the Devonian limestone, and even thin bands of culm; and the section is obscure: but if the interpretation given to it be correct, a part of the country near Clausthal rises into the carboniferous series.

Their next section commences with the limestone of Ebingerode (on the south side of the Brocken mountain). The limestone abounds with Devonian corals and other fossils, and some parts of it cannot be distinguished from the lower limestone of Westphalia. Other parts of it are pierced with trappean rocks and are overlaid by ferriferous deposits; in which respects, as well as in its fossils, it is strictly analogous to the Devonian limestones of Dillenburg and the Lahn. Again, the ferriferous bands are overlaid by black shale, containing *Kiesel schiefer*, and (if we are not misinformed) containing Possidonia schist. The analogy presented with the uppermost part of the Devonian series in Westphalia seems, therefore, perfect. From these facts the authors conclude, that the older rocks of the Hartz are chiefly Silurian and Devonian, with a few traces of the lower carboniferous.

If the great contortions and strike of the Rhenish provinces were produced contemporaneously with those of the Hartz, then must the great derangements of the Hartz have taken place *after* the deposit of the Belgian and Westphalian coal-fields. But the principal dislocations of the Hartz must have taken place *before* the deposit of the red conglomerates, sandstones, coal-beds and trappean masses, which rest on its eastern flank. Hence the authors conclude, that none of these red conglomerates are of the date of the old red sandstone; and that the coal-beds belong to the highest part of the carboniferous series, where it passes into the base of the new red sandstone.

Lastly, The authors describe a hasty traverse, made from the Thuringerwald through the forest of Upper Franconia, and thence to the north flank of the Fichtelgebirge. On the northern limits of the section (the strike and many accidents of position remaining as before) were rocks with a true slaty cleavage, which might (at least mineralogically) be compared with the upper slates of the Ardennes; and further south, the analogy was confirmed by bands of limestone, with stems of Encrinites, but with very few other fossils. Still further south occur a few impressions of plants, and the whole system appears to be at length overlaid by a series of limestones and schists, some of which are very rich in fossils. One of these zones of limestone (the lowest according to Count Munster) rests on calcareous slates, containing a *cardiola* of the upper Ludlow rock. It is in this zone that the Clymenia is most abundant. Goniatites, Orthoceratites, &c., are abundant in a higher zone; and the series is overlaid by a limestone with many species of true carboniferous productæ, &c., and identified with the mountain limestone. From these facts the authors conclude, that the fossiliferous region near Hoff (south of the Fichtelgebirge) belongs to the Devonian system, with the exception of the highest beds, which are carboniferous.

Such are the results arrived at by the authors, which seem to be in general accordance with one another, and to bear out the classification they proposed for the older British formations.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

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June 10.—Charles Lashmar, M.D., of Croydon, Surrey; William Henry Tancred, Esq., M.P., and Lord Stavordale, Old Burlington-street, were elected Fellows of this Society.

Eleven communications were read.

1. A notice of a mass of trap in the mountain limestone on the western extremity of Bleadon Hill, Somersetshire, and on the line of the Bristol and Exeter Railway, by the Rev. D. Williams, F.G.S.

This is the first discovery of trap *in situ* in the Mendip Hills or in Somersetshire, with the exception of the Hestercombe granite, described by Mr. Horner*, and a slate porphyry, observed by Mr. Williams, a little north of Simmon's birth, in Exmoor. The rock varies in character from a granular to a porphyritic and amygdaloidal greenstone. It occurs near a line of fault, which has brought the lias on a level with the carboniferous limestone; and when first exposed on the eastern side of the railway cutting, it appeared to be conformably interstratified with the limestone; but the cutting of the western side (the line of railway ranging north and south) has subsequently proved that the trap is clearly intrusive, intersecting at a considerable angle the limestone beds. On the east side the trap is in contact with the lias, but no change appears to have been produced in that formation, though the mountain limestone is stated to be considerably altered. The trap at the lower part presents a broad bed-like mass, but it rapidly diminishes in its upward course through the limestone thinning away entirely. Mr. Williams states, that the limestone appears to have yielded along the line of one of the north-west joints. He acknowledges his obligation to Mr. Peniston, the resident engineer, for a correct section of the cutting.

2. A memoir descriptive of a "Series of Coloured Sections of the Cuttings on the Birmingham and Gloucester Railway," by Hugh Edwin Strickland, Esq., F.G.S.

The author commences by expressing his regret at the irrecoverable loss, which science has experienced, in full advantage not having been taken of the valuable geological information, which has been exposed by the railway cuttings in different parts of England during the last ten years; and he suggests the propriety of each

* Geol. Trans., 1st Series, vol. 3. p. 348.

ine of railway being systematically surveyed by a competent observer, while the cuttings are in progress.

Anxious to contribute towards so desirable an end, Mr. Strickland gladly yielded to a request made to him by Captain Moorsom, the chief engineer of the Birmingham and Gloucester Railway, to undertake a geological survey of the line; and he expresses his obligations to that gentleman and to Captain J. Vetch for the valuable assistance they afforded him. The line was originally surveyed by Mr. Burr, when only the trial shafts had been sunk, and before the cuttings were commenced; but Mr. Strickland bears testimony to the accuracy of the account which Mr. Burr laid before this Society.—(Geol. Proceedings, vol. ii. p. 593.)

The direction of the railway ranges nearly parallel to the strike of the strata, and therefore intersects only the new red sandstone and red marl, the lias, and superficial detritus.

New red sandstone and red marl.—The lowest rock exposed belongs to the new red or bunter sandstone, resting on the anticlinal axis of the Lickey, ten miles south-south-west of Birmingham, and one mile south of the termination of the altered rock, or Lickey Quartz*. The sandstone is there thick-bedded, soft, and red, and dips on the western flank about 5° west-south-west, and on the eastern 5° east-south-east. In Grovely Hill, on the north-east of the Lickey, it passes occasionally into a hard quartzose conglomerate with a calcareous paste †; and at Finstal, on the south-west of the Lickey ridge, the upper portion of the sandstone is light-coloured, and contains obscure vegetable impressions, being a prolongation of the stratum, with similar impressions, at Breakback Hill, on the west of Bromsgrove ‡.

On each side of the Lickey, the sandstone is conformably overlaid by red marl, which extends on the north-east to Birmingham§, and on the south-west to Stoke Prior and the neighbourhood of Hadnor, where the railway intersects a ridge of lias. On the north side the marl is there cut off by a fault, but on the south, at Dunhamstead, the following juncture section is exposed:—

(*a.*)	Lias clay with contorted beds of lias limestone.	
(*b.*)	White micaceous sandstone, with numerous specimens of a smooth oval bivalve	2 Feet.
(*c.*)	Lias clay	6
(*d.*)	Grey marl	35
(*e.*)	Red marl	

Dip of the beds 5° north-north-east.

* See Mr. Murchison's Silurian System, p. 492.

† Similar conglomerates occur in Worcestershire, Staffordshire, and Warwickshire.—Silur. Syst., p. 42. Geol. Trans., 2nd Series, vol. v. 347.

‡ Geol. Trans., 2nd Series, vol. v. p. 341; Proceedings, vol. ii. p. 564.

§ The red marl extends from Birmingham along the London railway as far as Berkswell, forming the basin, in which occurs the lias outlier of Knowle south-west of Berkswell. The true boundary of the sandstone and marl in this district has been only recently ascertained; it ranges from Hewell Grange, nearly north, by Cofton Hacket to Northfield, and thence north-east to the south suburbs of Birmingham.

In the hill south of Dunhamstead, the grey marl (*d*) abuts against the red marl (*e*) in consequence of a fault. For the next five miles the railway traverses a valley of red marl, between the escarpment of the lias and a ridge of Keuper sandstone. On the south-east of Spetchley the strike of that sandstone is altered by a fault from south by east to south-west, and a projecting angle has been produced which is intersected by the railway. This stratum is a feeble representative of the Keuper sandstone of Burg Hill, &c.*, consisting chiefly of greenish marl with thin laminæ of white sandstone, about twenty feet thick, with red marl above and below. At Norton the railway ascends the lias escarpment, and cuts through a section exactly analogous to the one given above. A mile further south the lias clay contains many calcareous concretions abounding with fossils, including *Plagiostoma giganteum, Modiola minima,* and a coral. At Abbot's Wood the fissile sandstone at the base of the lias is again exposed, having been brought up by a fault. At Defford and Eckington the lias clay encloses numerous specimens of *Pachyodon Listeri* (Stuchbury), or *Unio Listeri,* of Sowerby, and *Ammonites Turneri.* At Bredon a higher portion of the lias series was reached, and a different suite of fossils found, the most marked being *Pleurotomaria Anglica, Hippopodium ponderosum, Gryphæa incurva, Nautilus striatus,* and several species of Ammonites. Between Cheltenham and Gloucester the lias has yielded great abundance of organic remains, a considerable number of which are considered to be new, and with the exception of *Hippopodium ponderosum, Gryphæa incurva,* and one or two others, they are distinct from the fossils of Bredon Hill; and at Hewlitt's, east of Cheltenham, the lias near the base of the marlstone presents another series of distinct fossils. The lower lias, therefore, Mr. Strickland observes, affords evidences of at least four well-marked successions of molluscous faunæ, in a vertical height of 400 or 500 feet, and unaccompanied by any change in the mineral character of the deposits.

Superficial detritus.—The author then proceeds to describe the deposits of superficial detritus, and he states, that they entirely confirm the views which he had previously entertained, respecting the distinction between the ancient terrestrial alluvia in which bones of mammalia occur, and the submarine drift which covers most parts of the island†.

He divides the detritus into fluviatile and marine, and the latter, according to its origin, into local and erratic, and this, according to its composition, into gravel with flints and without flints.

Marine erratic gravel without flints‡.—Commencing his details with the Birmingham end of the line, Mr. Strickland shows, that these accumulations occur extensively on all sides of that town, and at intervals along the line of the railway till it approaches the valley of

* Proceedings, vol. ii. p. 503. Geol. Trans., 2nd Series, vol. v. p. 332.

† See Reports of the British Association, vol. vi., Sessional Meetings, p. 61.

‡ Northern drift of Mr. Murchison, Silur. Syst., p. 523.

the Avon. Mammalian remains appear to be totally wanting. Chalk flints are so extremely rare in it around Birmingham as to prove that the materials were transported from the north. At Mosely it is upwards of 80 feet thick, and consists of rolled pebbles, rarely exceeding 4 inches in diameter, of various granitic and quartzose rocks and altered sandstones, imbedded in a clean ferruginous sand; and a bed of sand 30 feet thick, without pebbles, occurs in the middle of the gravel. Between Cotteridge and Wytchall is an erratic boulder, or shapeless mass of porphyritic trap, about 5 feet by 4, with the angles slightly rounded. At the Lickey, gravel analogous to that near Birmingham, but with a large proportion of slate rocks, attains, on the line of the railway, a height of 387 feet, and at the Lickey Beacon of more than 900 feet. Sugar's Brook is the next locality noticed by Mr. Strickland, but from that point no gravel occurs for sixteen miles. Near Abbot's Wood is another extensive deposit of quartzose gravel and ferruginous sand, devoid of flints and resting upon lias.

Marine erratic gravel with flints.—These accumulations commence immediately south of the Avon. The village of Bredon stands on a platform, seventy feet above the ordinary level of the Avon, composed of lias with an uneven surface, and capped with 10 to 15 feet of this gravel. It contains no mammalian remains.

Fluviatile gravel.—The only example of this drift, on the line of the railway, occupies the two opposite flanks of the Avon at Defford and Eckington, north of Bredon. At these localities the surface is a tabular platform which does not exceed forty-five feet above the Avon, including a capping of ten feet of gravel precisely similar to the flinty gravel of Bredon, but containing abundance of mammalian remains. They were chiefly found in the cutting north of Eckington, at the lower part of the deposit, and often on the surface of the lias clay; and are referrible to *Elephas primigenius, Hippopotamus major, Bos Urus,* and *Cervus giganteus*? On the north, or Defford side of the Avon, the remains of *Elephas primigenius* and *Rhinoceros trichorhinus* have been obtained. Associated with these bones are numerous freshwater shells, agreeing with those found at Cropthorne *; the most abundant species being *Cyclas amnica* and *C. cornea*. In endeavouring to account for the presence of these remains at only one point in the line of the railway, Mr. Strickland states that he can offer no other explanation than that previously proposed by him †, namely, that after the beds of marine gravel had been deposited and laid dry by the elevation of the land, a large river or chain of lakes extended down the valley of the Avon, at a height varying from twenty to fifty feet above its present course; and that the gravel previously accumulated by marine currents, was remodified by the river, and mixed up with remains of mammalia which tenanted its banks, or of mollusca which inhabited its waters.

Local gravel—This species of detritus occurs abundantly at Chel-

* Silur. Syst., p. 555; and Proceedings, vol. ii. pp. 6 and 95.

† Reports of British Association, vol. vi. Sections, p. 64.

tenham, and consists exclusively of detritus from the oolites and lias of the vicinity. No bones or terrestrial remains have been found in it; and, therefore, the author assigns to it, in the absence of other evidence, a marine origin.

Modern alluvia.—The only deposits of this nature mentioned in the paper, are the peaty accumulations on the banks of the Avon and its tributaries.

The memoir was accompanied by a copy of the Railway Section, and of the Tewkesbury branch, and the junction branch from the main line to the London and Birmingham Railway, presented by Capt. Moorsom, but coloured geologically by Mr. Strickland.

3. A letter addressed to Mr. Murchison by Capt. Lloyd, dated London, May 11th, 1840.

Having read in the instructions prepared by the Royal Society for the Antarctic Expedition under Capt. James Ross, that the island of Bourbon presents indications of the sea having formerly occupied a higher level than at present, and having observed similar appearances in the Mauritius, Capt. Lloyd was induced to lay the following facts before the Society.

The island of Mauritius is belted by an enormous coral reef throughout its whole circumference, except for about ten miles of the broadest and extreme southern side, or from Point Souffleur to Souillac, commonly called Port Savanne. Along that part of the island the coast is bold, and consists of a basaltic rock.

Near the Rivière des Galets, between Savanne and the Baie du Cap, the sea foams against a barrier of coral from five to fifteen feet in height, and wears it into the most fantastic shapes. At a considerable distance inland, and almost concealed by trees and shrubs, are two remarkable points or headlands of coral, from twenty to twenty-five feet above the present level of the sea. They present the same marks of abrasion as the barrier reef now undergoing the action of the waves. The Observatory, Port Louis, is built also on a stratum, ten feet above high-water mark, of very hard coral, which requires blasting. There are besides in several parts of the island, and at considerable distances inland, enormous blocks of coral surrounded with the debris of oyster and other shells and broken corals. Appended to Capt. Lloyd's communication are two letters from agents employed by him to collect information respecting inland blocks of coral. One of the letters is from Mr. Hill, surveyor of roads, and contains the following data respecting two blocks near Souillac:—

	1st Block.	2nd Block.
Distance from the sea.............	610 feet	1356 feet
Probable height above high water..	50 —	
Length	12 —	30 —
Breadth	10 —	12 —
Height	$7\frac{1}{2}$ —	14 —
Girt round the largest projections..	40 —	77 —

If the first of these blocks had been transported by the sea, Capt.

Lloyd says, it could have attained its present position only by passing over the almost perpendicular coast.

The other letter is from Mr. Sherlock, and gives the following measurements of two blocks on the Black river :—

	Height.	Width.	Circumference.	Distance from sea.
1st block ...	13 feet ...	30 to 40 feet ...	121 feet	350 feet.
2nd block...	10 — ...	25 feet	Length, 41 feet	840 —

Mr. Sherlock adds, there is no coral in the interior, except a small bed on the habitation, Le Gentele.

4. On the mineral veins of the Sierra Almagrera, in the province of Almeria, in the South of Spain, by J. Lambert, Esq., F.G.S.

The Sierra Almagrera extends from the mouth of the Almanzora (lat. about 37° 17′, long. about 15° 40′) in a N.N.W. direction for twelve miles. Its width is about a mile and a half, and its greatest height 1400 feet. It is composed of clay-slate, resting upon mica-slate, accompanied by beds of milky quartz, and crossed by numerous ferruginous veins containing sulphate of barytes and gypsum. The strata of the clay-slate are generally horizontal, but are sometimes inclined from 15° to 20°, and even more, where disturbed by masses of greenstone.

The vein of the Barranco Jaroso was the first discovered, and it is now of considerable richness. Its excavations extend more than 200 yards in length, with every indication of the lode continuing. The direction of the vein is north to south, between one and one and a half hours, or 15° to $22\frac{1}{2}$° east of north; and the inclination is from 65° to 70° east. The breadth of the vein, where it was commenced at the surface, was half a yard, but it had increased to three yards at the depth of forty yards, the point to which it had been carried in April 1840. The mineral contents of the vein consist of parallel divisions of several varieties of galena, as crystallized, radiated with an antimonial aspect, brilliant large-grained, fine steel-grained, and black, of oxide and carbonate of lead, and argillaceous iron ore; carbonate of iron and carbonate of copper also occur; and sulphates of barytes and gypsum are abundant.

Old workings, supposed to have been conducted by the Romans, occur in great numbers, principally at the mouths of the Barrancos or ravines of Pinalbo del Frances and de la Torre. Quantities of mine-timber, decayed iron tools and lamps of clay, have been found in them; but in no case does it appear that gunpowder was used in making the excavations. Large heaps of slags and scoria are of frequent occurrence; one of the most important being situated between the confluence of the Almanzora and the Rambla de Muleya at the foot of the little hill Cabéza de las Herrerias (Head of the Forges).

This hill, Mr. Lambert says, presents the aspect of a volcanic crater, and has disturbed the tertiary deposits of the neighbourhood. He states, that it is an enormous mass of oxide of iron, with a multitude of veins of sulphate of barytes; and that it is absolutely honey-combed by old excavations in the barytes veins, the contents of which, he believes, were used as a flux in smelting the argentiferous minerals. The tertiary beds at this locality consist of clays resting upon conglomerates, and are all charged with iron. They are stated to contain also "ferruginous and jaspery dendrites," veins of felspar and crystals of barytes.

A tertiary formation extends from the foot of the Sierra Almagrera to the Sierras de Filabres, de Alhamilla and Cabrera. The upper part consists of an arenaceous conglomerate alternating with marls, and beds of quartz and other pebbles of various sizes. The clays contain gypsum and sands very similar to those of the vicinity of Paris; and numerous organic remains, belonging principally to the genera Ostrea, Pecten, and Dentalium; likewise corals. The formation is disturbed in many parts by protruded masses of greenstone; also by porphyries, trachytes and basalts, which are stated to present very singular phænomena. Gneiss projects above the tertiary strata in many places.

The paper was accompanied by specimens of galena, of which the following analyses are given in the paper itself:—

Specimen, No. 1.	70·8 per cent. Lead	1·05 per cent. Silver	16 oz. per gal.
———— 2. Radiated	62·1 ————	0·65 ————	$10\frac{4}{10}$ —
———— 3. Black ...	22·25 ————	0·325 ————	$5\frac{2}{10}$ —

About 400 tons of numbers 1 and 2, have been extracted from the mine during the months it had been worked; and the produce about the time the paper was written was fifteen tons a day.

5. A notice on the Sierra de Gador, and its lead mines, by Josias Lambert, Esq., F.G.S.

The Sierra de Gador, celebrated for its lead mines, is situated between the Sierra Nevada and the Mediterranean. Its length from west to east is nearly forty miles; its breadth varies from five to ten miles, and its highest point,—the Collado de los Valientes, near its western extremity,—is upwards of 6000 feet above the sea. From that point eastward, the height gradually decreases till it is reduced near the Almeria to the level of that river. The southern face is precipitous, and from its base to the Mediterranean extends the tertiary plain of Dalias. The western flank is also precipitous, but the northern face rises more gently from the river Almeria, which separates the Sierra de Gador from the Sierra Nevada.

The principal mass of this range of mountains is composed almost exclusively of a limestone, considered by Mr. Lambert to belong to the lowest of the transition rocks, because its stratification is in general conformable to that of the nucleus of the Sierra Nevada, and because it is believed to contain no organic remains. It is of a grey or dark colour, and of a compact or finely grained texture, but it is sometimes, though rarely, friable. It passes downwards by alternations and transitions into clay-slate, talcose or mica-slate and in the upper part, it is connected with breccias and limestone conglomerates.

The limestone is generally traversed by veins of calcareous spar and fluor spar, frequently so arranged as to resemble the stripes in the skin of a zebra. It is also occasionally magnetic, on account of disseminated particles of magnetic iron. The stratification is regular in some places, but it generally presents great inflexions and disruptions, and curves of a thousand different natures. The prevailing strike of the beds is from east to west, but from the western base of the mountain at Castala to near the highest point in the Loma del Sueño and Collado de los Valientes, it is from north to south. The inclination of the beds varies very much both in direction and inclination; the former being sometimes south, but often north, and occasionally east; and the latter differing from 15° to 45°. The beds are for the greater part compact, but the higher consist of a breccia, mixed with slate-clay and clayey ochres. The stratification in these beds is sometimes well pronounced, and at others less so, being of great thickness. The fragments of the calcareous breccia are angular and of various sizes, and are cemented by carbonate of lime.

In the ravine of Cartala, protruded masses of trap, containing veins of asbestos, amphibole, and porcellanite, are stated to have dislocated the strata; an inconsiderable vein of trap is also described as interposed between two beds of limestone. The slate clays near the masses of trap, are said to be frequently of a green colour.

At the eastern extremity of the chain, the limestone is overlaid by beds of gypsum, containing masses and strings or small veins of native sulphur.

There is no doubt that mines in this mountain chain were worked by the Romans. The ore is generally found in nests or masses of inconsiderable size; also in veins and branches of limited extent in any constant direction, crossing each other, and forming almost always communications between the nests. Mr. Lambert is therefore induced to consider these metallic accumulations as of contemporaneous origin with the limestone. At the mine of Arnafe, on the western edge of the Sierra, the ore occurs between two beds of limestone, having the same direction east, 20° north, and dipping with them 80° to the N.E. It is one foot thick, and is accompanied by clay. The same agreement has been found in Santa Rosa, Santa Catalina, Cruzados, Trinidad primero, and in all the mines situated upon the western declivity, looking towards Berja.

In the Loma del Sueño, and the interior parts of the Sierra, where the beds incline only 20° to 30°, but frequently exhibit great dislocations, which change their position entirely, and often form crests, fissures, and hollows filled with argillaceous substances, are found the greatest masses of ore, lying between the beds, and conforming to all their modifications. Fluor almost always accompanies the galena.

One level has been carried nearly 600 yards in length, from the bottom of a precipice of nearly equal altitude, in order to undermine the rich deposits on the edge of the Loma del Sueño, but hitherto nothing has been met with but compact and slaty limestone. Mr. Lambert therefore infers, that the ore is more superficial, and he adds, there is no instance of its having been found at a greater depth than 200 yards from the surface.

The lower parts of the fissures which traverse the limestone, are frequently filled with fragments of ore enveloped in a red earthy soil, and associated with angular as well as rounded fragments of limestone. In the alluvial detritus of the ravines, and the dry deltas at their mouth, fragments and masses of ore have been extracted, often in considerable quantities, and at the Pecho de las Lastras to the extent of 100,000 tons.

In the limestone mountains which stretch westward from the Sierra de Gador to Marbella, within forty miles of Gibraltar, lead ore is found in variable quantities, but not so abundantly as in the Sierra de Gador.

In conclusion, Mr. Lambert observes, that the improvident method of working the ore in that mountain is fast destroying the best mines; that new trials have not been attended with anything like success; and that the hardness of the rock renders sinkings very expensive, and compels adventurers with limited funds to abandon their undertakings, unless ore be speedily obtained.

6. On the polished and striated surfaces of the rocks which form the beds of Glaciers in the Alps, by Professor Agassiz.

This paper was accompanied by a series of plates intended to represent the effect of glaciers upon the rocks over which they move.

These effects, consisting of surfaces highly polished, and covered with fine scratches, either in straight lines or curvilinear, according to the direction of the movement of the glacier, are constantly found, not only at the lower extremity, where they are exposed by the melting of the glaciers, but also, wherever the subjacent rock is examined, by descending through deep crevices in the ice. Grains of quartz and other fragments of fallen rocks, which compose the moraines that accompany the glaciers, have afforded the material which, moved by the action of the ice, has produced the polish and scratches on the sides and bottom of the Alpine valleys through which the glaciers are continually, but slowly descending. It is impossible to attribute these effects to causes anterior to the formation of the glacier, as they are constantly present and parallel to the direction of the movement of the ice. They cannot be considered as the effects of an avalanche, for they are often at right angles to the direction in which an avalanche would descend; they are constantly sharp and fresh beneath existing glaciers, but less distinct on surfaces which have for some time been left exposed to atmospheric action by the melting of the ice. In the valley of the Viesch, the direction of the scratches is from north to south, or towards the Rhone; the direction of those which accompany the glacier of the Rhone is from east to west; that of those beneath the glacier of the Aar is first from west to east, as far as the Hospice of the Grimsel; and then from south to north, from the Grimsel to the Handeck. If we would account for these scratches by the action of water, we must imagine currents of enormous depth filling these highest Alpine valleys, and descending in opposite directions from the narrow crest that lies between them. In the upper part of the valley of the Viesch, is a glacier, beneath which runs a rapid torrent, co-extensive in length with the great current, to which the above hypothesis would attribute the polish and scratches on the rocks of the valley. This small torrent corrodes the bottom of the valley into sinuous furrows and irregular holes, and polishes the sides of its bed; but the polish is of a different aspect from that produced by the action of the ice, and of the stones and sand which it carries with it. The polished surfaces beneath the ice are often salient and in high relief. The sides also of the valleys adjacent to the actual glaciers are frequently polished and scratched at great heights above the ice, in a manner identical with the surface beneath it, but different from the polish of the bed of the torrent.

The amount of polish and scratches varies with the nature of the rocks. In the valley of Zermatt and Riffelhorn, rocks of serpentine are most exquisitely polished; so also are the granites on the sides of the glacier of the Aar, where they have not been long exposed to the action of the air. Gneiss and limestone do not preserve their polish under similar exposure, but retain it while they are protected by ice or a covering of earth.

These facts seem to show, that the striated and polished condition of rocks beneath and on the sides of glaciers, is due to the action of the ice, and of the sand and fragments of stone forming the moraines which accompany it.

7. On a bed of lignite near Messina, by Dr. R. Calvert.

About thirty years ago, Dr. Calvert discovered a bed of lignite, a quarter of a mile from Messina, up a Fiumera to the left of Fort Gonzago. It cropped out to the north at an angle of about 45°, and was at least a yard in thickness. The lignite was swept down a precipice by the country people to make room for sticks to burn lime with; a superb quarry of which was then worked on the opposite side of the field. Dr. Calvert laid in a winter stock of the lignite; the dragoons used it in their forge, and the commander of the forces in his kitchen. Owing, however, to the unskilfulness of the people who dug the lignite (soldiers and officers' servants), the roof fell in, and the property above being injured, the excavations were stopped. Some of the lignite emitted a bad effluvia when burned.

8. A letter from Richard Greaves, Esq., addressed to Dr. Buckland, and dated June the 6th, 1840, on the discovery of bones of birds, fishes, and mammalia, in the limestone cliff at Eel Point in Caldy Island, and about eighty feet above the sea.

9. A note from Mr. Hamilton, Sec. G.S., addressed to Dr. Buckland, on the irregular occurrence of rounded fragments of rock crystal, throughout the Hastings sands, in the neighbourhood of Tunbridge Wells. Mr. Hamilton's principal object is to call atten-

tion to the inquiry whence the fragments were obtained; and to the assistance which this knowledge would afford in determining the origin of the other materials forming the Hastings sands.

10. A letter, dated May 6th, 1840, from M. Roemer, of Hildesheim, to Dr. Fitton, on the chalk and the subjacent formations to the Purbeck stone inclusive in the north of Germany.

a. Chalk with flints.—This formation, presenting characters which exactly agree with those of the chalk of England, is found only in the island of Rugen. It there consists of a white limestone, with frequent layers of flints, and includes the same fossils.

M. Roemer is of opinion that the Rugen deposit is of the age of the Maestricht beds, though most geologists believe it to be younger.

In the north of Germany there are very thick deposits of sandstone and sandy marls, which correspond, M. Roemer says, to the upper subdivision of the chalk formation. The characteristic fossils are *Callianassa* (*Pagurus*) *Faujasii*, *Belemnites mucronatus*, small corals, &c. No Ammonites have been found in it. The localities where it occurs, are Gehrden near Hanover, Goslar, Quedlenburg, and Halberstadt.

b. Chalk without flints exists near Piena and Luneberg, with the same external characters as in England. Near Ilseburg, Lemforde, Dulmen, and other localities, it is represented by sandy marls and sandstones. It contains *Belemnites mucronatus*, many Scyphia, some Ammonites, &c.

c. Chalk marl (Pläner Kalk).—This formation is extensively distributed and well exposed in the north of Germany, and exhibits everywhere the same characters as in England. It contains no *Belemnites mucronatus*, but *Ammonites varians*, *A. Mantelli*, *A. Gutoni*, *Turrilites costatus*, *T. undulatus*, *Plicatula inflata*, &c.

d. Upper greensand.—This formation, as a greyish green marl, with grains of silicate of iron, occurs only near Dresden and near Wal in Westphalia; also in the neighbourhood of Hildesheim. It contains *Ammonites falcatus*, *Terebratula biplicata*, *Ostrea carinata*, *Spatangus subglobosus*, &c.

The chalk marl in general gradually becomes more sandy, and passes into a sandstone with veins of oxide of iron, but which contains no fossils. The sandstone constantly accompanies the chalk marl.

e. Gault.—This deposit has not been detected with certainty in the north of Germany, but M. Roemer thinks it may be represented by a marl which occurs between Hanover and Hildesheim, and contains *Hamites compressus;* and by a blue clay near Ottbergen. He has not been able to find it near Aix-la-Chapelle.

f. Lower greensand.—The mineralogical characters of this formation are the same as in England. It occurs in Saxony, at the foot of the Hartz, near Celfeld, near Bilefeld, and near Hattern in Westphalia, also near Aix-la-Chapelle. Its fossils are not very numerous.

g. Hils conglomerate.—To M. Roemer, geologists are indebted for first pointing out the existence, as distinct deposits, of the Hils conglomerate and the Hils clay.

The *Hils conglomerate* consists of a yellowish or brownish marl, containing grains of quartz, schist, and oxide of iron. It forms very thick beds, and includes in some localities very rich iron ores. It occurs near Brunswick, at Goslai, and near Essen on the Ruhr in Westphalia. Its fossils are very numerous, and partly identical with those of the lower greensand of England; for example, it contains *Terebratula latissima, T. depressa, T. oblonga, T. sella, Ostrea carinata, O. macroptera, Pecten quinquecostatus,* &c. M. Roemer asks if it be the equivalent of the Neocomien.

h. The *Hils clay* is a bluish pure clay, 100 feet thick. M. Roemer considers it to be the Speeton clay of England, as it contains *Mya depressa* (Phillips), *Glyphæa ornata* (*Astacus ornata,* Phillips), and *Isocardia angulata* (Phillips), with a great quantity of other fossils, which are in part Jurassic species, namely, *Ammonites sublævis, A. mutabilis,* and *A. coronatus.* M. Roemer has noticed the Hils clay near Hildesheim, near Celfeld, where it contains a considerable layer of iron; at the foot of the Deister near Hanover, and near Trenndorf.

i. Weald clay.—A stiff bluish or brownish clay, seldom containing subordinate beds of limestone and sandstone. The fossils are almost exclusively the same as those enumerated in Dr. Fitton's memoir on the beds below the chalk in the south-east of England; and are entirely freshwater, with the exception of an Astarte.

k. Hastings sandstone.—In the north of Germany this formation is composed of a white, grey or fawn-coloured sandstone, sometimes alternating in the upper part with greyish clay, and contains from seven to ten beds of coal. Its general thickness amounts to 500 or 800 feet. The beds of coal vary from one to three feet in thickness, and are separated by sandstone, which is sometimes only a few feet thick. The fossils belong to the genera *Paludina, Unio, Endogenites, Abies, Sphenopteris,* and *Lonchopteris,* and M. Roemer has found every species mentioned in Dr. Fitton's memoir before alluded to. The sandstone is generally less ferruginous than in England.

l. Purbeck strata.—These beds are described by M. Roemer as consisting of shelly limestones alternating with thin layers of sandstone, and concretional masses of grit. He has observed two dirt-beds, but as yet no Cycadeoidea. The shells which he has found, are partly marine, partly freshwater, and belong to the genera *Paludina, Ostrea, Cyrena, Gervilia, Serpula,* &c.

m. Portland stone.

The Wealden formation, M. Roemer states, is exhibited near Helmsted. He hopes it will be exposed near Hildesheim. More westward it extends from Hanover by Minden, to Iburg and Rheine near Munster in Westphalia; furnishing almost everywhere a very good coal. The fossils found in the strata below the lower greensand, M. Roemer has accurately figured and described in his works; and they proved the identity of the Wealden deposits of England and the north of Germany.

11. A letter from H. B. Mackeson, Esq. to Dr. Fitton, dated Hythe, June 7th, 1840.

On the 19th of May, Mr. Mackeson discovered some portions of a large saurian, he believes an Iguanodon, near the bottom of the lower greensand in the vicinity of Hythe. On the 6th of June, he revisited the quarry, and ascertained that the work-people had followed the remains for upwards of fifteen feet. On that occasion, Mr. Mackeson superintended the disinterment of probably a tibia. This bone, and others previously obtained, with their bulky matrix, required a cart and two horses for their removal. Up to the date of the letter, no vertebræ, teeth, phalangeal or smaller bones of the extremities had been found by the workmen. In the same quarry, Mr. Mackeson has obtained a large Ammonite, *Gervillia aviculoides*, and other shells characteristic of the lower greensand.

This being the last Meeting of the Session, the Society adjourned at the close of the evening's business to Wednesday, November 4th.

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TO THE COMMUNICATIONS READ DURING THE SESSION

1839—1840.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

Vol. III. Part II. 1840—1841. No. 72.

Nov. 4.—A paper was read on Glaciers, and the evidence of their having once existed in Scotland, Ireland, and England, by Professor Agassiz, of Neuchâtel.

M. Agassiz commences by observing, that the study of glaciers is not new, as Scheuchzer visited, and even drew, most of the glaciers of Switzerland; and as, at a later period, Gruner and De Saussure examined them in great detail, and left few of their phænomena uninvestigated. Hugi also, in his account of the Alps, and Scoresby, in his descriptions of the arctic regions, have communicated much valuable information respecting glaciers, but without giving rise to any important geological results. Venetz and De Charpentier first ascribed to the agency of glaciers, the transport of the erratic boulders of Switzerland, supposing that the Alps formerly attained a greater altitude than at present, and that the glaciers extended to the plains of Switzerland, and even to the Jura. This assumed greater height of the Alps M. Agassiz dissents from, as no geological phænomena compel him to admit it; and the arrangement of the boulders proves that the blocks were not pushed forward by the glaciers, as conjectured by M. de Charpentier. Moreover, the phænomena of erratic boulders extend over all the temperate and northern regions of Europe, Asia and America, and, consequently, could not depend upon so local an event as a greater altitude of the Alps. The consideration of these difficulties induced M. Agassiz to resume the study of glaciers; and after devoting the suitable portion of five successive summers to the study of their details, and all that has been written respecting their structure, he has arrived at the conviction, that the formation of glaciers did not only depend upon the actual configuration of the globe, but was also connected with the last great geological changes in its surface, and with the extinction of the great mammifers which are now found in the polar ice. He is also convinced that the glaciers did not advance from the Alps into the plains, but that they gradually withdrew towards the mountains from the plains which they once covered. In this belief, he says, he is supported by many considerations which escaped previous observers, depending chiefly on the form and relative position of the erratic blocks, and the commonly called diluvial gravel, the former being in Switzerland always angular, and resting on the latter, which consists of rounded materials. Considered in this point of view, glaciers assume an entirely new importance, for they introduce a long period of intense cold between the present epoch and that during which the animals existed, whose remains are buried in the usually called diluvial detritus.

Having established his theory as completely as he could, by repeated investigations of Switzerland and the adjacent portions of France and Germany, M. Agassiz became desirous of investigating a country in which glaciers no longer exist, but in which traces of them might be found. This opportunity he has recently enjoyed, by examining a considerable part of Scotland, the north of England, and the north, centre, west and south-west of Ireland; and he has arrived at the conclusion, that great masses of ice, and subsequently glaciers, existed in these portions of the United Kingdom at a period immediately preceding the present condition of the globe, founding his belief upon the characters of the superficial gravels and erratic blocks, and on the polished and striated appearance of the rocks *in situ*.

M. Agassiz does not suppose that his views respecting glaciers will at once meet with the general concurrence of geologists; and he admits that the study of the phænomena of glaciers in different latitudes, as well as at different altitudes, together with the examination of their different effects where in contact with the sea, will introduce many modifications in the consideration of analogous phænomena in countries where glaciers have disappeared; but he is prepared to discuss his theory within the limits of observed facts, conscious of having searched for truth solely to advance the interests of science.

To avoid useless discussion, he states, that in attributing to the action of glaciers a considerable portion of the results hitherto ascribed exclusively to that of water, he does not wish to maintain that everything hitherto assigned to the agency of water has been produced by glaciers; he only wishes that a distinction may be made in each locality between the effects of the different agents; and he adds, that long-continued practice has taught him to distinguish easily, in most cases, the effects produced by ice from those produced by water.

Proceeding to the consideration of facts, he says the distribution of blocks and gravel, as well as the polished and striated surfaces of rocks *in situ*, do not indicate the action of a mighty current flowing from north-west to south-east, as the blocks and masses of gravel everywhere diverge from the central chains of the country, following the course of the valleys. Thus in the valleys of Loch Lomond and Loch Long, they range from north to south; in those of Loch Fine and Loch Awe from north-west to south-east; of Loch Etine and Loch Leven from east to west; and in the valley of the Forth from north-west to south-east, radiating from the great mountain masses between Ben Nevis and Ben Lomond. Ben Nevis in the north of Scotland, and the Grampians in the south, are considered by the author to constitute the great centres of dispersion in that kingdom; and the mountains of Northumberland, Westmoreland, Cumberland, and Wales; as well as those of Ayrshire, Antrim, the west of

Ireland, and Wicklow, to be other points from which blocks and gravel have been dispersed, each district having its peculiar debris, traceable in many instances to the parent rock, at the head of the valleys. Hence, observes M. Agassiz, it is plain the cause of the transport must be sought for in the centre of the mountain ranges, and not from a point without the district. The Swedish blocks on the coast of England do not, he conceives, contradict this position, as he adopts the opinion that they may have been transported on floating ice.

In describing the phænomena presented by erratic blocks and gravel, M. Agassiz first insists upon the necessity of distinguishing between stratified gravel and mud containing fossils, which could not have been accumulated by true glaciers, although the materials may have often been derived from them; and unstratified masses, composed of blocks, pebbles, and clay. These stratified deposits he considers to be of posterior origin to the glacier epoch. The till of Scotland, or the great unstratified accumulation of mud and gravel, containing blocks of different size heaped together without order, and containing no organic remains but bones of Mammalia and insignificant fragments of shells, he is of opinion was also not produced by true glaciers, although intimately connected with the phænomena of ice. The polished and striated surfaces of the blocks leave no doubt on M. Agassiz's mind that these masses have been acted upon by ice in the same manner as the blocks which are observed under existing glaciers, and which are more or less rearranged by water derived from the melting of the glaciers.

Similar detritus fills the bottom of all the Alpine valleys, as that of the Rhone from its mouth to its junction with the Lake of Geneva, and the valley of Chamounix: it is found between the Hospice de Grimsel and the borders of the lower glacier of the Aar; thence to the neighbourhood of Goutharen in the valley of Oberhasli, at Im Grund, in the plains of Meiringen, and in Interlasken; also between Thun and Berne. At all these localities, M. Agassiz considers, the blocks were left, when the glaciers extended to them.

With respect to the valley of the Aar, M. Agassiz says it is easy to prove that the rounded pebbles of Alpine rocks spread along its whole course, were not transported to their present position by that river, because between the glacier from which it issues and Berne, the flowing of the stream is interrupted by the barrier of Kirchet, the Lake of Brienz, and the Lake of Thun; and because between these lakes its velocity is so small, that it transports only mud and very fine gravel, and that the pebbles over which the river flows below Thun do not issue from the lake. Supposing that the volume of the Aar was formerly greater, why, asks M. Agassiz, are not the lakes of Brienz and Thun filled in the same manner as the plain of Meiringen and the bottom of the valley which separates the two lakes? All difficulties, however, he is of opinion, vanish, if the pebbles be considered the detritus of retreating glaciers, and that the hollows occupied by the lakes of Brienz and Thun were filled with glaciers.

The existence of a glacier in this valley is not imagined by the author to explain the origin of the detritus, as its having existed is proved by the polish on the rocks *in situ*, from the glacier of the Aar to Meiringen, a distance of twenty English miles, at the height of 8000, 7000, and 6000 feet successively above the level of the sea; and even on the shores of the Lake of Thun. Similar phænomena have been noticed by M. Agassiz in Scotland, in the valleys of Loch Awe and Loch Leven, near Ballachalish, and in England in the neighbourhood of Kendal.

The author then proceeds to describe the moraines of Switzerland, or the accumulations of blocks and pebbles deposited longitudinally on the borders, and transversely in front, of glaciers, and successively abandoned by them in their retreat. The longitudinal moraines differ from glacier-detritus remodelled or spread out by water, in being disposed in ridges with a double talus, one flank of which is presented to the glacier, and the other to the side of the valley; and their continuity and parallelism at the same height easily distinguish them from the debris disposed along the bottoms of valleys by currents. They occur on the flanks of all glaciers, but they have been also observed by M. Agassiz where no glaciers exist, as in the valleys of the Rhone, the Arve, the Aar, &c.; likewise in Scotland, near Inverary, at Muc Airn, at the outlet of Loch Traig, at Strankaer, and on the borders of the bay of Beauley; in Ireland to the south-east of Dublin, and near Enniskillen; and in England in the valley of Kendal, as well as near Penrith and Shap.

The common origin of moraines, and of accumulations of rounded pebbles and of blocks, M. Agassiz says, cannot be doubted. The former are simple ridges formed on glaciers; the latter, materials rounded and polished under glaciers, or great masses of ice, and exposed by the melting of the ice, and re-disposed by the water thus produced.

The author next describes the differences in the internal arrangement of the various accumulations. In the stratified deposits the materials are comparatively much smaller than in glacier-detritus; the pebbles also are elongated, and fine gravel and mud ordinarily form the upper beds. On the contrary, in the detritus of glaciers large and small materials are associated without order, the largest blocks being often in the upper part; and where very large *angular* blocks occur, they rest on the surface. In moraines there is a further distinction, blocks of all dimensions and every form are intermingled; and this difference, he says, is easily understood, by recollecting that moraines are composed of the angular blocks which fall on the surface of the glacier, as well as of pebbles with rounded edges.

The striated and polished surfaces, so often observed on solid rocks *in situ*, are next described by M. Agassiz. Without denying absolutely the power of water to produce such effects, he says that he has sought for them in vain on the borders of rivers and lakes, and on sea-coasts; and that the effects produced by water are sinuous furrows proportioned to the hardness of the rocks; not even uniform polished surfaces, such as those presented by the rocks under discussion, and which are independent of the composition of the stone; moreover wherever the moveable materials which are pressed by the ice on rocks *in situ* are the hardest, there occur, independent of the polish, striæ more or less parallel, and in the general direction of the movement of the glaciers. Thus in the neighbourhood of glaciers are found those rounded bosses which Saussure distinguishes by the name of "roches moutonnés." These phænomena M. Agassiz has traced under the glacier of the Aar, and he has observed them in the valley of the Rhone, and of Chamounix; also in Scotland, on the banks of Loch Awe and Loch Leven; and he says they are very remarkable in the environs of Kendal.

The most striking points in the distribution of the striæ, are their diverging at the outlets of the valleys, and their being oblique, and never horizontal on the flanks, which they would be, were they due to the agency of water, or floating masses of ice. The cause of this obliquity the author assigns to the upward expansion of the ice, and the descending motion of the glacier.

The most remarkable striated rocks in the Alps are near Handeck, and near the cascade of Pissevache; and the best examples M. Agassiz has seen in Scotland, are those of Ballahulish, and in Ireland those of Virginia.

If the analogy of the facts which he has observed in Scotland, Ireland, and the north of England, with those in Switzerland, be correct, then it must be admitted, M. Agassiz says, that not only glaciers once existed in the British Islands, but that large sheets (*nappes*) of ice covered all the surface.

The author then details the proofs that glaciers did not descend from the mountain summits into the plains, but are the remaining portions of the sheets of ice which at one time covered the flat country. It is evident, he says, if the glaciers descended from high mountains, and extended forward into the plains, the largest moraines ought to be the most distant, and to be formed of the most rounded masses; whereas the actual condition of the detrital accumulations is the reverse, the distant materials being widely spread, and true moraines being found only in valleys connected with great chains of lofty mountains.

It must then be admitted, the author argues, that great sheets of ice, resembling those now existing in Greenland, once covered all the countries in which unstratified gravel is found; that this gravel was in general produced by the trituration of the sheets of ice upon the subjacent surface; that moraines, as before stated, are the effects of the retreat of glaciers; that the angular blocks found on the surface of the rounded materials were left in their present position at the melting of the ice; and that the disappearance of great bodies of ice produced enormous debacles and considerable currents, by which masses of ice were set afloat, and conveyed, in diverging directions, the blocks with which they were charged. He believes that the Norwegian blocks found on the coast of England have been correctly assigned by Mr. Lyell to a similar origin.

Another class of phænomena connected with glaciers, is the forming of lakes by the extension of glaciers from lateral valleys into a main valley; and M. Agassiz is of opinion, that the parallel roads of Glen Roy were formed by a lake which was produced in consequence of a lateral glacier projecting across the glen near Bridge Roy, and another across the valley of Glen Speane. Lakes thus formed naturally give rise to stratified deposits and parallel roads, or beds of detritus at different levels.

The connexion of very recent stratified deposits with glacier-detritus, M. Agassiz observes, is difficult to explain; but he conceives that the same causes which can bar up valleys and form lakes, like those of Brienz, Thun and Zurich, may have formed analogous barriers at the point of contact with the sea sufficiently extensive to have produced large salt-marshes to be inhabited by animals, the remains of which are found in the clays superimposed on the till of Scotland; and he adds, that the known arctic character of these fossils ought to have great weight with those who study the vast subject of glaciers.

In conclusion, the author remarks, that the question of glaciers forms part of many of the great problems of geology; that it accounts for the disappearance of the large mammifers inclosed in the polar ice, as well as for the disappearance of the organic beings of the so-called diluvian epoch; that in Switzerland it is associated with the elevation of the Alps, and the dispersion of the erratic blocks; and that it is so intimately mixed up with the subject of a general diminution of the terrestrial heat, that a more profound acquaintance with the facts, noticed in this paper, will probably modify the opinions entertained respecting it.

Nov. 18.—The reading of the first part of a Memoir on the Evidences of Glaciers in Scotland and the North of England, by the Rev. Prof. Buckland, D.D., Pres. G. S., commenced on the 4th of November, was resumed and concluded.

Dr. Buckland's attention was first directed by Prof. Agassiz in October 1838 to the phænomena of polished, striated, and furrowed surfaces on the south-east slope of the Jura, near Neuchâtel, as well as to the transport of the erratic boulders on the Jura, as the effects of ice; but it was not until he had devoted some days to the examination of actual glaciers in the Alps, that he acquiesced in the correctness of Prof. Agassiz's theory relative to Switzerland. On his return to Neuchâtel from the glaciers of Rosenlaui and Grindelwald, he informed M. Agassiz that he had noticed in Scotland and England phænomena similar to those he had just examined, but which he had attributed to diluvial action: thus in 1811 he had observed on the head rocks on the left side of the gorge of the Tay, near Dunkeld, rounded and polished surfaces; and in 1824, in company with Mr. Lyell, grooves and striæ on granite rocks near the east base of Ben Nevis. About the same time Sir George Mackenzie pointed out to the author in a valley near the base of Ben Wyvis, a high ridge of gravel, laid obliquely across, in a manner inexplicable by any action of water, but in which, after his examination of the effects of glaciers in Switzerland, he recognizes the form and condition of a moraine.

After these general remarks, Dr. Buckland proceeds to describe the evidence of glaciers observed by him in Scotland last autumn, partly before and partly after an excursion, in company with Prof. Agassiz; but he forbears to dwell on the phænomena of parallel terraces, though he is convinced that they are the effects of lakes produced by glaciers.

The district which Dr. Buckland examined previously to his excursion with Prof. Agassiz, lay in the neighbourhood of Dumfries; and the line of country which he investigated subsequently, extended in Scotland from Aberdeen to Forfar, Blair Gowrie, Dunkeld, and by Loch Tumel and Loch Rannoch to Schiehallion and Taymouth, and thence by Crief, Comrie, Loch Earn Head, Callender and Stirling, to Edinburgh; and in England by Berwick, Wollar, the Cheviots, Penrith, and Shap Fell, to Lancashire and Cheshire.

Moraine near Dumfries.—The picturesque ravine of Crickhope Linn, about two miles north of Closeburn, and one mile east of Thornhill, intersects nearly horizontal strata of new red sandstone, and is traversed by the Dolland rivulet. On emerging from the upper end of the ravine a long terminal moraine is visible, stretching nearly across the mountain valley, from which the Dolland Burn descends to fall into Crickhope Linn; and it resembles, when viewed from a distance, a vallum of an ancient camp, being covered with turf. It is formed principally of an unstratified mass of rolled pebbles, derived from the slates of the adjacent Lowder Hills, with a few rounded fragments of granite, the nearest rock of which *in situ* is that of Loch Doon, in Galloway, thirty miles to the north-west. Its height varies from twenty to thirty feet; its breadth at the base is about one hundred feet, and its length is four hundred yards. At the southern extremity it is traversed by the Dolland rivulet, and at the northern by the Crickhope Water; and in the centre it is intersected by a road.

Moraines in Aberdeenshire.—Dr. Buckland considers the gravel and sand which cover the greater part of the granite table-land from Aberdeen to Stonehaven to be the detritus of moraines; and the large insulated tumuli and tortuous ridges of gravel, occupying one hundred acres, near Forden, a mile east of Achinbald, to be terminal moraines; also the blocks, large pebbles, and small gravel spread over the first level portions of the valley of the North Esk, after emerging from the Sub-Grampians, to be the residue of moraines re-arranged by water.

Moraines in Forfarshire.—The cones and ridges of gravel at Cortachy and Piersie, near Kirriemuir, and at the confluence of the Carity valley with that of the Proson, are considered by Dr. Buckland to have been produced by glaciers, and modified in part subsequently by water. The polish and striæ on a porphyritic rock near the summit of the hill, on the left side of the main valley, and immediately above the moraines, he is of opinion must also be assigned to glacier action. The vast longitudinal and insulated ridges of gravel, extending for two or three miles up the valley east of Blair

Gowrie, and the transverse barriers forming a succession of small lakes in the valley of the Lunanburn, to the west of that town, he considers to be moraines; likewise the lofty mounds comprising the ornamental grounds adjacent to Dunkeld Castle; the detritus covering the left flank of the valley of the Tay, along a great part of the road from Dunkeld to Logierait; that on the left flank of the Tumel valley from Logierait to Killicrankie; and on the left flank of the Garrie, from Killicrankie to Blair Athol.

The vast congeries of gravel and boulders on the shoulder of the mountain, exactly opposite the gorge of the Tumel, Dr. Buckland is of opinion was lodged there by glaciers which descended the lateral valley of the Tumel from the north side of Schiehallion and the adjacent mountains, and were forced across the valley of the Garry, in the same manner as modern glaciers of the Alps (that of the Val de Bagne, for example,) descend from the transverse, and extend across the longitudinal valleys. Dr. Buckland mentions the mammillated, polished and striated slate rocks, about one mile above the falls of the Tumel, on the left portal of the gorge of the valley, as the effects of a glacier which descended the gorge: he notices also the rounded outline and polish on veins of quartz, which project eight or ten inches above the weathered surfaces of masses of mica slate near the same locality. Similar mammillated masses of mica slate retaining striæ and flutings are visible at Bohaly, one and a half miles east of Tumel Bridge.

Evidences of Glaciers on Schiehallion.—The north and north-east shoulders of the mountain present rounded, polished, and striated surfaces, many of which have been recently exposed by the construction of new roads. On the left flank of the valley called the Braes of Foss, and near the thirteenth milestone, a newly-exposed porphyry dyke, forty feet wide, exhibited a polished surface and striated, parallel to the line of descent which a glacier from Schiehallion would take; and on the right flank, one hundred yards north of the eleventh milestone, another and smaller dyke of porphyry presented similar phænomena. In the intermediate space the recently uncovered slate rocks and quartzite are rounded, polished, grooved, and striated, parallel to the direction which a glacier would assume where each surface is situated.

Moraines at Taymouth.—Two lofty ridges of gravel, which cross the park at right angles to the sides of the valley between the village of Kenmore and Taymouth Castle, the hill, on which stands an ornamental dairy-house, and the gravel, on which are situated the woods overhanging the left bank of the lower end of Loch Tay, Dr. Buckland considers to be moraines, or the detritus of moraines; also the deeply-scored and fluted boulders of hornblende rock, with other debris near Fortingal, at the junction of Glen Moulin with Glen Lyon.

Moraines in Glen Cofield.—A remarkable group of moraines occurs on the high lands which divide the valleys of the Tay and the Bran; and between the sixteenth and fourteenth milestones thirty or forty round-topped moraines, from thirty to sixty feet high, are crowded together like sepulchral tumuli. These mounds, composed of unstratified gravel and boulders, Dr. Buckland says cannot be referred to the action of water, as they are placed precisely where a current descending from the adjacent high lands would have acted with the greatest velocity; and they exactly resemble some of the moraines in the valley of the Rhone, between Martigny and Löek. The village of Amulrie is considered by the author to stand on a group of low moraines; and the road for two or three miles from it, towards Glen Almond, to traverse small moraines or surfaces of mica slate, rounded by glaciers. A few conical moraines appear also on the high lands between Glen Almond and Crieff.

Proofs of Glaciers in and near Strath Earn.—This part of the valley of the Earn is flanked irregularly with ridges and terraces of gravel, the detritus of moraines; and on its north side, in the woods adjacent to Lawers House, near Comrie, hard slaty rocks of the Devonian or old red sandstone system have been rounded and striated. At the west end of Comrie, near the bridge, blue slate rocks have been also rounded and guttured.

Evidence of Glaciers near Comrie.—In this district Dr. Buckland tested the value of the glacial theory by marking in anticipation on a map the localities where there ought to be evidences of glaciers having existed, if the theory were founded on correct principles. The results coincided with the anticipations. On a hill above the gorge, called the Devil's Cauldron, near Fentallich, are rounded surfaces of greenstone, partially covered by moraines; and at Kenagart, also immediately above the Devil's Cauldron, is a small cluster of moraines, easily separable into lateral and terminal. Two miles up the valley a medial moraine forms a ridge on the level ground, in front of the confluence of Glen Lednoch and Glen Garron. The farmhouse of Invergeldy is stated to stand on the detritus of a moraine, and the glen descending to it from Bën-na-cho-ny to be partially obstructed with moraines. The surface of the granite at Invergeldy, which supplied the stone for Lord Melville's monument at Crieff, is rounded and mammillated, but too much weathered to present a polish or striæ. On a hill of trap, however, half a mile south of the farm of Lurg, there is a distinct polish, striated in the direction which a glacier descending the subjacent valley would assume. In Glen Turret, on the shoulder of the mountain immediately above the south-west extremity of Loch Turret, a very deep ravine intersects a vast lateral moraine, which Dr. Buckland shows must have been lodged there whilst the Loch was a mass of ice, and the valley above it filled with a glacier more than five hundred feet above the present level of the lake. At the falls of the Turret, at the lower extremity of the gorge, is an extensive lodgement of moraines; and at the upper end, on the left bank of the Turret, near a gate which crosses the road, the slate-rocks are polished and furrowed; and at both these localities Dr. Buckland had anticipated that glacial action ought to be found.

Evidence of Glaciers near Loch Earn.—On the north bank of the Loch rounded and furrowed surfaces and portions of lateral moraines are exposed by the roadside; and at Loch Earn Head is a group of conical moraines at the junction of Glen Ogle with Loch Earn, and at the very point where, had they been brought by a rapid current, they would have been propelled into the Loch. It is nevertheless the exact position where the terminal moraine of a glacier would be deposited.

Moraines near Callender.—Moraines are stated to cover more or less the valley of the Teith from Loch Katherine to Callender, and the lofty terraces flanking the valley from Callender to Doune are considered to be the detritus of moraines, modified by the great floods which accompanied the melting of the ice. One of them, near Callender, has been mapped as the vallum of a Roman camp. The little lakes on the right bank of the Teith, four miles east of Callender, Dr. Buckland considers due to moraines obstructing the drainage of the country; and the greater part of the first table-land on the right bank of the Teith, between Callender and Doune, including the portion on which stands Mr. Smith's farm, to be composed of re-arranged glacial detritus.

Proofs of Glacial Action at Stirling and Edinburgh.—Having thus shown that glaciers once existed in the glens and mountainous districts of Scotland, Dr. Buckland proceeds to point out the evidence of glacial action at points but little raised above the level of the sea, and distant from any lofty group of mountains. In 1824 he had noticed that the trap-rock then recently exposed on the summit of the hill, between the castle and the church, was polished and striated, but at his last visit in 1840 these evidences had become obliterated by weathering. The grooves and scratches described by Sir James Hall on the Costorphine hills near Edinburgh, and on the surface of Calton Hill, Prof. Agassiz is of opinion cannot be explained by the action of water; but they resemble, he says, the effects produced by the under-surface of modern glaciers. In his recent examination, in company with Mr. McLaren, of the Castle Rock at Edinburgh, Dr. Buckland found further proofs of the correctness of the glacial theory, by discovering at points where he anticipated they would occur, namely, on the north-west angle of the rock, distinct striæ upon a vertical polished surface; and at its base a nearly horizontal portion of rock, covered with deep striæ; also on the south-west angle obscure traces of striæ and polished surfaces*. Some of these effects may be imagined to have been produced by stones projecting from the sides or bottom of floating masses of ice; but it is impos-

* In October 1840, Mr. McLaren found a polished surface on a portion of rock near the south-west base of Arthur's Seat.

Dr. Buckland has in his possession lithographs copied from drawings made by Mr. James Hall, of distinct west and east furrows which extend over a portion of the north side of the summit of Calton Hill, and on the surface of the carboniferous sandstone at Craig Leith Quarry. Dr. Buckland saw similar dressings in 1824 in a sandstone quarry near the house of Lord Jeffrey, two miles west of Edinburgh; and in 1840, in a railway section at Bangholm Bower, one mile north-east of Edinburgh, he found in stratified till and sand many striated and fluted boulders.

sible, Dr. Buckland observes, to account by such agency for the polish and striæ on rocks at Blackford Hill, two miles south of Edinburgh, pointed out to him by Lord Greenock in 1834. On the south face of this hill, at the base of a nearly vertical cliff of trap, is a natural vault, partly filled with gravel and sand, cemented by a recent infiltration of carbonate of lime. The sides and roof of the vault are highly polished, and covered with striæ, irregularly arranged with respect to the whole surface, but in parallel groups over limited extents. These striæ, Dr. Buckland says, cannot be referred to the action of pebbles moved by water; 1st, because fragments of stone set in motion by a fluid cannot produce such continuous parallel lines; and 2ndly, because if they could produce them, the lines would be parallel to the direction of the current: it is impossible, he adds, to refer them to the effects of stones fixed in floating ice, as no such masses could have come in contact with the roof of a low vault. On the contrary, it is easy, he says, to explain the phænomena of the polish by the long-continued action of fragments of ice forced into the cave laterally from the bottom of a glacier descending the valley, on the margin of which the vault is placed; and the irregular grouping of the parallel striæ to the unequal motion of different fragments of ice, charged with particles of stone firmly fixed in them, like the teeth of a file. The cave is not three hundred feet above the level of the sea, and the proving of glacial action at this point justifies, the author states, the belief that glaciers may also at that period have covered Calton Hill and the Castle Hills of Edinburgh and Stirling.

A paper "On the Geological Evidence of the former existence of Glaciers in Forfarshire," by Charles Lyell, jun., Esq., F.R.S., F.G.S., was commenced.

Dec. 2.—James Smith, Esq., of Deanston near Doune, Stirlingshire; Charles Christian Hennell, Esq., Hackney; Joseph Parker, jun., Esq., Exeter; the Right Hon. Sir Robert Peel, Bart., M.P., Whitehall Gardens; John Floyer, Esq., of Stafford, Dorchester; and the Marquess of Breadalbane, Taymouth Castle, N.B., were elected Fellows of this Society.

Mr. Lyell's memoir "On the Geological Evidence of the former existence of Glaciers in Forfarshire," commenced on the 18th of November, was concluded.

Three classes of phænomena connected with the transported superficial detritus of Forfarshire, Mr. Lyell had referred, for several years, to the action of drifting ice; namely, 1st, the occurrence of erratics or vast boulders on the tops and sides of hills at various heights, as well as in the bottoms of the valleys, and far from the parent rocks; 2ndly, the want of stratification in the larger portion of the boulder formation or till; and 3rdly, the curvatures and contortions of many of the incoherent strata of gravel or of clay resting upon the unstratified till*. When, however, he attempted to apply

* See Mr. Lyell's paper on the Norfolk Drift, Phil. Mag., May 1840, and the Abstract of the paper, *antè*, p. 171.

the theory of drifting ice over a submerged country to facts with which he had been long acquainted in Forfarshire, he found great difficulty in accounting for the constant subterposition of the till with boulders to the stratified deposits of loam and gravel; for the till ascending to higher levels than the gravel, and often forming mounds which nearly block up the drainage of certain glens and straths; for its constituting, with a capping of stratified matter, narrow ridges, which frequently surround lake-swamps and peat-mosses; and for the total absence of organic remains in the till.

Since, however, Professor Agassiz's extension to Scotland of the glacial theory, and its attendant phænomena, Mr. Lyell has re-examined a considerable portion of Forfarshire, and having become convinced that glaciers existed for a long time in the Grampians, and extended into the low country, many of his previous difficulties have been removed. There are, nevertheless, facts connected with the ridges of stratified materials resting upon till, which he is unable to explain. He also states, that though he had for years inferred from the evidence of fossil shells sent to him from Canada by Capt. Bayfield, that the climate of North America, in the latitude of Quebec, was far more intensely cold at one period than it is now*, yet, that his thoughts had been diverted from the consideration of a long-continued covering of snow on the Scottish mountains, by the knowledge that the climate of Great Britain during the several tertiary epochs was warmer than it is at present. He is of opinion that, during a period immediately antecedent to the existing, several oscillations of temperature may have occurred in the northern hemisphere.

Forfarshire, Mr. Lyell divides geologically into three principal districts: 1st, the Grampians, composed of granite, gneiss, mica-slate, and clay-slate, flanked by a lower range of vertical beds of old red sandstone, associated with trap; 2ndly, the great synclinal trough of Strathmore, occupied by the middle and newer members of the old red sandstone; and 3rdly, the anticlinal chain of the Sidlaw Hills, consisting of the inferior or grey beds of the old red sandstone, usually accompanied by trap. He further states, that it represents, on a small scale, both geologically and physically, the portion of Switzerland where erratic blocks are most abundant, the Grampians with their crystalline rocks being comparable to the Alps, the secondary chain of the Sidlaw Hills to the Jura, and Strathmore to the great valley of Switzerland; and that the resemblance is increased by the occurrence in Strathmore and on the Sidlaw Hills of angular and rounded blocks of Grampian rocks.

The superficial detritus of Forfarshire, Mr. Lyell divides into three deposits: 1st, the thin unstratified covering on the Grampians, derived from the disintegration of the subjacent strata, with a slight intermixture of pebbles traceable to rocks at a higher level, not far distant; 2ndly, the unstratified materials enclosing boulders which occur at the base of the hills on both sides of every glen, and not due to taluses formed by landslips, but constituting terraces of

* See *antè*, p. 119.

transported debris, with a nearly flat top, and sometimes with two steep sides, one towards the river, and the other of less height towards the mountain; and 3rdly, the stratified gravels, sands and clays which overlie the unstratified detritus. Mr. Lyell confines his observations principally to the second and third divisions.

The terraces or lateral mounds very generally increase in width and depth as they descend from the higher to the lower glens, attaining in the latter sometimes a thickness of 100 feet, and occasionally so great a breadth as to leave only sufficient room for the river to pass. The inferior part is always unstratified, consisting of mud and sand, in which large angular and rounded fragments of rocks are imbedded. These boulders are more and more rounded as their distance increases from the hills whence they could have been detached; but they are more frequently flat-sided than pebbles which have been rounded by water; and they become more diversified in character by the junction of every tributary glen. In the upper part the mounds often consist of 40 to 80 feet of the same materials as the lower, but regularly stratified. Mr. Lyell then proceeds to illustrate his subject by describing in detail the phænomena presented by the valley of the South Esk and those of its tributaries.

The South Esk springs from a shallow lake nearly 3000 feet above the level of the sea, and twenty miles from Strathmore. For six miles the river flows through a district composed partly of gneiss, traversed by veins of granite or eurite, and partly of granite. The fragments derived from this high region may be traced downwards continuously for twelve miles to Cortachie; and as a proof that the detritus forming the lateral mounds has followed the same downward course, Mr. Lyell states that it preserves throughout, as well in the main as in the lateral glens, an uniformly grey colour; while the detritus of the lower zone of mica-slate is invariably tinged red, this colour being also imparted to the debris of the still lower portions of the glens, notwithstanding the intermixture of pale brown materials obtained from the clay-slate of that district. Another proof of the detritus not having been drifted upwards, is the absence in the higher portions of the glens of the blocks of pure white quartz which abound in the region of mica-schist, and have been derived from the numerous veins and beds of quartz belonging to that formation. The chief exception to this arrangement is a boulder of conglomerate in the bed of the Proson, evidently derived from hills two miles to the south, but which are considerably above the level of the glen. A few other similar exceptions have been noticed, but the distances to which the stragglers have been traced are inconsiderable. The phænomena exhibited by the lateral mounds, Mr. Lyell states, agree well with the hypothesis of their being the lateral moraines of glaciers; and he adds, that he had never been able to reconcile these phænomena, particularly the want of stratification, with the theory of the accumulations of the detritus during submergence, and the removal by denudation of the central portions of a deposit which had by that means filled the glens. The distribution of an enormous mass of boulders on the southern side of Loch Brandy, and clearly derived from the precipices which overhang the Loch on the three other sides, is advanced as another proof in favour of the glacial theory. It is impossible to conjecture, Mr. Lyell says, how these blocks could have been transported half a mile over a deep lake; but let it be imagined that the Loch was once occupied by a glacier, and the difficulty is removed. Loch Whorral, about a mile to the east of Loch Brandy, is also surrounded on its north, east and western sides by precipices of gneiss, and presents on its southern an immense accumulation of boulders with other detritus, strewed over with angular blocks of gneiss, in some instances twenty feet in diameter. This moraine is several hundred yards wide, and exceeds twenty feet in depth, terminating at the borders of the plain of Clova in a multitude of hillocks and ridges much resembling in shape some terminal moraines examined by Mr. Lyell in Switzerland.

The great transverse barrier at Glenairn, where the valley of the South Esk contracts from a mile to half a mile in breadth, and is flanked by steep mountains, Mr. Lyell formerly regarded as very difficult of explanation. Seen from below, this barrier resembles an artificial dam 200 feet high, with numerous hillocks on its summit. On the eastern side it appears to have been denuded to the extent of about 300 yards by the Esk. Its breadth from north to south is about half a mile. The lower part, 30 feet in depth, laid open in the river cliff, consists of impervious, unstratified mud, full of boulders; but the total vertical thickness of this deposit is stated to be from 50 to 80 feet; and the upper part of the barrier is composed of from 50 to 100 feet of very fine stratified materials. It is not possible, Mr. Lyell observes, to account for the accumulation of this barrier by the agency of water, particularly as no tributary joins the Esk at this point; but if the barrier be supposed to be the large terminal moraine of a receding glacier, then its form and position, he says, are easily to be understood. M. Agassiz, in his work on glaciers, shows, that when these masses of ice enter a narrow defile from a broader valley, the lateral moraines are forced towards the centre, and the mass of transported matter is spread more uniformly over the whole. Such a terminal moraine left by a receding glacier in a defile, Mr. Lyell states, would dam back the waters of the glacier, and produce a lake; and the phænomena presented by the barrier of Glenairn, and the plain which extends in its rear, are fully explicable on the assumption of their having been produced by a glacier. The stratification of the upper portion of the barrier is also shown to be partly in accordance with the effects produced by the formation of ponds of water on the surface of moraines; but Mr. Lyell states, that the accumulation of so great a capping of stratified materials is still the most obscure character of the deposits under consideration.

At Cortachie, about four miles below the barrier of Glenairn, the South Esk enters the country of old red sandstone, and a mile and a half lower it is joined by the Proson, and a mile yet lower by the Carity. In the district in which these streams unite there is a considerable thickness of unstratified matter full of Grampian boulders, and covered for the greater part with stratified gravel and sand. In some cases the latter exhibit the diagonal laminæ common in subaqueous formations; and in others the strata are so contorted, that a perpendicular shaft might intersect the same beds three times. In the latter instances the surface of the subjacent red boulder clay has not partaken of the movement by which the stratified deposit was contorted; and in consequence Mr. Lyell ascribed the effect, when he first beheld it in 1839, to the lateral pressure of large masses of drifted ice repeatedly stranding upon a shoal of soft materials*. In the middle of the tract between the South Esk and the Proson is a dry valley, and to the south of this valley, near the Proson, an excavation was made ten years ago, which exposed extremely contorted beds overtopped by others perfectly horizontal, having been formed by tranquil deposition after the disturbance of strata previously deposited. The phænomena exhibited by the till in this district, Mr. Lyell conceives, might be well accounted for by supposing the union of three or four large glaciers; but he considers it difficult to explain the accumulation of the overlying stratified materials, the top of which must be 600 feet above the level of the sea, and facing the Strath. In following out the narrow ridge which intervenes between the Proson and the Carity, during last October, in company with Dr. Buckland, the latter drew the author's attention to a spot half a mile south-west of the House of Pearsie, where the surface of a porphyry rock was polished, furrowed, and scratched. The quarrymen of Forfarshire also state as a general fact, that rocks of sufficient hardness, when first laid bare, are smooth, polished and scored; and Mr. Blackadder has found on the Sidlaw Hills large boulders of sandstone grooved and polished. Another general fact mentioned by Mr. Lyell is, that the unstratified boulder-clay becomes more and more impervious in the lower part of the Grampian glens, not in consequence of the influx of distinct materials, but in the author's opinion of the grinding down by the ice of the mud and other detritus.

Mr. Lyell then describes the phænomena of the second district, or Strathmore. Though this district may be considered as one great strath, yet it is divided into many longitudinal ridges and valleys. The former, sometimes 300 feet in height, are for the greater part parallel to the strike of the old red sandstone, and are generally covered to the depth of sixty or more feet with till and erratics, derived from the Grampians and the subjacent strata. This covering is so general, that the structure of the district can be detected only in the ravines through which the principal rivers pass. The till constitutes invariably the oldest part of the detritus. The boulders which it contains sometimes exceed three feet in diameter: on the north muir of Kerriemuir is a block of trap-rock, six feet by five feet, and near it is a mass of mica-schist, nine feet long by four feet wide and three high. The till has been ascertained by Mr. Blackadder to fill, in many places, deep hollows in the sandstone,

* See *antè*, p. 178.

which would become lakes or peat-mosses if the till were extracted. This distribution of the detritus, Mr. Lyell observes, may be explained on the supposition that, if the cold period came on slowly, the advance of the glaciers would push forward the detritus accumulated at their termination, and fill up, wholly or in part, the lakes or other cavities which they would encounter in their progress. Along most of the river courses, and in the lowest depressions of Strathmore, the till is covered by stratified sand and gravel.

One of the most remarkable peculiarities of the transported materials of Forfarshire and Perthshire is a continuous stream, from three to three and a half miles wide, of boulders and pebbles, traceable from near Dunkeld, by Coupar, to the south of Blairgowrie, then through the lowest part of Strathmore, and afterwards in a straight line through the lowest depression of the Sidlaw Hills from Forfar to Lunan Bay, a distance of thirty-four miles. No great river follows this course, but it is marked everywhere by lakes or ponds, which afford shell-marl, swamps, and peat-mosses, commonly surrounded by ridges of detritus from fifty to seventy feet high, consisting in the lower part of till and boulders, and in the upper of stratified gravel, sand, loam and clay, in some instances curved or contorted. The form of the included spaces is sometimes oval, sometimes quadrangular. The finest examples are in the lower tract, which has the Dean for its southern boundary, and the road from the bridge of Ruthven to the south of the grounds of Lindertis for its northern. The Grampian boulders are throughout the same; but there are associated with them masses of actinolite schist, which Mr. Blackadder has ascertained could be derived only from the valley of the Tay. The fragments of secondary rocks belong to the formations of the districts in which they occur. Though the country occupied by these marl-loch lakes is not traversed longitudinally by any river, yet it is so low, that if the transported matter were removed, a very slight depression would cause the sea to flow from Lunan Bay by Forfar to Blairgowrie and Dunkeld. Mr. Lyell therefore formerly conceived that an estuary might have extended in that direction, and that the till might have been drifted by masses of ice floated from the Grampians and contiguous hills. The overlying ridges of sand and gravel he thought might have been bars formed one after the other, in the same manner as the bar of sand and shingle, which now crosses the mouth of the Tay. The inland ridges of sand with boulders, which Mr. Lyell noticed in Sweden, and certainly produced under the sea, confirmed him in this view. These Swedish ridges are from fifty to several hundred yards broad, but sometimes so narrow on the top as to leave little more than room for a road; they are from fifty to a hundred feet high, and they may be often traced in unbroken lines for many leagues, ranging north and south. In his account of these ridges, in a memoir published in the Philosophical Transactions *, Mr. Lyell states his belief that they were thrown down at the bottom of the Gulf of Bothnia, in lines parallel to the ancient coast, and during

* 1835, pp. 15, 16.

the successive rise of the land. They usually consist of stratified sand and gravel, the layers being often at high inclinations; but where they are composed of boulders, no stratification is observable. After a long search, Mr. Lyell succeeded in finding shells in a layer of marl belonging to a ridge in the suburbs of Upsala, about twelve feet below the summit of the ridge, and eighty above the sea. The shells consisted of *Mytilus edulis, Cardium edule, Tellina Baltica, Littorina littorea,* and *Turbo ulvæ,* the most common species in the Baltic, and they constituted the greater part of the layer. On the summit of the ridge, at a short distance, he noticed angular masses of gneiss and granite, from nine to sixteen feet long, which had evidently been lodged when the ridge was submarine.

In Forfarshire Mr. Lyell never succeeded, as in the above case in Sweden, in finding marine shells in the ridges of sand; nor does he remember to have seen in Sweden transverse ridges at right angles to the north and south. The glacier theory, the author states, appears to offer a happy solution of the problem of the marl-loch gravels, the longitudinal banks being regarded as lateral and medial moraines, and the transverse ridges as terminal. The chief objections are the stratification of the upper part of the banks, and the necessity of assuming a glacier thirty-four miles in length, with a fall of only 300 or 400 feet of country.

It has always appeared to Mr. Lyell and Mr. Blackadder remarkable, that the marl-loch gravels at Forfar are nearly 100 feet above the tract of till which separates them from the valley of South Esk, in Strathmore. In the present configuration of the country, water could not deposit the Forfar gravels without extending to the South Esk, the detritus of which is distinct, and separated by a low district of till without gravel. The only explanations of these phænomena Mr. Lyell considers to be either that the till is the moraine of a glacier, or that there has been a local change of relative levels of lands, by which the gravel of Forfar was uplifted, or the till to the northward depressed.

Another line of stratified detritus ranges at a higher level from the Loch of Lundie, along the Dichty Water, to the sea at Moray Firth, a distance of thirteen miles; and it is stated that many others might be enumerated. It is only on the coast to the east and west of Dundee, at heights varying from twenty to forty feet, that stratified clay and gravel have been found by Mr. Lyell to contain marine shells, all belonging to known existing species except a *Nucula.* Although these remains prove a certain amount of upheaval subsequent to the deposition of the till, or to the commencement of the glacial epoch, including an equal movement in the interior, still Mr. Lyell objects to a general submergence of that part of Scotland, since the till and erratic blocks were conveyed to their present positions; as the stratified gravel is too partial and at too low a level to support such a theory; and he would rather account for the existence of the stratified deposits, by assuming that barriers of ice produced extensive lakes, the waters of which threw down ridges of stratified materials on the tops of the moraines. With respect to the geological age of the beds containing the marine shells, Mr. Lyell is of opinion that it is synchronous with that of the older of the recent formations on the Clyde, examined by Mr. Smith of Jordan Hill, and Mr. E. Forbes; and with respect to the age of the till and stratified gravel last formed, he is of opinion that it is very modern, because these accumulations constitute exclusively the dams of certain marl-lochs to the very bottom of the sediment formed, in which al the Testacea and skeletons of quadrupeds, as well as the remains of plants which have been found, are of existing species.

The third district, or that of the Sidlaw Hills, claimed Mr. Lyell's attention more particularly on account of the Grampian boulders with which it abounds. This range, whose greatest height is 1500 feet above the sea, is composed of anticlinal strata of grey sandstone, belonging to the old red sandstone, with associated trap. It is covered, as well as the whole of the country between Strathmore and the Tay, with the impervious till, containing Grampian boulders and fragments of the subjacent grey sandstone. The finest instances of erratics observed by Mr. Lyell occur on Pitscanly Hill, 700 feet, and the adjacent hill of Turin, 800 feet above the level of the sea. About forty feet below the summit, on the southern side of the former, is a block of mica-slate thirteen feet long, seven broad, and seven in height above the ground, Four smaller and equally angular masses, from three to six feet in diameter, lie close to its north end, as if severed from it. One of the nearest points at which this gneiss occurs *in situ*, is the Craig of Balloch, fifteen miles distant, on the northern extremity of the Creigh Hill, and between these points intervenes the great valley of Strathmore and the hills of Finhaven. Other Grampian boulders, from three to six feet in diameter, occur on the hills between Lumley Den and Lundie, at the height of 1000 feet; and Mr. Blackadder has found fragments of mica-schist one foot in diameter on the summit of Craigowl, the highest point of the Sidlaw Hills, and exceeding 1500 feet above the level of the sea.

In conclusion, Mr. Lyell offers some remarks on the conditions under which glaciers may have existed in Scotland, and the differences between them and those of the glaciers of Switzerland. He states that the glaciers of the latter country being situated 11° further to the south, they can present but an imperfect analogy with permanent masses of ice in Forfarshire, and that it is to South Georgia, Kergulen's Land and Sandwich Land that we must look for the nearest approach to that state of things which must have existed in Scotland during the glacial epoch. In those regions of the southern hemisphere the ice reaches to the borders of the sea, and the temperature of summer and winter being nearly equalized, the glaciers probably remain almost stationary, like those of the Alps in winter, and can be diminished by only the first two of the three causes which tend to check an indefinite accumulation of snow in Switzerland; viz. 1st, evaporation without melting; and 2ndly, the descent of glaciers by gravitation, considered by M. Agassiz to be not very influential:—the third cause, the descent of glaciers arising from alternate liquefaction and freezing, he conceives must be wholly suspended in these regions.

As the tertiary strata prove that a warm climate certainly preceded the assumed glacial epoch in the northern hemisphere, and as a mild climate has since prevailed, Mr. Lyell says, there are three distinct phases of action to be considered in studying the supposed glaciers of Scotland: 1st, the coming on of the epoch; 2nd, its continuance in full intensity; and 3rd, its gradual retreat. At the commencement of the first condition, only the higher mountains would send down glaciers to be melted in the plains below, as at present in Switzerland, and in Chili between the 40th and 50th degrees of latitude. The ice would therefore thus be constantly advancing and retreating, but progressively, century by century, gaining ground, in consequence of diminishing summer heat; and pushing its terminal moraines forward, it would fill up lakes and other inequalities, till it finally reached the sea. During the second condition, when the motion of the ice would be very small, there would be, Mr. Lyell states, vast accumulations of snow filling the plains and valleys to a great height, and leaving bare only the higher peaks and precipices of the mountains. From these points, he conceives the erratic blocks were detached and conveyed almost imperceptibly along the surface of the frozen snow to great distances. Lastly, at the breaking up and gradual retreat of the glaciers during the third period, he is of opinion, the boulders were deposited in the various situations in which they are now found, and that moraines, or lateral and transverse mounds, were successively deposited, and lakes formed, by which stratified materials were accumulated in certain positions.

The second part of Dr. Buckland's Memoir on the Evidence of Glaciers in Scotland and the North of England, was then read.

The first part of the Memoir concluded with an account of glacial phænomena in the neighbourhood of Edinburgh (see *antè*, p. 337); and the line of country more particularly described in this portion extends southward from Edinburgh by Berwick, Newcastle, the Cheviots, the lake districts of Cumberland and Westmoreland, Kendal and Lancaster, to Shap Fell. A large portion of the low lands between Edinburgh and Haddington is composed of till or unstratified glacier-mud containing pebbles. In the valley of the North Tyne, about one mile east of Haddington, is a longitudinal moraine midway between, and parallel to, the river and the high road; and Dr. Buckland directs attention to the trap-rocks which commence a little further eastward, and are intersected by the Tyne for four or five miles above Linton, as likely to present scored and striated surfaces, where the valley is most contracted. Four miles west of Dunbar another long and lofty ridge of gravel stretches along the right bank of the river; and for three miles to the south-east of Dunbar extends a series of terraces or modified lateral moraines. In the high valleys at the east extremity of the Lammermuir hills, between Cockburn's Path and Ayton, moraines dispersed in terraces are also visible at various heights on both sides of the river; and on the left margin of the estuary of the Tweed, three miles north of Berwick, round tumuli and oblong mounds of gravel are lodged on the slope of a hill 300 or 400 feet above the level of the sea.

Moraines in Northumberland.—On many parts of the coast of Northumberland, especially near Newcastle, deposits of till rest upon the carboniferous rocks. At the village of North Charlton, between Belford and Alnwick, Mr. C. Trevelyan pointed out to Dr. Buckland in 1821, a tortuous ridge of gravel which was supposed to be an inexplicable work of art; but which he became convinced, after an examination in 1838 of the upper glacier of Grindelwald and that of Rosenlaui, is a lateral moraine. Dr. Buckland was prevented from examining the gorges through which the Burns descend from the eastern extremity of the Cheviots, but he directs attention to them as points where striæ and other proofs of glacial action may be found. Immediately below the vomitories of the eastern valleys of the Cheviots, enormous moraines are stated to cover a tract four miles from north to south, and two from west to east; and the high road to wind among cultivated mounds of them from near Woller, through North and South Middleton, and by West and East Lillburn to Rosedean and Wooperton. On the left bank of the College Burn*, immediately above the bridge at Kirknewton, Dr. Buckland discovered last autumn a moraine thirty feet high, stratified near the top to the depth of a few feet, but composed chiefly of unstratified gravel, inclosing fragmentary portions of a bed of laminated sand about three feet thick. Some of these fragments were in a vertical position, others were inclined, and the laminæ of which they were composed, were, for the greater part, variously contorted. He is of opinion that these detached portions were severed from their original position, moved forward, and contorted by the pressure of a glacier, which descended the deep trough of the College Burn from the northern summit of the Cheviots.

Evidence of Glaciers in the mountains of Cumberland and Westmoreland.— Proofs of glacial action, Dr. Buckland says, are as abundant throughout the lake districts and in the districts in front of the great vomitories through which the waters of the lakes are discharged, as in Scotland and Northumberland. Thus, in the vicinity of Penrith, near the junction of the Eden with the Eament and the Lowther, are extensive moraines loaded with enormous blocks of porphyry and slate, brought down, Dr. Buckland observes, by glaciers, which descended from the high valleys on the east flanks of Helvellyn, and in the mountains around Patterdale, into the lake of Ulleswater (considered to be then occupied by ice), and from the valleys by which the tributaries of the Lowther descend from the east flank of Martindale, from Haweswater and Mardale. A remarkable group of these moraines is by the road side near Eden Hall four miles east of Penrith; and the detritus of moraines is stated to occupy the greater part of the valley of the Eamont, from Ulleswater to its junction with the Eden. On the southern frontier of these moun-

* For a notice by the late Mr. Cully, of a sudden flood in this district in 1830, see Proceedings, vol. i. p. 149.

tains in Westmoreland and Lancashire similar moraines occur on an extensive scale. Thus, immediately below the gorge through which the Kent descends from the mountains of Kentmere and Long Sleddale, many hundred acres of the valley of Kendal are covered with large and lofty insulated piles of gravel; and smaller moraines, or their detritus, nearly fill the valley from Kendal to Morecombe Bay. Five miles north-east of Kendal, on the high road from Shap, on the shoulder of the mountain in front of the valley of Long Sleddale, and at an elevation of 500 feet, a group of moraines occupies about 200 acres, and is distinguished from the adjacent slate rocks by a superior fertility. On the south of Kendal, the high roads from Burton and Milnthorpe to Lancaster, pass for the greater part over moraines or their detritus; and Lancaster Castle, placed in front of the vomitory of the Lune, is stated to stand on a mixed mass of glacial debris, probably derived from the valley of the Lune. The districts of Furness, Ulverston, and Dalton are extensively covered with deep deposits of glacier origin, derived from the mountains surrounding the upper ends of Windermere and Coniston lakes; and they contain a large admixture of clay, in consequence of the slaty nature of many of the mountains. A capping of till and gravel, thirty to forty feet thick, overlies the great vein of hæmatite near Ulverston. The numerous boulders upon the Isle of Walney also indicate the progress of the moraines from Windermere and Coniston to the north-west extremity of Morecombe Bay.

Dr. Buckland was prevented from personally examining, during his late tour, the south-west and west frontiers of the Cumberland mountains, but he conceives that many of the conical hillocks laid down on Fryer's large map of Cumberland, in the valley of the Duddon, at the south base of Harter Fell, are moraines; that some of the hillocks in the same map on the right of the Esk, at the east and west extremities of Muncaster Fell, are also moraines formed by a glacier which descended the west side of Sca Fell; and that many of the hillocks near the village of Wastdale were formed by moraines descending westward. Dr. Buckland is likewise convinced that moraines exist near Church in the Valley; also between Crummoch Water and Lorton, in the valley of the Cocker; and near Isle, in the valley by which the Derwent descends from Bassenthwaite lake towards Cockermouth, though there are no indications of them on Fryer's map.

Near the centre of the lake district are extensive medial moraines on the shoulder of the hill called the Braw Top, and formed by glaciers at the junction of the valley of the Greta with that of Derwent Water.

Dr. Buckland had no opportunity of seeking for polished and striated surfaces in the high mountain valleys of the lake district; but he found them on a recently exposed surface of greywacke in Dr. Arnold's garden at Fox Howe near Ambleside; likewise near the slate quarry at Rydal; and on newly bared rocks by the side of the road ascending from Grassmere to the Pass of Wythburn; he is also of opinion that many of the round and mammillated rocks at the bottom of the valley, leading from Helvellyn by the above localities to Windermere, owe their form to glacial action.

The remarkable assemblage of boulders of Criffle granite at Shalkbeck, between Carlisle and Cockermouth, Dr. Buckland conceives may have been transported across the Solway Frith on floating masses of ice, in the same manner as the Scandinavian blocks are supposed to have been conveyed across the Baltic to the plains of Northern Germany.

Dispersion of Shap Fell Granite by Ice.—The difficulties which had long attended every attempt to explain the phænomena of the distribution of the Shap Fell boulders, Dr. Buckland considers, are entirely removed by the application of the glacial theory. One of the principal of these difficulties has been to account for their dispersion by the action of water; northwards along the valley, descending from Shap Fell to Shap and Penrith; southwards in the direction of Kendal and Morecombe Bay; and eastward, over the high table-land of Stainmoor Forest, into the valley of the Tees, as far as Darlington. A glacier descending northwards from the Fell would, on the contrary, carry with it, Dr. Buckland says, blocks to the village of Shap, and strew them thickly over the space where they are now found; another, taking a southern course, would drop the boulders on the hills and valleys over which the road descends by High Borough Bridge to Kendal; and a third great glacier, proceeding eastwards betwixt Crosby, Ravensworth, and Orton, would cross transversely the upper part of the valley of the Eden, near Brough, and accumulate piles of ice against the opposite escarpment until they overtopped its lowest depression in Stainmoor Forest, and disgorged their moraines into the valleys of the Greta and the Tees. There are abundant proofs, Dr. Buckland states, of the existence of this glacier in large mud and boulder moraines, in the ascent of the gorge between Shap Fell and Birbeck Fell, and in the furrows and striæ, as well as the mammillated forms of the rocks at the portals of the gorge, particularly on the northern side. In the physical structure of this neighbourhood, Dr. Buckland points out other conditions which would have facilitated the accumulation of glaciers, as the lofty mountains of Yardale Head, which overtop Shap Fell on the north-west, and the still higher mountains to the west, whose snows must have nourished enormous glaciers; and he concludes by stating that Professor Agassiz, during an independent tour, arrived at similar conclusions respecting the mode by which the Shap boulders were distributed.

ERRATA IN NUMBER SEVENTY-ONE.

P. 314, *line* 31, *for* Hadnor *read* Hadsor.
— 315, — 27, *after* Bredon *dele* Hill.
— 315, — 3 *from bottom, for* Sessional *read* Sectional.
— 316, — 13, *for* 387 *read* 587.
— 316, — 34, *for trichorhinus read tichorhinus.*

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

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Dec. 16.—Edward Kater, Esq., F.R.S., Mexborough, Yorkshire; and Sir Francis Shuckburgh, Bart., the Pavilion, Hans-place, Sloane-street, and of Shuckburgh, near Daventry, were elected Fellows of this Society.

A paper "On the Relative Connection of the Eastern and Western Chalk Denudations," by P. J. Martin, Esq., F.G.S., was read.

The author advances this as the first of a series of papers on the construction of that part of the country usually considered as appertaining to the great chalk denudation of the Weald, or more properly, the upburst of the secondary formations between the tertiary of the respective basins of London and Hampshire.

In venturing on this field of inquiry, he professes also to take up the subject where it was left by him in two former memoirs, one published in 1828 under the title of a 'Geological Memoir of Western Sussex, with some Observations on Chalk Basins and the Weald Denudation,' the other in the 'Philosophical Magazine' for February 1829; and to extend the number of demonstrative facts that bear upon the theory of denudation by disruptive violence and contemporaneous aqueous abrasion, there brought forward as a corollary to Dr. Buckland's theory of 'Valleys of Elevation.'

In pursuance of this object, he begins by an examination into the arrangement of the great chalk dome of Hampshire and Wiltshire,—the *Patria* of the chalk of Pennant and Conybeare; its anticlinal lines of disturbance or upheaval, and their connections with those of the Weald and the smaller western denudations of Pewsey, Wardour and Warminster.

He finds that six great anticlinal lines are the main instruments of the upbearing of this abraded chalk; that the three which characterize the smaller anticlinal western valleys are projected onward, and in a manner decussate three others which emanate from the western extremity of the greater valley of the Weald, the vale of Wolmar Forest, from whence he starts his inquiry; and that these lines do not inosculate or enter into each other; approximating, indeed, but little in any part of their course; severally dying out, and their respective synclinal lines playing off into each other. Their course is rather irregular, and their force exceedingly variable; but their general parallelism is maintained throughout, their progress being E. and W., with a point to the N.

The Pewsey line, after passing through the valleys of Ham and Kingsclere, is traceable between Woolverton and Hannington, on towards Monks Sherborne, and fades away at Old Basing, apparently without entering the tertiary beds of the London basin *. This meets in synclinal relation with a line projected from the north-west corner of the Wolmar valley from Pease Marsh, near Guildford, through Farnham and the high chalk range of Froyle, Shaldon, Dummer and Popham, and appears to fade away in the country west of Andover, where it is lost in the greater swell of the Burghclere Hills, and the more dominant power of the Pewsey upheaval.

The anticlinal line of Wardour, left by Dr. Fitton (in his 'History of the Beds below the Chalk' †) at Harnham Hill, S. of Salisbury, Mr. Martin finds traceable eastward, north of Dean Hill, and east of the Avon, to the banks of the Test, where it dips under the tertiary beds between Michaelmarsh and Romsey, and appears to fade away between the above-mentioned river and the Itching. In synclinal relation this line is also met and passed by a very remarkable anticlinal, traceable in strict approximation with, and by-and-by to be proved to be the *proximate cause* of, the whole line of the South Down escarpment (with a small exception between Lewes and Poynings) from Beachy Head to East Meon. In the vicinity of this place, at Langrish, it enters the chalk, passes through the anticlinal valley of Chilcomb near Winchester and that city, and is lost in the Bossington Hills, pointing towards, but not satisfactorily traced into, the Warminster line.

The details of all three lines of elevation are made out in the Ordnance Map, and sections given of the most illustrative points: and Mr. Martin adds some observations respecting the entrance of the great central line of elevation of the Weald into the chalk at Selborne, and its progress westward between the lines of Peasemarsh on the north, and of Greenhurst or the South Down on the south, till it fades away in the great plateau of Salisbury Plain.

The author concludes this paper with some reference to the subject of transverse fractures in these several longitudinal fissures, and the cross drainage, to which, like that of the Weald, he proposes to return, in extension and emendation of the disquisitions formerly published by him, as above alluded to, and which will be adduced as illustrative of the strong probability, if they do not amount (in connexion with the phænomena of drift) to absolute proof, of the close relation of the acts of upheaval and violent aqueous abrasion. This necessarily implies the belief that the date of these lines of disturbance is posterior to that of all the stratified beds of the south-east part of England, as maintained in the author's former essays,

* The author thinks, that although this line fades away as it enters the tertiary beds at Old Basing, it is probable that, after passing silently along the London basin, it is revived again in the Isle of Thanet, which is a chalk outlier, by protrusion; in the same way that the parallel line of Portsdown Hill, High-down, near Worthing, and the Seaford Cliff (figured by Dr. Mantell) does on the southern coast.

† Geol. Trans., second series, vol. iv. p. 244. *et seq.*

but in the full discussion of which he declines to enter till the whole subject is before the Society.

Jan. 6, 1841.—John Dakin Gaskell, Esq., Norfolk-street, Strand, and the Marquess of Bute, F.R.S., Camden Hill, Kensington, were elected Fellows of this Society.

A paper was first read "On the Illustration of Geological Phænomena by means of Models," by Thomas Sopwith, Esq., F.G.S.

Mr. Sopwith commences by stating, that drawings cannot convey to the mind a correct notion of geological phænomena where more planes than one are required; and that few persons are aware of the extraordinary changes which are produced in the combinations of strata by viewing them on different planes, especially if the strata are dislocated; or in undisturbed and parallel strata, of the totally different apparent forms which are exhibited on an undulating surface and in any plane section of the interior. This difference is of great importance in mining plans, where the surface only in the first instance is accessible to examination, and the observer is too apt to infer from it, the subterranean relations of the strata. To convey clear notions of these differences Mr. Sopwith has prepared a series of hand models, about two inches square, formed of layers of differently coloured woods, and capable of being dissected, to a certain extent, vertically, obliquely or horizontally. They are also so shaped on the upper surface as to exhibit the undulations of the ground. It is not possible to convey verbally, a clear notion of the many curious combinations exhibited by these models.

A paper was next read, "On the Geology of the island of Madeira," by James Smith, Esq., of Jordan Hill, F.G.S.

The crust of that island, Mr. Smith states, is composed to the depth of several thousand feet of subaërial volcanic matter, erupted during the tertiary period; and he adds, perhaps no other volcanic region offers more favourable opportunities for investigation. To account for its rugged and fragmentary character, it is not necessary, he says, to have recourse to the supposition that Madeira is one of the remains of a vast continent, as there are in the volcanic constitution of the island, and in the action of the mountain torrents, sufficient elements to afford data for explaining every physical phænomenon.

The igneous rocks composing the greater part of the island, are lavas, sand, and ashes, with bombs, lapilli, pumice, volcanic scoriæ or cinders, tufas and conglomerates; and the non-igneous, the limestone of San Vincente, the coal or lignite of San George, and the sands of Caniçal.

Volcanic Rocks.

The lavas are wholly basaltic, containing numerous crystals of olivine; and they are compact, scoriaceous and vesicular.

The compact variety occurs in beds or *coulées* interstratified with the other volcanic products, and in dykes which intersect all the igneous rocks. It is occasionally amorphous, but more often rudely columnar; it also, though rarely, presents regular columns; and it is sometimes schistose, possessing planes of cleavage as well as of regular stratification.

The scoriaceous basalt is rough and porous, resembling the slag of a foundry. Where the bed is thin it is scoriaceous throughout, but where it is of a certain thickness only the upper and lower surfaces exhibit this character. Two caverns of considerable magnitude occur immediately to the west of the principal landing-place at Funchal, and there are others in the island.

The vesicular lava or basalt presents through its whole mass a porous texture. The large vesicles have been flattened by the gravity of the lava, and elongated in the direction in which the *coulée* flowed. Where they are numerous and minute, they permit the rock to be easily hewn; and this variety is called *cantaria rija*, or the hard building stone.

The lapilli, sand, ashes and volcanic bombs, appear to have been projected simultaneously, as the bombs were evidently half imbedded in the finer materials by the force of their fall, the laminæ beneath them being bent upwards, and in some instances to a greater height on one side than the other, indicating the direction in which the bombs fell.

The pumiceous lapilli are white or light yellow, and rarely exceed in size a pigeon's egg. Beds of pumice, varying in thickness from a few inches to several feet, occur either on the surface or interstratified with the basalt and tufa; and they often contain portions of heavier volcanic products, as cinders or scoriæ, dispersed without regard to gravitation, proving, Mr. Smith says, that these various materials could not have been deposited under the sea, because in water they would instantly have separated according to their respective weights. The scoriæ or cinders also form extensive beds. They are generally reddish, and vary in size according to the distance from the orifice of eruption.

The ashes, both dark and light-coloured, are incoherent, except where they are mixed with earthy matter, or apparently fell on a heated cone of eruption; and in these cases they form a scoriaceous mass. Tufas and conglomerates compose a large proportion of the volcanic rocks of Madeira, and are considered to owe their consistency to water. Fragments of vegetables are not uncommon in them, but Mr. Smith is not aware that they contain any other organic remains. Many of these beds have been converted into vegetable soils, and it is interesting, the author says, to observe the roots of plants still in the attitude in which they grew; and to witness traces of the very same phænomena which are now taking place at the surface, in strata which have been buried for so many ages under solid rocks. The remains of plants are chiefly found in the vegetable soils, but their roots occasionally occur in the hard rock, and the cracks or fissures are in many cases filled with closely-matted masses of what was once roots and fibres, but now consist of carbonate of lime. Where the soils have been overflowed with lava, the vegetable remains are charred, and the soils have been burnt to the colour and hardness of brick; and if the overlying lava is of great thickness, a columnar structure appears. This conversion of soil into brick has been observed in the Azores and elsewhere.

The principal chain of mountains must at one time, Mr. Smith states, been much higher, because their very summits consist of beds which are met with only at the base of active volcanic cones. There is consequently no great crater in the island, but there are the ruins of several truncated craters, and many small lateral cones. The most extensive of the former is the Curral dos Freiras, an immense ravine about three miles in length, one in breadth, and 2000 feet in depth, and open on its southern side. The beds of basalt, tufa and ashes of which it is composed, dip outwards to the base of the mountain, and parallel to its surface. Mr. Smith is convinced, the volcanic products of the island being subaërial, that this is not a crater of elevation, though it agrees with the characters which have been assigned to such craters; and he is further induced to infer, from the resemblance of the Curral dos Freiras to the more ancient portions of Teneriffe and the other Canary Islands, said to be craters of elevation raised from beneath the level of the sea, that a wrong conclusion has been drawn respecting them. He does not object to there being elsewhere true craters of elevation.

The principal lateral cones are to the west of Funchal, but they are in general so completely blotted with vegetation that their structure is concealed. In the ditch of a fort constructed on one of them, called Pico de St. João, a scoriaceous conglomerate intersected by minute basaltic veins is exposed; and a similar conglomerate occurs in the fortified island in Funchal Bay, also at the eminence at the landing-place. Some of these cones are covered by beds of lava and tufa erupted from craters at Cape Giram, in one instance to the thickness of 1400 feet. The beauty and regularity, within limited distances, of these volcanic strata, and the richness and variety of their colouring, are exceedingly striking. The most remarkable volcanic series, amounting to many hundred beds, is at Cape Giram, the cliff, 1600 feet in height, being stratified from the base to the summit. It has been rent in many places, and the fissures which terminate upwards in acute angles, have been filled with lava ejected from below.

Non-volcanic Rocks.

The limestone of San Vincente, Bowditch considered to be transition, but Mr. Smith shows that it belongs to the tertiary epoch, yet he believes it to be the fundamental rock of the island. It crosses a mountain stream between 2000 and 3000 feet above the level of the sea, and abounds in zoophytes and marine testacea belonging to the genera *Cardium, Pecten, Pectunculus, Spondylus, Cypræa, Voluta, Fasciolaria, Strombus* and *Murex*. The state of preservation, generally in that of casts, rendered it impossible to determine accurately the species. The limestone is traversed by two dykes of basalt, and it lies immediately under the Paul de Serra, a volcanic plateau which rises 2500 feet above the limestone.

The coal or lignite occurs on the north side of the island, on the banks of one of the tributaries of the St. George. Professor Johnstone considers it to be the dried relict of an ancient peat bog, and its lustre, compactness and rhomboidal fracture to be due to the action of the basalt which overlies it. An analysis gave

Carbon	60·7
Hydrogen	5·82
Oxygen and nitrogen	33·47
	99·99

and 20·05 per cent. of ash. This is the organic constitution of true peat; but no peat exists at present in Madeira, nor as far as Mr. Smith is aware, has any been noticed so near the equator. He therefore suggests that this deposit may indicate a former colder climate in that latitude.

The sands of Caniçal are found near the eastern extremity of the island, in a valley which extends from the northern to the southern shore; and they consist of small particles of basalt and comminuted testacea, enclosing vast numbers of land shells as well as calcareous incrustations of plants. The shells have been most carefully examined by the Rev. Mr. Lowe, and one sixth ascertained to belong to species not now found living in the island; the Caniçal sands therefore are assigned by Mr. Smith to the Pleistocene or newest tertiary æra. The calcareous incrustations have been considered by some observers not to be of vegetable origin, in consequence of the general absence of organic structure; and Dr. Macaulay is of opinion, from their consisting of carbonate and phosphate of lime, silica and animal matter, that they are of animal origin, and probably belonged to the family of *Alcyonidæ*. As however they are mere casts, Mr. Smith conceives that an analysis cannot throw light on their origin; and as all of them bear the most perfect resemblance to trunks or branches, and one of his specimens exhibits impressions externally of cellular structure, he has no doubt of their being the calcareous casts of plants.

In one of the small islets adjoining Porto Santo is a bed of fossiliferous limestone, which supplies the kilns of Funchal. The fossils consist almost exclusively of casts, but Professor Agassiz having been enabled to identify some of them with casts of recent species, Mr. Smith infers that the limestone is an extremely modern formation, though it has all the characters of primary marble. In this case, the volcanic action, Mr. Smith states, was evidently submarine, as the contact of the basalt and the limestone is so intimate that the two rocks never separate when a mass composed partly of each is detached by force. The elevation of the islet above the level of the sea has not, however, disturbed the horizontal position of the beds.

On the island of Porto Santo the volcanic action was sub-aërial, as the basalt is scoriaceous on the surface, and rests on volcanic brick. In this island there is a sandy deposit similar to that at

Caniçal. The Disertas, lying about three leagues to the south-east of Madeira, Mr. Smith describes as a chain of volcanic mountains ranging north and south, or nearly at right angles to that of Madeira. The sea-cliffs reach to their very summits, and exhibit a series of beds of basalt, ashes, tufas, and volcanic brick, intersected by innumerable dykes. No fossils have yet been discovered on these islands.

The occurrence of the marine limestone of San Vincente at an elevation of 2500 feet, proves a relative change in level of land and sea to that amount, previously, Mr. Smith is of opinion, to the ejection of the overlying volcanic products; but he has not observed in Madeira any proofs of elevation of the land during or subsequent to the volcanic period; though there are strong indications of subsidence, the beds of scoriæ and ashes, and those containing vegetable remains, dipping under the sea, and occurring in situations where they could not have remained, had the sea level been always the same as at present.

A letter, dated Madras, July 1840, addressed to John Taylor, Esq., Treas. G.S., by Mr. Frederick Burr, on the Geology of Aden, on the coast of Arabia, was afterwards read.

The promontory of Aden, eighty miles eastward of the Straits of Bab-el-mandel, consists of a bold cluster of volcanic rocks with lofty jagged peaks, and is connected with the main land by a low isthmus. Its extreme length is about six miles, and its breadth is about three miles, and the summit of the highest point is about 1776 feet above the level of the sea. The loftier portions of the promontory are wholly volcanic, and the lower are partly volcanic and partly consolidated sea-sand. The most interesting portion of the district is an immense, nearly circular crater, situated at the extremity of the promontory next the main land, and in the centre of which, upon a flat little raised above the sea-level, stands the town of Aden. The diameter of the crater is about one and a half mile, and it is surrounded on all sides but the eastern with precipices chiefly composed of lava, and rising from 1000 to 1776 feet in height. Although the crater appears at first sight almost perfect, Mr. Burr says, it has been affected by some rude shocks which have cleft it entirely through from north to south, forming two rents, known as the northern and southern passes. The portion to the west of the fissures, and called the Gebel Shunsam, rising to the height of 1776 feet, stands entire; but that to the east has evidently undergone a partial subsidence, attaining to not more than half the height of the western side, and for the distance of about half a mile it has been broken down, allowing the sea to come almost close to the town and form a little bay; but the direction of the original outline of the crater is indicated by the island of Seerah, situated in about the middle of the gap.

To the northward of this great crater is an immense mass of lofty and jagged volcanic products, probably the remains of smaller craters.

The prevailing rock is a dark brown or chocolate lava, generally of a very cellular structure. About the middle of the east side of the great crater, it contains a very thick mass, composed of alternations of greenish porphyry, slightly lamellar in structure, and of red ochreous clay. Near the northern pass Mr. Burr noticed a granular rock, or volcanic breccia. The inclination of the beds is generally 15° from the crater.

Numerous perpendicular dykes intersect the volcanic rocks, and are harder and more compact than the beds they traverse. Small veins of calcedony also occur.

Dr. Malcolmson showed Mr. Burr some specimens of black and green obsidian obtained on the promontory, but the conditions under which they exist Mr. Burr was prevented from ascertaining.

The deposits of consolidated sea-sand occur more especially near the northern pass, towards the base of the volcanic ridges. The stratification is diagonal, and this arrangement Mr. Burr conceives to have been produced by the drifting of opposing currents. The flat line of coast on the northern part of the promontory, the author says, is evidently a raised beach, and the consolidation of the sand he assigns to the action of a tropical sun upon the calcareous materials. The stone incloses numerous shells and corals of species existing in the Arabian Sea.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

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Jan. 20.—William Lindley, Esq., Adelphi Terrace, Colonel Edgar Wyatt, and James Hastie, Esq., of Broad-street Buildings, were elected Fellows of this Society.

A paper was first read, "On the Teeth of Species of the Genus *Labyrinthodon* (*Mastodonsaurus Salamandroides*, and *Phytosaurus* (?) of Jäger) from the German Keuper and the Sandstone of Warwick and Leamington, by Richard Owen, Esq., F.G.S., F.R.S.

The Warwick sandstone having been considered by some geologists to be the equivalent of the Keuper*, and by others of the Bunter Sandstein†, and as its true position remains to be determined, Mr. Owen, in the preliminary remarks to his memoir, points out the assistance which the discovery of reptilian remains in the Warwick sandstone of the same generic characters as those of fossils obtained in the Keuper of Germany, may afford in determining the question.

Before he proceeds to describe the fossils forming the immediate object of his paper, Mr. Owen shows that the genus *Phytosaurus* was established on the casts of the sockets of the teeth of *Mastodonsaurus*; and that the latter generic appellation ought not to be retained, because it recalls unavoidably the idea of the mammalian genus *Mastodon*, or else a mammilloid form of the tooth, whereas all the teeth of the genus so designated are originally and, for the greater number, permanently of a cuspidate and not of a mammilloid form; and because the second element of the word, *saurus*, indicates a false affinity, the remains belonging, not to the Saurian, but to the Batrachian order of Reptiles. For these reasons, and believing that he has discovered the true and peculiarly distinctive dental characters of the fossil, he proposes to designate the genus by the term *Labyrinthodon*.

The only portions of the Batrachian found in the Keuper of Germany, which have hitherto been described, consist of teeth, a fragment of the skull, and a few broken vertebræ; and in the Warwick sandstone of teeth only. In this memoir, therefore, Mr. Owen confines his attention to a comparison of the dental structure of the Continental and English remains. The teeth of the *Labyrinthodon Jaegeri* (*Mastodonsaurus Jaegeri*, Meyer) of the Keuper are of a

* See Proceedings, vol. ii. p. 453. † Ibid. vol. ii. p. 565.

simple, conical form, with numerous fine longitudinal striations; and the teeth transmitted to Mr. Owen from the Warwick sandstone by Dr. Lloyd, bear a very close resemblance to them. Their external characters not being sufficient to establish either specific or generic identity, Mr. Owen had sections prepared for microscopic examination of portions of teeth of the *Labyrinthodon Jaegeri* forwarded to him by Prof. Jäger, and of the English reptile; and though, from his previous examination of the intimate texture of the teeth of the Plesiosaur, Megalosaur, as well as of the Crocodile, Monitor, and most recent Lacertians, he did not hope to detect such modifications of structure as would obviously mark specific or even generic identity, yet the slices exhibited such decided characters, and those of the German fossils agreed so intimately with the sections obtained from the Warwick specimen, that Mr. Owen was enabled not merely to separate these fossils from all known reptilian animals, but to establish a generic community of character in the Keuper and sandstone remains. It was not, however, until he had caused sections to be made in various directions, and had studied them attentively in comparison with the teeth of true Saurians, Batrachians, and other animals, that he was enabled to comprehend the principle of the singular cerebriform convolutions which pervade the dental structure of this remarkable reptile. The base of the tooth of the *Ichthyosaurus* approaches most nearly in character to the peculiarities of nearly the entire tooth of the *Labyrinthodon*. It is impossible to convey clearly without illustrations the structure alluded to. It may, however, be stated, that in the fang of the tooth of the *Ichthyosaurus* vertical folds of the external layer of cement (the enamel ceasing at the base of the crown) are inflected inwards, at pretty regular distances around the circumference of the tooth, towards the centre to a distance about equal the breadth of the interspaces of the inflected folds; the interspaces being occupied by corresponding processes of the dentine, which radiate from the central mass of that substance. The thickness of this interblended cement and dentine, surrounding the pulp-cavity, is about one-eighth of the diameter of the tooth.

The plan and principle of the structure of the tooth of the *Labyrinthodon* are the same as those of the tooth of the *Ichthyosaurus*, but they are carried out to the highest degree of complication. The converging vertical folds of the external cement are continued close to the centre of the tooth, and, instead of being straight, simple lamellæ, they present a series of irregular folds, increasing in complexity as they proceed inwards, and resembling the labyrinthic anfractuosities of the surface of the brain; each converging fold is slightly dilated at its termination close to the pulp-cavity. The ordinary laws of dental structure are, however, strictly adhered to, and every space intercepted by a convolution of the folds of the cement is occupied by corresponding processes of the dentine. These characters were presented by a transverse section of a fragment of a tooth of the *Labyrinthodon Jaegeri* from the German Keuper, which included about the middle third part of a tooth, and Mr. Owen considers that the entire length of the tooth might be $3\frac{1}{2}$ inches, and the breadth at the basis $1\frac{1}{2}$ inch.

The external longitudinal grooves, which correspond to the inflected folds of the cement, extend upwards from the base of the tooth to about three-fourths of its height, decreasing in number as the tooth diminishes in thickness, and disappearing about half an inch from the summit of the tooth. Each fold of cement penetrates less deeply as the groove approaches its termination; and Mr. Owen conceives that the structure of the upper part of the tooth may be more simple than that of the lower, but he has not yet been able to extend his investigations to it.

The dentine consists of a slender, central, conical column or "modiolus," hollow for a certain distance from its base, and radiating outwards from its circumference a series of vertical plates, which divide into two, once or twice, before they terminate at the periphery of the tooth. Each of these diverging and dichotomizing vertical plates gives off throughout its course narrower vertical plates, which stand at nearly right angles to the main plate, in relation to which they are generally opposite, but sometimes alternate. Many of the secondary plates, which are given off near the centre of the tooth, also divide into two before they terminate. They partake of all the undulations which characterize the inflected folds of the cement.

The central pulp-cavity is reduced to a line, about the upper third of the tooth; but fissures radiate from it, corresponding in number with the radiating plates of the dentine. One of these fissures is continued along the middle of each plate, dividing where it divides, and penetrating each bifurcation and process; the main fissures extend to within a line or half a line of the periphery of the tooth; the terminations of these, as well as the fissures of the lateral processes, suddenly dilating into subcircular, oval, or pyriform spaces. All these spaces constitute centres of radiation of the fine calcigerous tubes, which, with their uniting clear substance, constitute the dentine. The number of these calcigerous tubes, which are the centres of minor ramifications, defies all calculations. Their diameter is the $\frac{1}{7000}$th of a line, with interspaces equal to seven diameters of their cavities.

Mr. Owen then compares the structure of the section of a tooth procured in the sandstone of Coton-End Quarry, and lent to him by Dr. Lloyd of Leamington. The tooth nearly resembles in size and form the smaller teeth of *Labyrinthodon* figured by Prof. Jäger. All the peculiarities of the labyrinthic structure of the Keuper tooth are so clearly preserved in this specimen, that the differences are merely of a specific nature.

At the upper part of the tooth a thin layer of enamel*, besides a coating of cement, is inflected at each groove towards the centre of the dentine; but about the middle of the tooth the enamel disap-

* Mr. Owen has subsequently ascertained that this is not true enamel, but a layer of firm dentine, separated from the rest by a thin stratum of fine calcigerous cells.

pears, and the convolutions consist of interblended layers of cement and dentine. Thus, on the supposition that the tooth of the *Labyrinthodon* of the German Keuper be capped with enamel, its extent must be less than in the tooth of the Warwick sandstone.

The inflected folds are continued for a greater relative distance before the lateral inflections commence than in the German species, and the anfractuosities are fewer in number, and some of the folds are reflected backwards from near the central pulp-cavity for a short distance before they terminate.

The modifications of the complex diverging plates of the dentine hardly exceed those of a specific character, and the dentine itself is composed of calcigerous tubes of the same relative size and disposition as in the *Labyrinthodon Jaegeri.*

In a section taken from the middle of a smaller and relatively broader and shorter conical tooth from the Warwick sandstone, Mr. Owen found that the anfractuosities were more complicated, with numerous secondary and tertiary foldings, and the external layer of cement was relatively thicker than in the *Lab. Jaegeri.*

The generic identity of the Reptiles, indicated by the teeth from the Warwick sandstones, with the *Mastodonsaurus* of the German Keuper, Mr. Owen believes to be fully established by the concordance of their peculiar dental structure above described. And in conclusion, he says, if, on the one hand, geology has in this instance really derived any essential aid from minute anatomy, on the other hand, in no instance has the comparative anatomist been more indebted to geology than for the fossils which have revealed the most singular and complicated modification of dental structure hitherto known; and of which not the slightest conception could have been gained from an investigation, however close and extensive, of the teeth of existing animals,

A paper was next read, entitled "Observations relative to the Elevation of Land on the shores of Waterford Haven during the Human Period, and on the Geological Structure of the District;" by Thomas Austin, Esq.

The shore on the west side of Waterford Haven, from the rock of Passage to Woodstown, a distance of three miles, presents an almost uninterrupted cliff of clay and gravel, composed chiefly, if not wholly, of detritus of old red sandstone, and enclosing a bed from one to four feet thick of *Cardium edule,* with other marine testacea of existing species, and a few land-shells. This bed of shells is not confined exclusively to the coast, but it extends inwards to the distance of eight miles, distinct traces of it occurring between Waterford and Tramore, and at several intermediate points. In the alluvial valley of Woodstown, close to Newtown Head, the shells rest on an ancient peat bed, raised but a few inches above the sea-level. On the eastern side of Waterford Haven beds of similar shells occur at the same level; also in the cliff north of Bluff Head, at the height of eight feet. The greatest elevation at which the shelly beds have been observed by Mr. Austin in the county of Waterford, is forty feet.

Immediately north of Newtown Head, at the point where a gradual rise takes place in the cliff, the greater part of a human skeleton was found resting on its back, five feet three inches below the surface, and about the same distance above high-water level, in the centre of the shelly bed. The *Cardium edule* was as numerous in and around the skeleton as in other portions of the bed, many of them being lodged in the cavity of the skull. Mr. Austin carefully examined the conditions under which the skeleton was found, and he is convinced that the ground had never been disturbed for sepulture, the continuity of the shelly bed being unbroken where the skeleton occurred, and no specimens of the *Cardium edule* being dispersed at random through the incumbent loam. He is therefore of opinion, that the body was washed into the estuary during the period when the shelly bed was accumulated; that it was arrested at the point where it has been found by the rise in the level of the bed; and that consequently an elevation of the country has taken place since the commencement of the human period.

From an extended examination Mr. Austin is convinced, that the estuary now limited to Waterford Haven formerly covered a much larger area, as proved, in part, by the patches of shells noticed above; and that the change of relative level has been slow and uniform, producing no local disturbances; and he is further of opinion, that the operation may be still in progress.

Mr. Austin then gives a general description of the geological structure of the two shores of Waterford Haven and of the adjacent districts. The formations consist of mountain-limestone, old red sandstone, schistose strata, considered to be of the age of the Silurian system on account of the fossils found near Duncannon Fort and Newtown Head, and trap rocks.

The mountain-limestone constitutes Hook Point, the southernmost headland of the Wexford side of the Haven. It is succeeded to the north, conformably, by a red or yellow sandstone, containing obscure vegetable remains, also thin seams and nodules of anthracite, likewise some small masses of black copper ore. These beds are assigned by the author to the upper part of the old red sandstone. They are succeeded in regular descending order by various marls, sandstones and conglomerates, composing the mass of the formation, and estimated to be 1600 feet thick. A series of contorted and tilted slaty beds are then presented; but at Broom Hill the conglomerates of the old red sandstone reappear with the same dip towards the south. Immediately north of this promontory the slates recommence, and are displayed in unconformable juxta-position with the old red sandstone, the latter dipping southwards, and the former at a higher angle northwards. From Broom Head to Arthurstown the slates constitute the whole line of coast, except at Duncannon Fort. The strata are, for the greater part, variously contorted; but near Arthurstown they dip 70° to the north, and are overlaid by beds of old red sandstone, which also dip to the north, but at an angle of only 30°. At Duncannon Fort an impure limestone occurs, containing Trilobites, corals and testacea, and considered by Mr. Austin to be analogous to species found in the Silurian system.

On the opposite or Waterford side of the Haven the old red sandstone occurs at Creden Hill and Knockavelish Head, eminences corresponding to Broom Hill; a small patch of it is displayed a little to the northwards, inserted unconformably in the slate series; and it forms the rock of Passage, a prolongation of the old red sandstone near Arthurstown. Between Knockavelish Head and Passage the slate series prevails, except near Newtown Head, where trap-rocks are exposed. A little to the north of that headland are some highly inclined fossiliferous strata, corresponding in position to the beds near Duncannon Fort on the opposite side of the Haven; they are visible only at ebb-tide.

The trap-rocks constitute the point on which stands Duncannon Fort; Newtown Head is also formed of trap; and Mr. Austin is of opinion that the same mass strikes westwards to Tramore and thence to Great Newtown Head, where it is lost in the St. George's Channel. Along this line, wherever the trap comes to the surface, the slates are tilted.

With respect to the numerous contortions exhibited in the schistose rocks, Mr. Austin ascribes their existence to lateral pressure, which he says must have been excessive; and he is of opinion that a considerable portion of the upper part of these contorted beds has been removed by denudation.

A paper by C. Lyell, Esq., F.G.S., was afterwards read, "On the Freshwater Fossil Fishes of Mundesley, as determined by M. Agassiz."

In a memoir on the boulder formation and associated freshwater deposits of Eastern Norfolk*, Mr. Lyell stated, on the authority of Mr. Yarrell and the Rev. L. Jenyns, that the scales and teeth of fishes which had been then procured in the fluviatile beds of Mundesley belonged to the *Esox lucius,* to a trout or an undeterminable species of *Salmo,* to a carp, probably the *Cyprinus carpio,* and to a distinct species of *Perca.*

This collection, with some additions recently sent to the author by Mr. Wigham, was examined by M. Agassiz during his late visit to England. The decision of Mr. Jenyns with respect to the distinctness of the perch, M. Agassiz fully confirmed; but he was of opinion that the pike differs from the *Esox lucius,* and that the supposed carp is a species of *Leuciscus*; and that the trout is not truly a trout, although one of the same great family.

From this examination, therefore, Mr. Lyell says it is apparent that these remains belong to species not identical with any European freshwater fishes hitherto described; but that they nevertheless belong to an ichthyological fauna, more modern and more nearly resembling the recent than any other with which M. Agassiz is acquainted in a fossil state.

Similar remains have been found by Mr. Lyell at Runton, near Cromer, but both there and at Mundesley the associated testacea all belong to living freshwater species; even the *Paludina minuta* (Strick-

* See Proceedings, *antè,* p. 171.

land), which Mr. Morris has pointed out to the author to be identical with the *P. marginata* of Michaud, a living French species. It is a question therefore, the author states, whether these unknown fishes may not still inhabit the rivers and lakes of the more northern parts of Europe or America, especially as M. Agassiz is at present unacquainted with the freshwater fishes of Norway, Sweden, Spitzbergen, Iceland, Greenland, Labrador and Canada, and even of the northernmost parts of Scotland and the Shetland Islands; and in conclusion Mr. Lyell says, it seems natural to look northward for types analogous to the Mundesley fishes, because the beds in which they occur were deposited contemporaneously with the drift accumulated by the agency of floating ice.

Feb. 3.—A paper was read, "On the Geological Structure of the Wealden District, and of the Bas Boulonnais," by William Hopkins, Esq., F.G.S.

This paper is divided into two parts. In the first the author describes the phænomena of elevation presented in the two districts comprised respectively within the boundary of the great Chalk escarpment of the south-eastern part of England, and an exactly similar escarpment forming the inland boundary of the Bas Boulonnais. The former is well known as extending from the coast at Folkstone, by Seven Oaks, Godstone, Farnham, Petersfield, etc., round to the coast again at Beachy Head. On the opposite side of the channel, the escarpment, commencing at Wisant on the north, forms nearly a semicircle, of which Boulogne is not far from the centre. If we conceive the northern Weald escarpment continued from Folkstone to Wisant, and the southern one from Beachy Head to the southern extremity of the Bas Boulonnais, it will be seen that the whole tract comprised within the Chalk would be a regular oval, except that its axis instead of being straight is *curved*, so as to incline towards the S.E. in its eastern portion. These two districts are thus connected by relative position not less than by a community of geological character.

In the second part of his paper the author compares the laws of the existing phænomena in these districts with the results given by his 'Theory of Elevation,' published in the Transactions of the Cambridge Philosophical Society (Vol. VI. Part I.).

I. The lines of elevation in the Wealden district are partly marked by an anticlinal arrangement of the beds, and partly by strong flexures, forming *one-sided saddles*. The latter have been termed by the author *lines of flexure*. The central portion of the district is first described. The following lines of elevation are found in it.

1. *Hastings Line*.—This line runs to the north-east of Hastings towards Battle. It has been mentioned by Dr. Fitton and other geologists. The author had not had time to examine it himself.

2. *Brightling Line*.—This is strongly anticlinal, and runs along the high ridge of Brightling Down as far as Heathfield Park, where its distinct features are lost. The author has not ascertained whether it is a continuation of the Hastings line.

3. *Wadhurst Line.*—This line runs by Wadhurst and Hawkshurst, to the south-west of which place it is lost. It also ranges westerly along the ridge between Wadhurst and Mark Cross.

4. *Crowborough Line.*—Crowborough Beacon stands on what must be regarded as the great central ridge of the district. The anticlinal line runs near the Beacon and is continued westerly to the north of Balcombe. No traces of it however are distinguishable beyond Horsham.

5. *Cuckfield Line.*—This line extends parallel to that last described, and immediately to the north of Cuckfield. It is not to be traced far to the west of that place. To the east it is continued across the Brighton railway, where it was very distinctly exhibited in the new cuttings.

6. *Frant Line.*—At Lamberhurst this line is distinctly marked. It proceeds westward along Frant Hill, where its evidence, however, is not very distinct. It appears to be lost entirely not far to the west of Frant.

7. *Bidborough and Brenchley Line.*—Bidborough Hill is formed by a strong flexure of the beds by which the Hastings sand is brought up from beneath the Weald clay. Brenchley Hill is formed in the same manner, but presents a more distinct anticlinal arrangement. These hills are separated by a wide transverse valley of denudation, but there can be little doubt, it is conceived, that they belong to the same line of elevation. The dislocation is also continued westward, but with less distinctness, across the Medway.

All these lines preserve a remarkable parallelism with each other and with the *curved central axis* of the district.

The author also describes several transverse valleys of the central portion of the district, and states the evidence on which he believes them to have originated in transverse dislocations.

8. *Greenhurst Line.*—This line has been described by Mr. Martin, by whom it was first detected. It is distinctly marked from a point south-west of Pulborough, whence it runs not far from and parallel to the chalk escarpment, till it strikes into the chalk at Piecomb. Its continuation westward is not very distinct, but eastward it is strongly defined at Lewes. Several remarkable transverse valleys across the greensand ridge are also found in the south-western part of the district, and present evidence of having originated in transverse dislocations. Their directions are as nearly as possible perpendicular to that of the Greenhurst line.

9. *Line from Farnham to Seven Oaks.*—This line runs parallel to the chalk escarpment of the North Downs and near to it. It is a line of flexure, with a great dip to the north, but without the corresponding dip to the south necessary to form an anticlinal arrangement, except in one or two localities. Towards the west it runs immediately at the foot of the Hog's Back with a dip, which, near its western extremity, amounts to 70 or 80 degrees. Near Guildford it passes by the foot of the hill on which Margaret's chapel stands. To the east it passes south of Dorking and Reigate to the summit of Tilburstow Hill. It is afterwards continued by Limpsfield to the east of Seven Oaks, as formerly described by Dr. Fitton. At some points

between these last-mentioned places, the line assumes a distinct anticlinal character.

Transverse valleys exist in the greensand ridge of this part of the district as well as in that on the southern side. The author also alludes to what he conceives to be incipient valleys of this description, and states his reasons for believing them to be indications of transverse fractures. He conceives this opinion to be strongly corroborated by the existence of the perennial springs by which these valleys are characterized. Several are pointed out, especially in Leith Hill and the Seven Oaks ridge overlooking the valley of the Weald.

Transverse river-courses through the Chalk escarpment form one of the most striking features in the geology of this district. The analogy which they bear to the transverse valleys across the greensand ridges would seem to leave no doubt of their being referrible to the same physical cause; and as there are in many instances direct evidence which renders the origin of these latter valleys in transverse fractures highly probable, the same conclusion appears almost equally probable with respect to the river-courses through the Chalk. In the evidence of dislocation which the Chalk itself affords, there is nothing, however, very conclusive; but it must be remembered, that the evidence of faults is always difficult to detect in a massive formation like the Chalk, possessing not more than two general divisions which admit of distinct identification.

The central chalk ridge of the Isle of Wight is traversed in like manner by three transverse valleys, two of which are river-courses. The author has pointed out some direct evidence in support of the conclusion, that the central one (that of the Medina) has originated in transverse dislocation.

Bas Boulonnais.—With respect to the structure of the Bas Boulonnais, it is only necessary here to state, that the author has recognized three parallel lines of dislocation commencing at the coast and running in a direction coinciding with that of the lines of elevation of the Weald, supposing them produced across the Channel according to the law which they follow on this side of it. The southernmost of these lines passes immediately to the north of Boulogne.

II. In the second part of this paper, previously to his comparing the observed phænomena with theoretical deductions, the author recapitulates some fundamental points of his theory. It is assumed, that an elevatory force has acted simultaneously at every point of the lower surface of the elevated mass in each district throughout which the phænomena of elevation are observed to follow the same law. This force is not supposed to have been necessarily of uniform intensity throughout. If it has been greater in one portion of the district than in the rest of it, a corresponding modification will be produced in the directions of the lines of elevation, or a deviation from those positions in which they would have existed had the intensity of the force been uniform throughout. If the force has been uniform, the directions of the lines of dislocation and elevation will depend on the *form* of the boundary of the surface of the elevated area. If this be given, these directions must be investigated on mechanical principles; and if the force be supposed to have acted with greater intensity in any assigned portion of the district, the corresponding modification in the directions of the lines must be determined. This has been done by the author in some particular cases in the memoir above referred to in the Transactions of the Philosophical Society of Cambridge.

Any irregularity in the cohesive power of the elevated mass will have but little effect on the general directions of the lines of elevation; but if there be any considerable continuous portion of the district throughout which the elevated crust is *thinner*, and therefore lighter and weaker, the effect will manifestly be the same as if the crust had been of uniform thickness throughout, and had been acted on in this particular portion with a force of greater intensity. Consequently the modifications in the lines of elevation will be the same, whether they arise from a weaker crust or a greater intensity of force.

In the application of this theory, the boundary of the area under which the elevatory force has simultaneously acted must be determined as nearly as may be by the actual boundary of the disturbed district, throughout which we recognize a character of continuity in the phænomena of elevation. That portion of the district also in which the force may appear to have acted with greater intensity must be determined by the existing indications of greater elevation. Thus it is conceived, that a simultaneous effort of the elevatory force was made throughout the whole tract extending from the Bas Boulonnais on the east, beyond the Wiltshire Chalk on the west, and from the Vale of Pewsey and the valley of the Thames on the north, beyond the southern coast of this country on the south. The Wealden district, with the Bas Boulonnais, presents us also with a case, in which it is presumed, from its greater elevation, either that the disturbing force acted there with greater intensity, or that the elevated crust was there thinner, than in the other part generally of the district. Assuming such to have been the case, the author points out what would be the general directions of the lines of elevation throughout the Wealden and the Bas Boulonnais, and comparing them with the lines described in the first part of his paper, he shows the remarkable accordance which exists between the results of observation and of theory; an accordance which he considers as strongly confirmatory of his theory as applied to this district.

Hence the author concludes, that the fissures or dislocations in which he conceives all the observed lines of elevations (whether faults, anticlinal lines, or lines of flexure,) to have originated, must have been produced by one simultaneous and momentary effort of the elevatory force. It is not, however, to be regarded as a necessary consequence of this conclusion, that the whole elevation of the district was thus produced at once; it might be in some degree produced by previous, and in a considerable degree by subsequent movements; but it would seem at least highly probable, that that general movement which produced the dislocations of the elevated mass, and impressed upon it its present distinctive characters, should have been the most energetic of those repeated movements to which the whole elevation has probably been due.

PROCEEDINGS

OF

THE GEOLOGICAL SOCIETY OF LONDON.

VOL. III. PART II. 1840—1841. No. 75.

AT THE

ANNUAL GENERAL MEETING,

19th of February, 1841.

THE following Report from the Council was read:—

The Council have again the satisfaction of commencing their Annual Report by announcing the progressive increase of the Society during the past year. The number of Fellows has increased from 768 to 781, there having been 35 new Fellows elected and admitted, besides 3 others elected in former years, but who had not paid their admission fees, making an addition of 38 new Fellows; while, during the same period, there have been announced 20 deaths and 5 resignations. The number of Foreign Members has at the same time been diminished by 1, there having been 4 deaths and 3 elections; while that of Honorary Members and Personages of Royal Blood has been reduced by deaths from 40 to 35; the total number of Members is therefore increased from 855 to 862. It should, however, be observed, with regard to the number of deaths, which appears greater than usual, that the names of several persons are included in this Return who had died in previous years, but whose decease was not known to the Society.

It is most gratifying to the Council to be able to state that the Finances of the Society are in a flourishing condition, showing an excess of income over expenditure during the past year to the amount of 165*l.* 19*s.* 6*d.*

The Council have to announce that three Fellows have compounded during the year 1840, and that in furtherance of the recommendation contained in the Auditors' Report for 1833, the whole amount of their compositions has been invested in Consols; the number of Compounders remaining the same, viz. 108, there having been three deaths during the same period. The value of these 108 compositions is 3402*l.*, not 3244*l.* 10*s.* as erroneously stated in the Report of last year (which is the value of only 103 compositions). While the value of the funded property of the Society at the present price of Consols is 2086*l*., or within 1316*l*. of the sum received for contributions.

The Council have also to state to the Society, that the third part of Volume V. has been published since the last Anniversary, and that the first part of Volume VI. is in the press. The Council having considered the adoption of a fuller page advisable, the breadth will be increased for the future without any additional expense. The Council have also determined that with each Part a list of donations shall be printed, on an improved plan, whereby the bulk of the last part of a volume will be diminished, and the expense more equably divided to the purchasers of single parts.

In consequence of the great change which has taken place in the postage, the Council have determined that the Proceedings shall for the future be sent to the Non-resident as well as Resident Fellows; but have ordered that for this purpose they shall be printed upon thinner paper, so as to reduce the weight of each number to within a single postage.

The Council have also to state to the Society, that in consequence of numerous expressions of regret at the early termination of the Meetings in June, they have considered it desirable to call a Special General Meeting to consider the propriety of extending the present and future Sessions to a Second Evening of Meeting in June.

The Council have resolved that the Wollaston Gold Medal be awarded to M. Adolphe Brongniart for his work on Fossil Botany.

Report of the Museum Committee.

The Committee appointed to examine the Society's Museum have to report that it has been greatly enriched during the year by new donations, and that considerable progress has been made in its arrangement. Without specifying a considerable number of miscellaneous fossils worked into different parts of the collection, it may be stated that the number of newly-arranged drawers in the British and Irish series amounts to no less than 112, and by far the greater part of these are filled with newly-acquired specimens.

Among the principal additions, the Committee may call attention to a fine series of rock specimens from the various subdivisions of the lias and oolitic formations, collected and presented by Mr. Lonsdale. They occupy 20 drawers, and are intended to illustrate the various changes in lithological character which each of the different members of the oolitic series undergo in their course from Oxfordshire to the Humber.

Another important accession consists of specimens of rocks and fossils explanatory of the mineral and palæontological characters of the Devonian system, from Devonshire and the neighbouring counties, filling 27 drawers. The trap rocks also of Cornwall and Devon have been newly arranged, and occupy 18 drawers. Ten drawers have been added to the carboniferous or mountain-limestone series of England, including a large suite of specimens from the Isle of

Man. Many specimens also of fossils from the English chalk have been worked into their respective places in the series.

In the Scotch collection many fossil plants and fishes from the coal-measures have been arranged and named by Mr. Lonsdale and M. Agassiz. A most valuable present has been received from Lady Gordon Cumming, of 120 specimens of fossil fishes from the old red sandstone near Forres, all of which were named by M. Agassiz during his late visit to London.

The new accessions made to the Irish collection consist of 28 drawers of fossils from the mountain-limestone, the greater part of which were formerly presented by the Earl of Enniskillen, Sir Philip Egerton, Mr. Weaver, and Mr. Griffiths, and which have been named by Mr. Lonsdale. The Committee have to express their regret, that a still more complete suite of the corals of this formation, obtained by Lord Enniskillen in Sligo and Fermanagh, and which were lately sent off from Belfast to the Society by him, were lost in the Thames steamer wrecked off the Scilly Islands.

Besides the fossil fish of the old red sandstone, before alluded to, M. Agassiz has examined generally all the Ichthyolites in the British series, and has named among others those of the crag of Norfolk and Suffolk, the London clay, and the cretaceous, Wealden, and oolitic formations.

In conclusion, the Committee have to remark, that in carrying into effect the arrangement of the Museum above alluded to, the labour of selecting the specimens, and of specifically determining and naming the fossil shells, corals, plants, and other organic remains, has devolved exclusisely upon Mr. Lonsdale. Mr. Woodward has been employed in affixing to the specimens labels descriptive of the names, localities, names of donors, and references to books; and has in the course of the year finished in this way 81 drawers, making at the same time hand-catalogues for the fossils of the English series. Besides these occupations, and the preparing of enlarged illustrations and other arrangements for the Evening Meetings, much of his time has been devoted to the students and numerous visitors who have inspected the Society's Museum, and the Committee are of opinion that he has discharged his several duties with zeal and assiduity.

Among the principal donors to the Museum during the past year, the Committee have to notice Lady Gordon Cumming, to whom the Society is indebted for the fossil fishes of the old red sandstone before mentioned, and Baron de Meyendorf, from whom we have received a fine specimen of crystallized native gold from Ekaterinenbourg, and also a specimen of platinum from the mines of Tagil.

As all the drawers now in the Museum are full, the Committee beg to recommend to the Council that four new cabinets, capable of containing 84 drawers, be immediately ordered, the estimated cost of which is 51*l*.

Library.

The Library has been increased during the past year by the donation of about 150 volumes and pamphlets, and the titles of these have been duly entered into the catalogue by Mr. Nichols.

Among the donations to the Library we may mention the numbers hitherto published of M. D'Orbigny's new and valuable work entitled "Paléontologie Française." The Society also continues to receive from the Board of Ordnance and the Admiralty the maps and charts published by them respectively.

CHARLES LYELL.
LEONARD HORNER.
R. I. MURCHISON.

Comparative Statement of the Number of the Society at the close of the years 1839 *and* 1840.

	Dec. 31st, 1839.		Dec. 31st, 1840.	
Compounders		108		108
Residents		255		258
Non-residents		405		415
		768		781
Honorary Members	37		32	
Foreign Members	47		46	
Personages of Royal Blood	3		3	
		87		81
		855		862

General Statement explanatory of the alteration in the Number of Fellows, &c., at the close of the years 1839 *and* 1840.

Number of Fellows, Compounders, Contributors, and Non-residents, 31st December, 1839			768
Add Fellows elected during 1840 and paid	Residents	16	
	Non-residents	19	
			35
Ditto in former years and paid in 1840	Residents	2	
	Non-residents	1	
			3
			806
Deduct, Compounders		3	
Deceased Residents		8	
Non-residents		9	
Resigned		5	
			25
Total number of Fellows 31st December, 1840, as above			781

Number of Honorary Members, Foreign Members, and Personages of Royal Blood, Dec. 31, 1839		87
Add, Foreign Members elected		3
		90
Deduct, Deceased Honorary Members	5	
Foreign Members	4	
		9
Total number of Honorary Members, &c., at the close of 1840, as in the last page		81

Number of Fellows liable to Annual Contributions at the close of 1840, *with the Alterations during the year* 1840.

Number at the close of 1839, as in the last page		255
Add, Elected during 1840, paid and not compounded	16	
Elected during former years and paid in 1840	2	
Non-residents who became Residents and did not compound	6	
		24
		279
Deduct, Deceased	8	
Resigned	5	
Residents who Compounded	3	
——— became Non-resident	5	
		21
Total number liable to Annual Contribution at the close of 1840, as in the last page		258

Deceased Fellows:

Compounders (3): Duke of Bedford; Sir John Lubbock; Sir Jeffrey Wyattville.

Residents (8): William Hobson, Esq.; Earl of Durham; Bishop of Chichester; T. H. Holdsworth, Esq.; Thomas Nettleship, Esq.; N. A. Vigors, Esq.; Robert Ferguson, Esq.; John Gibson, Esq.

Non-residents (9): Richard Bright, Esq.; Richard Cotton, Esq.; Hutches Trower, Esq.; Dr. Lockhart Muirhead; Robert F. Seale, Esq.; Major-Gen. David Stewart; Rev. George Cook, M.D.; James Laird, M.D.; Henry H. Price, Esq.

Honorary Members (5): Edward Martin, Esq.; J. Lloyd Williams, Esq.; S. Skurry Day, Esq.; Thomas Du Gard, M.D.; William Clayfield, Esq.

Foreign Members (4): Dr. J. F. Blumenbach; M. Philippe L. Voltz; M. A. J. M. Brochant de Villiers; William Maclure, Esq.

The following Persons were elected Fellows during the year 1840.

January 8th.—Robert Fellowes, Esq. LL.D., of Dorset Square, Marylebone; and James Phillips Kay, M.D., of the Albany.

January 22nd.—William Laverack, Esq., of Catherine Hall, Cambridge; Zacharias Daniel Hunt, Esq., of Aylesbury, Bucks; Robert Maulkin Lingwood, Esq. M.A., of Mordiford, near Hereford; Rev. William Strong Hore, M.A., of Stoke, Devonport; Joseph Dobinson, Esq., of Egham Lodge, Egham, Surrey; and Walter Ewer, Esq., of 23 Hanover Square.

February 5th.—Alexander Robertson, Esq., of Inverugie House, County of Moray; and William Sharp, Esq., President of the Bradford Philosophical Society, Yorkshire.

March 11th.—Rev. Richard Taylor, M.A., of the Bay of Islands, New Zealand; Graham Francis Moore, Esq., of 1, Brick Court, Temple; and Samuel Smith, Esq., of Combe Hurst, Kingston, Surrey.

March 25th.—Morgan John O'Connell, Esq. M.P. for the County of Kerry; John Samuel Enys, Esq., of Enys, Cornwall; Thomas Joyce, Esq., Bath; John Eddowes Bowman, Esq., of Hulme, near Manchester; and Viscount Valentia, of Arley Hall, Bewdley, Staffordshire.

April 8th.—Richard Vaughan Barnewall, Esq., of 13 King's Bench Walk, Temple.

April 29th.—Abraham Gesner, Esq., of Nova Scotia; Rev. James Cartmell, M.A., of Christ's College, Cambridge; and Algernon Sydney Aspland, Esq., of Lamb's Buildings, Temple.

May 13th.—John Ruskin, Esq., of Christ Church, Oxford; W. J. West, Esq., of Tunbridge; and Frederick Dixon, Esq., of Worthing.

May 26th.—William Humble, M.D., of Worthing, Sussex.

June 10th.—Charles Lashmar, M.D., of Croydon, Surrey; Henry William Tancred, Esq. M.P., of Regent Street; and Lord Stavordale, of 31 Old Burlington Street.

December 2nd.—James Smith, Esq., of Deanston, near Doune, Stirling; Charles Christian Hennell, Esq., of 23 Threadneedle Street; Joseph Parker, jun. Esq., of 13 Mount Radford, Exeter; the Right Hon. Sir Robert Peel, Bart. M.P., of Drayton Manor, Tamworth; John Floyer, Esq. B.A., of Stafford, Dorchester; and the Marquess of Breadalbane, of Taymouth Castle, Taymouth, N.B.

December 16th.—Edward Kater, Esq., of 12 Nottingham Terrace; and Sir Francis Shuckburgh, Bart., of Shuckburgh, near Daventry.

The following Persons were elected Foreign Members.

February 5th.—M. Puillon de Boblaye, of Paris; Professor Gustav Rose, of Berlin; and Professor Adolphe Brongniart, of Paris.

Among the Donations to the Museum received since the last Anniversary the following are included:—

British and Irish Specimens.

Additional Specimens from the Silurian System; presented by R. I. Murchison, Esq. F.G.S.

Specimen of Fossil Wood from Adderbury West; presented by Rev. E. Faulkner.

Specimens of Fishes from the Old Red Sandstone of Morayshire; presented by the Rev. G. Gordon and William Stables, Esq.

Specimens of Old Red Sandstone, and of Fishes and Ores from the same formation, obtained in the Orkneys; presented by the Rev. Mr. Coulston and Dr. Malcolmson, F.G.S.

Fossils from the Chalk at Sutton in Surrey; presented by Sir John Lubbock, Bart., Treas. R.S.

Specimen of a Clypeaster from the Cornbrash near Bedford; presented by Miss Gale.

An Ammonites from Tasburgh, near Norwich; presented by John Wright, Esq.

A Specimen of *Ammonites Bucklandii*; a Slab of Lower Green Sand, containing remains of Corals and Sponges, from Coxwell Pits, near Farringdon; and Specimens of polished and striated Boulders from the neighbourhood of Glasgow; presented by the Rev. Prof. Buckland, D.D., Pres. G.S.

Bones of recent Mammalia from Portland, and Crinoidal Remains from the Mountain Limestone near Frome; presented by Miss Benett, of Norton House.

Fossils from Bracklesham Bay; presented by James Bowerbank, Esq. F.G.S.

A mass of Metamorphic Rock from Fishguard; presented by H. Maclauchlan, Esq. F.G.S.

Concretions from the New Red Sandstone from Hearddist; presented by Joseph Parker, jun., Esq.

Chalk Fossils from the neighbourhood of Charing, Kent; presented by William Harris, Esq. F.G.S.

Crinoidal and other Remains from the neighbourhood of New Kilpatrick; presented by John Baillie, Esq.

A collection of Fossil Fishes from the Old Red Sandstone of Scotland; presented by Lady Gordon Cumming.

A series of Specimens obtained while boring for water at Poole, 1838 and 1839; presented by William Thompson, Esq.

Fossils from the Plymouth Limestone; presented by the Rev. R. Hennah, F.G.S.

Specimens of *Petrophiloides Richardsonii*; presented by W. Richardson, Esq. F.G.S.

Specimens of Boulders from Walney, North Arm of Morecombe Bay, and Mouth of the Wyre, South Horn of Morecombe Bay; presented by H. M. Denham, Esq.

Fossils from the Mountain Limestone of the North of Ireland; presented by the Earl of Enniskillen, F.G.S.

Foreign Specimens.

Specimens from the Bas Boulonnais; presented by M. Dutertre Yvart.
Specimens of Granite from Simon's Bay, Sandstone from Cape Flat, and of Silicified Wood from Orange River; presented by Sir J. F. W. Herschel, Bart. F.G.S.
A specimen of Crystallized Native Gold from Ekaterinenbourg, and one of Native Platina from the Mines of Tagil; presented by Baron de Meyendorf.
Fossils from Tournay; presented by R. I. Murchison, Esq. F.G.S.
Fossil Shells from the Marl and Coral Rock of Barbadoes; presented by John Wheeler, Esq.
Geological Specimens from the West Indies, collected by Captain Barnett, R.N.; presented by Captain Beaufort, R.N., Hon. Mem. G.S.
Fossils from the Carboniferous System on the banks of the Bystritz, near Borovitz; presented by General Tcheffkine.
Specimens of Gold from New Granada; presented by J. H. Deacon, Esq. F.G.S.
Specimens from Beyrout and the Lebanon Range, Syria; presented by J. C. Brettell, Esq.
Specimens from Madeira; presented by James Smith, Esq. F.G.S.
Specimens from Ciampo, near Vicenza; presented by R. W. Mackay, Esq. F.G.S.
Specimens from the Mines of Monserrat, in Central America; presented by Hon. T. H. F. Strangways, F.G.S.

MISCELLANEOUS.

Cast of the Cranium of the *Hyracotherium*; presented by W. Richardson, Esq. F.G.S.
Cast of a head of *Ichthyosaurus communis* in the Birmingham Institution; presented by the Birmingham Institution.
Models of Saurian remains from the Wealden strata; presented by Mr. J. Tennant, F.G.S.
A Series of Farey's Models of Strata; presented by G. B. Greenough, Esq. V.P.G.S.

The LIBRARY has been increased by the Donation of about 150 Volumes and Pamphlets.

Charts and Maps.

Ordnance Townland Surveys of the Counties of Mayo, 125 Sheets; Wicklow, 49 Sheets; King's, 49 Sheets; and Carlow, 28 Sheets; presented by Colonel Colby, F.G.S., by direction of the Lord Lieutenant of Ireland.

Geological Index Map of the British Isles, by John Phillips, Esq. F.G.S.; presented by Mr. J. W. Lowry.

Maps of the Lands of Glengary and Inverlochy; presented by the Rev. Prof. Buckland, D.D., Pres. G.S.

Charts, Sailing Directions, &c., published by the Admiralty during 1839; presented by Capt. Beaufort, R.N., by direction of the Lords Commissioners of the Admiralty.

Geological Map of the Middle and Southern parts of Sweden, by M. Hisinger; presented by the Rev. W. Bilton, F.G.S.

Geological Map of Saxony, Sheets 7, 11, and 12; presented by the Council of Mines of Freyberg.

Geological Map of Turkey in Europe, by Dr. Boué; presented by Dr. Boué.

Geological Map of Central and Western Europe, including the British Isles, &c., by W. Hughes, F.R.G.S.; presented by Mr. J. Weale.

The following List contains the Names of all the Persons and Public Bodies from whom Donations to the Library and Museums were received during the past year.

Academy of Sciences of Paris.
Admiralty, The Right Hon. the Lords Commissioners of the.
Agassiz, M. le Prof.
Alexander, Capt., F.G.S.
American Philosophical Society, held at Philadelphia.
Asiatic Society of Calcutta.
Athenæum Club.
Athenæum, Editor of.

Baillie, John, Esq.
Beaufort, Captain, R.N. Hon. M. G.S.
Belfast, Natural History Society of.
Bellardi, M. Luigi.
Benett, Miss, of Norton House.
Bilton, Rev. William, F.G.S.
Birmingham, Philosophical Institution of.
Bohn, Mr. H. G.
Boston Society of Natural History.
Boué, Ami, M.D. For. Mem. G.S.
Bowerbank, J. S., Esq. F.G.S.
Brettell, J. C., Esq.
British Association for the Advancement of Science.
Brongniart, M. Adolphe.
Buckland, Rev. Professor, D.D. Pres. G.S.

Charlesworth, Edw., Esq. F.G.S.
Cockburn, William, D.D.
Colby, Colonel, R.E. F.G.S.
Coulston, Rev. Mr.
Cumming, Lady Gordon.

D'Archiac, V^{te}.
Darwin, Charles, Esq. Sec. G.S.
Daubeny, Prof., M.D. F.G.S.

Deacon, J. H., Esq. F.G.S.
De Meyendorf, Baron.
Denham, H. M., Esq.
De Serres, M. Marcel.
D'Hombres-Firmas, M. le Baron.
Dickinson, John, Esq. F.G.S.
Dillwyn, L. W., Esq. Hon. Mem. G.S.
D'Omalius D'Halloy, M. J. J., For. Mem. G.S.
D'Orbigny, M. Alcide.
D'Orbigny, M. Charles.
Dumont, Prof. A. H.

École des Mines.
Ehrenberg, Hr. C. G.
Eichwald, Herr von Edward.
England, Royal Agricultural Society of.

Faraday, Michael, Esq. F.G.S.
Faulkner, Rev. Mr.
Fischer de Waldheim, M. G.
Fitton, W. H., M.D. F.G.S.
Freyberg, Council of Mines of.

Gale, Miss.
Galeotti, Sig. H.
Geological and Polytechnic Society of the West Riding of Yorkshire.
Geological Society of France.
Gibson, William Sidney, Esq. F.G.S.
Gordon, Rev. George.
Grant, Professor, M.D. F.G.S.
Grateloup, Dr.
Greenough, G. B., Esq. V.P.G.S.
Griffin, John Joseph, Esq.
Guillemard, John, Esq. F.G.S.

Hancock, John, M.D.
Harris, William, Esq. F.G.S.
Hausmann, Herr J. F. L.
Hawkins, Thomas, Esq. F.G.S.
Hennah, Rev. R., F.G.S.
Herschel, Sir J.F.W., Bart. F.G.S.
Hœninghaus, M.
Humble, William, M.D. F.G.S.
Huzard, M. V.

Ibbetson, L. L. B., Esq. F.G.S.

Jäger, Dr. Georg. Fried.
Jackson, Charles T., M.D.
Jerdan, William, Esq.

Keilhau, Herr, B.M.

Lea, Isaac, Esq.
Leeds Philosophical Society.
Liebig, Justus, M.D.
Linnean Society of London.
Literary Fund Society.
Locke, John, Esq.
Loudon, John Claudius, Esq.
Lowry, Mr. J. W.
Lubbock, Sir J. W., Bart.
Lyell, Charles, Esq. F.G.S.

Mackay, R. W., Esq. F.G.S.
MacLauchlan, H., Esq. F.G.S.
Madras Literary Society.
Malcolmson, J. G., M.D. F.G.S.
Mantell, Gideon, LL.D. F.G.S.
Meisser, Dr.
Michellotti, Sig. Giovanni.
Modena, Scientific Society of.
Murchison, Roderick Impey, Esq. F.G.S.
Mushet, David, Esq. Hon. Mem. G.S.
Mylne, R. W., Esq.

Nattali, Mr. M. A.
Neuchâtel Natural History Society.
Newfoundland, The Governor of.
Numismatic Society of London.

Parker, Joseph, jun. Esq. F.G.S.
Petzholdt, Dr. A.
Pilla, Dr. Leopold.
Pratt, S. P., Esq. F.G.S.
Pringle, Captain J. W., F.G.S.

Quebec Literary and Historical Society.
Quetelet, M. A.

Rennie, George, Esq. F.G.S.

Repertory of Patent Inventions, the Proprietor of.
Richardson, W., Esq. F.G.S.
Roberts, George, Esq.
Royal Academy of Berlin.
Royal Academy of Brussels.
Royal Asiatic Society.
Royal Astronomical Society.
Royal Botanic Society of London.
Royal Geographical Society of London.
Royal Geological Society of Cornwall.
Royal Irish Academy.
Royal Polytechnic Society of Cornwall.
Royal Society of Copenhagen.
Royal Society of Göttingen.
Royal Society of London.
Royle, J. Forbes, M.D. F.G.S.

Scarborough Philosophical Society.
Schomburgk, R. H., Esq.
Scientific Society of London.
Silliman, Prof., M.D. For. Mem. G.S.
Sismonda, Prof. Angelo.
Smith, James, Esq. F.G.S.
Smith, Rev. J. Pye, D.D. F.G.S.
Society of Arts.
Sowerby, Mr. J. D. Carle.
Stables, William, Esq.
Strangways, Hon. T. H. F., F.G.S.
Strickland, H. E., Esq. F.G.S.
Sutcliffe, Thomas, Esq.

Taylor, John, Esq. Treas. G.S.
Taylor, Richard, Esq. F.G.S.
Taylor, R. C., Esq. F.G.S.
Taylor and Walton, Messrs.
Tcheffkine, General.
Tennant, Mr. James, F.G.S.
Thompson, William, Esq.

Van der Maelen, M.
Vaughan, J., Esq.
Von Glocker, Herr E. F.
Von Meyer, Herr Hermann.

Weale, Mr. J.
Weaver, Thomas, Esq. F.G.S.
Wernerian Natural History Society.
Wheeler, J., Esq.
Whewell, Rev. Prof., F.G.S.
Wood, Serles V., Esq. F.G.S.
Woodley, William, Esq. Cap. R.N.
Worcestershire Natural History Society.
Wright, John, Esq.

Yvart, M. Dutertre.

Zoological Society of London.

List of PAPERS *read since the last Annual Meeting, February* 21, 1840.

February 26th.—Further observations on the Fossil Trees found on the Manchester and Bolton Railway, by John Hawkshaw, Esq. F.G.S.

———— On the characters of the Fossil Trees lately discovered on the Manchester and Bolton Railway; and on the formation of Coal by gradual subsidence, by John Eddowes Bowman, Esq. F.G.S.

———— On the character of the beds of Clay lying immediately below the Coal Seams of South Wales, by W. E. Logan, Esq. F.G.S.

March 11th.—On the Rocks which form the west shore of the Bay of Loch Ryan in Wigtonshire, by John Carrick Moore, Esq. F.G.S.

March 11th.—On the siliceous bodies of the Chalk, Green-sand, and Oolites, by James Scott Bowerbank, Esq. F.G.S.

March 25th.—On the Limestones of South Devonshire, by William Lonsdale, F.G.S.

——— On the Bone Caves of Devonshire, by R. A. C. Austen, Esq. F.G.S.

April 8th.—On the great Fault called the Horse, in the Forest of Dean coal-field, by John Buddle, Esq. F.G.S.

——— Remarks on the structure of the Royal George, and on the condition of the timber, iron and copper brought up during the operations of Colonel Pasley, by Mr. Creuze. Communicated by Captain Basil Hall, R.N. F.G.S.

——— A Letter addressed to Dr. Mantell, by C. Hullmandel, Esq., on the Subsidence of the Coast near Puzzuoli.

——— A Notice on Borneo Proper, by Tradescant Lay, Esq.

——— On some Geological Specimens from Syria, by W. C. Williamson, Esq.

April 29th.—On parts of Asia Minor, by W. J. Hamilton, Esq. Sec. G.S.

——— On Concretions in the New Red Sandstone, by Thomas Ottley, Esq.

——— On Remains of a bird, a turtle, and a lizard, from the Chalk, by Richard Owen, Esq. F.G.S. Hunterian Professor in the Royal College of Surgeons.

May 13th and 27th.—A Memoir on Westphalia, the Hartz, the Eifel, &c., by the Rev. Adam Sedgwick, F.G.S. Woodwardian Professor in the University of Cambridge, and R. I. Murchison, Esq. F.G.S.

June 10th.—Notice of an intrusive mass of trap in the mountain-limestone of Bleadon Hills, by the Rev. David Williams, F.G.S.

——— A Memoir descriptive of a series of coloured sections of the cuttings on the Birmingham and Gloucester Railway, by Hugh E. Strickland, Esq. F.G.S.

——— A Letter addressed to R. I. Murchison, Esq. by Capt. Lloyd, on the occurrence of Coral Rocks in the Mauritius.

——— Notice on the Mineral Veins of the Sierra Almagrera in the province of Almeria, Spain, by Josias Lambert, Esq. F.G.S.

——— Notice on the Sierra de Gador and its Lead Mines, by Josias Lambert, Esq. F.G.S.

——— On the constant presence of polished and striated surfaces on the rocks which form the beds of Glaciers in the Alps, by Professor Agassiz, of Neuchâtel.

——— On the Occurrence of a Bed of Lignite near Messina, by Dr. R. Calvert.

——— A Letter from Mr. Greaves, on the discovery of bones of Fishes, Birds, and Mammalia in a limestone cliff at Eel Point, in Caldey Island.

June 10th.—A Letter from W. J. Hamilton, Esq. Sec. G.S., on the occurrence of rounded fragments of rock-crystal in the Hastings sand near Tunbridge Wells.

——————— A Letter addressed to Dr. Fitton, F.G.S., by M. Roemer of Hildesheim, on the formations between the Chalk and the Portland beds in the North of Germany.

——————— A Letter to Dr. Fitton, F.G.S. from Mr. Makeson of Hythe, on the discovery near the bottom of the green-sand in the vicinity of that town, of portions of a large Saurian, supposed to be an Iguanodon.

November 4th.—On Glaciers, and the evidence of their having once existed in Scotland, Ireland, and England, by Professor Agassiz, of Neuchâtel.

November 18th.—On Glaciers, and their former existence in Scotland, by the Rev. Dr. Buckland, Professor of Geology and Mineralogy in the University of Oxford, Pres. G.S.

November 18th and December 2nd.—On the geological evidence of Glaciers in Forfarshire, by Charles Lyell, Esq. F.G.S.

December 2nd.—On the evidence of Glaciers in the North of England, by the Rev. Dr. Buckland, Professor of Geology and Mineralogy in the University of Oxford, Pres. G.S.

December 16th.—On the relative connexion of the Eastern and Western Chalk denudations, by P. J. Martin, Esq. F.G.S.

January 6th, 1841.—On the illustration of Geological Phænomena by means of Models, by Thomas Sopwith, Esq. F.G.S.

——————— On the Geology of the Island of Madeira, by James Smith, Esq. of Jordan Hill, F.G.S.

——————— On the Geology of Aden, by Frederick Burr, Esq.

January 20th.—On the teeth of species of the Genus *Labyrinthodon*, by Richard Owen, Esq. F.G.S. Hunterian Professor in the Royal College of Surgeons.

——————— Observations relative to the Elevation of Land on the shores of Waterford Haven, during the human period, by T. Austin, Esq.

——————— On the Freshwater Fossil Fishes of Mundesley, as determined by Prof. Agassiz, by Charles Lyell, Esq. F.G.S.

February 3rd.—On the Geological Structure of the Wealden District and of the Bas Boulonnais, by William Hopkins, Esq. F.G.S.

Sums actually Received and Expended

RECEIPTS.

	£.	s.	d.	£.	s.	d.	£.	s.	d.
Balances in hand, January 1, 1840:									
Banker (including 52*l.* 19*s.* 8*d.* Wollaston Fund)				108	8	2			
Accountant				40	0	0			
							148	8	2
Arrears:									
Admission Fees				23	2	0			
Annual Contributions				217	7	0			
Transactions				1	5	0			
							241	14	0
Ordinary Income:									
Annual Contributions				737	12	6			
Admission Fees:									
Residents (16)	100	16	0						
Non-Residents (19)	199	10	0						
				300	6	0			
							1037	18	6
Compositions:									
Three at 31*l.* 10*s.* each							94	10	0
Transactions				437	14	6			
Proceedings				13	12	0			
							451	6	6
Geological Map							233	0	0
Wollaston Donation Fund, 12 months' Interest on 1084*l.* 1*s.* 1*d.* Red. 3 per cents.							32	10	4
Dividends:									
Six months on 2108*l.* 18*s.* 10*d.* Consols				31	12	8			
Ditto, 2212*l.* 12*s.* 11*d.* Consols				33	3	9			
							64	16	5
							£2304	3	11

We have compared the Books and Vouchers presented to us with these Statements, and find them correct.

Signed, W. H. SYKES, ROBERT HUTTON, ARTHUR AIKIN, } AUDITORS.

Geol. Society,
Feb. 2, 1841.

during the year ending December 31, 1840.

PAYMENTS.

	£.	s.	d.	£.	s.	d.
Bills outstanding:						
Scientific Expenditure	4	1	0			
Parochial Rates	6	12	6			
Household Furniture	4	1	0			
House Expenditure	0	14	0			
Stationery	0	17	6			
Collector's Poundage	2	10	0			
				18	16	0
General Expenditure:	£.	s.	d.			
Repairs of House	23	13	11			
House Expenses	193	9	8			
Taxes, Assessed	26	5	8			
Sewers' Rates	2	13	0			
Poors' Rates	10	12	0			
Household Furniture	7	14	9			
——— Linen	5	17	8			
				270	6	8
Insurance				9	0	0
Salaries and Wages:	£.	s.	d.			
Curator	125	0	0			
Sub-Curator	84	0	0			
Clerk	75	0	0			
Porter and Housekeeper	77	10	0			
Servant	33	4	0			
Collector's Poundage	39	1	6			
				433	15	6
Scientific Expenditure				56	11	4
Stationery and Miscellaneous Printing				33	14	0
Investment in the Funds				94	10	0
Tea for Meetings				54	14	9
Cost of Publications:	£.	s.	d.			
Transactions	620	5	11			
Proceedings	119	19	9			
				740	5	8
Map Account				238	7	0
Contributions repaid				12	12	0
Award of Wollaston Donation Fund:	£.	s.	d.			
M. Dumont, Gold Medal	10	10	0			
Mr. James Sowerby, One Year's Proceeds	32	10	4			
				43	0	4
Balances in hand:	£.	s.	d.			
Banker (including 42*l.* 9*s.* 8*d.* Wollaston Fund)	258	10	8			
Accountant	40	0	0			
				298	10	8
				£2304	3	11

Valuation *of the Society's Property;* 31*st December* 1840.

Property.

	£.	s.	d.	£.	s.	d.
Balances in hand, including 42*l*. 9*s*. 8*d*. Wollaston Fund				298	10	8
Arrears due to the Society :						
Admission Fees	33	12	0			
Annual Contributions	424	4	0			
Transactions	2	10	0			
Map Account	5	7	0			
				465	13	0
Estimated value of unsold Transactions				998	5	6
———— Proceedings				35	0	0
Value of Funded Property, 2318*l*. 4*s*. 8*d*. Consols at 90				2086	0	0
				£3883	9	2

[*N.B. The value of the Collections, Library and Furniture is not here included; nor is the "Donation Fund," instituted by the late Dr. Wollaston, amounting at present to* 1084*l*. 1*s*. 1*d*. *in the Reduced* 3 *per cent. Annuities; the dividends thereof being appropriated to the purposes of the Founder.*]

Signed, JOHN TAYLOR, Treasurer.

Feb. 2, 1841.

Debts.

	£.	s.	d.	£.	s.	d.
Bills outstanding :						
Scientific Expenditure	10	0	0			
Solicitor's Account	20	0	0			
House Expenditure	5	0	0			
Collector's Poundage	3	10	0			
Taxes	13	5	0			
Annual Contribution overpaid 1840	3	3	0			
				54	18	0
Cash belonging to the "Wollaston Fund"				42	9	8
Arrears not likely to be received				180	0	0
				277	7	8
Balance in favour of the Society				3606	1	6
				£3883	9	2