THE

EDINBURGH NEW PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

CONDUCTED BY

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CONTENTS.

Page

ART. I. Historical Eloge of the late Sir JOSEPH BANKS, Baronet, President of the Royal Society. By Baron CUVIER, - - - - - 1

II. Remarks and Experiments relating to Hygrometers and Evaporation. By Mr HENRY MEIKLE. Communicated by the Author, - - 22

III. On Coloured Shadows. By Messrs ZCHOKKE and TRESCHEL *junior*, - - - - - 32

IV. Notice regarding the Little Andaman Island in the Bay of Bengal. Communicated by Cornet J. E. ALEXANDER, H. M. 13th Light Dragoons. With a Plate, - - - - - - 43

V. Some particulars relative to the Tides in the upper part of the River Thames, and of the obstructions caused by the present London Bridge. By P. BARLOW, F. R. S. Mem. Imp. Acad. Petrop., &c. Communicated by the Author, - - 49

VI. On the Affinities of the Empetreæ, a natural Group of Plants. By Mr DAVID DON, Libr. L. S. &c. Communicated by the Author, - - 59

VII. Establishment of Vegetation at the Surface of the Globe, - - - - - - 64

VIII. Observations made during a Visit to Madeira, and a residence in the Canary Islands. By Baron LEOPOLD VON BUCH. (Continued from former Volume, p. 380.), - - - - - - 73

IX. Observations on the Arctic Sea and Ice, and the intended Expedition of Captain Parry to the North Pole. By THOMAS LATTA, M. D. Communicated by the Author, - - - - - 86

ART. X. General Observations on the former and present Geological Condition of the Countries discovered by Captains Parry and Ross. By Professor JAMESON, 104
XI. Remarks tending to explain the Geological History of the Earth. By Professor ESMARK, - 107
XII. Observations on the Structure and Functions of the Sponge. By R. E. GRANT, M.D. F.R.S.E. F.L.S. M.W.S. Honorary Member of the Northern Institution, &c. Communicated by the Author. Concluded from the preceding Volume, p. 351. With a Plate - - - - - 121
XIII. Enumeration of the Instruments requisite for Meteorological Observations; with Remarks on the mode of conducting such Observations. By Professor LESLIE, - - - - - 141
XIV. Description of the Eruption of Long Lake and Mud Lake, in Vermont, and of the desolation effected by the rush of the waters through Barton River, and the lower country, towards Lake Memphremagog, in the summer of 1810, in a Letter to Prof. Silliman. By the Rev. S. EDWARDS DWIGHT. With a Plan of the Lakes, - - 146
XV. Information regarding the Overland Arctic Expedition, - - - - - 161
XVI. On the Luminousness observed in the Eyes of Human Beings, and also in those of Cats, Dogs, Horses, and Sheep. By Dr CHARLES LUDWIG ESSER, - - - - - 164
XVII. Account of the Habits of the Turkey Buzzard (Vultur aura), particularly with the view of exploding the opinion generally entertained of its extraordinary power of Smelling. In a Letter to Professor JAMESON, by JOHN J. AUDUBON, Citizen of the United States, - - - - - 172
XVIII. List of Rare Plants which have Flowered in the Royal Botanic Garden, Edinburgh, during the last three months; with Descriptions of several New Plants. Communicated by Dr GRAHAM, 184
XIX. Celestial Phenomena from January 1. to April 1. 1827, calculated for the Meridian of Edinburgh, Mean Time. By Mr GEORGE INNES, Aberdeen, 188

Art. XX. Proceedings of the Royal Society of Edinburgh, 190
XXI. Proceedings of the Wernerian Natural History Society, - - - - - - 191

XXII. Scientific Intelligence.

METEOROLOGY.

1. Meteors seen in India. 2. Water-spouts in the Irish Channel. 3. Winds in the Polar Regions, - 191-193

CHEMISTRY.

4. The presence of animal and vegetable matter, or emanations from them, not necessary for the formation of Nitre. 5. Phosphorus in Kelp, - - - 193, 194

GEOLOGY.

6. Geognostical Structure of the Country around Darwar. 7. Account of Libellulite found at Solenhoffen. 8. Beds Sea-shells, nearly in a fresh state, 200 feet above the level of the Sea. 9. Green-sand formation in Sweden. 10. Coal of Hoganäs. 11. Hill of Magnetic Iron-Ore. 12. Hyæna Cave, - - - 194-197

MINERALOGY.

13. Crystallizations of Sulphate and Carbonate of Lead observed by M. Hartmann. 14. Geognostic Position of Platina in America. 15. Jet discovered in Wigtonshire. 16. Geognostical Distribution of Gold in the Uralian Mountains. 17. Geognostic situation of the Siberian Platina. 18. Cordierite found in Norway. 19. Magnificent Crystals of Sulphate of Iron, or Green Vitriol. 20. Iserine and Iron-sand in Cheshire. 21. Bismuth Cobalt-Ore. 22. Selenium in Red Copper-Ore, 197-201

HYDROGRAPHY.

23. Discovery of a New Substance in Sea Water. 24. Iodine and Lithion in the Mineral Springs of Theodoreshall at Kreutznach. 25. Thickness of Salt Water Ice, 201, 202

ZOOLOGY.

26. Sword Fish found in the Frith of Forth. 27. Discovery of the Circulation of the Blood in Insects. 28. Turf-

Leech. 29. Notice of two new species of British Sponges. 30. South African Museum, (1st Series). 31. Ditto (2d Series). 32. Narcotic Spider. 33. Power of the Stomach of Birds. 34. Vulture shot in Somersetshire. 35. Gigantic Orang Outang, - - - 201–207

BOTANY.

36. Irish Furze, Broom, and Yew, - - 207

ARTS.

37. Easy mode of Cutting Glass, - - - ib.

ART. XXIII. NEW PUBLICATIONS.

1. Mathematics practically applied to the Useful and Fine Arts; by Baron CHARLES DUPIN, Member of the Institute, of the Academy of Sciences, &c. &c. Adapted to the State of the Arts in England; by GEORGE BIRKBECK, Esq. M. D. President of the London Mechanics' Institution, - - - 208
2. AUDUBON'S great Work on the Birds of the United States of America, - - - - 210
3. The Aberdeen, Leith and London Tide Tables for the year 1827; by GEORGE INNES, Astronomical Calculator, Aberdeen, - - - - - 211

XXIV. List of Patents granted in England from 18th September to 18th November 1826, - 211

XXV. List of Patents granted in Scotland from 9th September to 8th November 1826, - 212

CONTENTS.

Page

Art. I. Biographical Memoirs of Charles Bonnet and Horace Benedict de Saussure. Read to the Royal Institute of France by Baron Cuvier, - 213

II. A Description of some appearances of remarkable Rainbows. By the Reverend William Scoresby, F. R. S. Lond. & Edin. M. W. S. &c. Communicated by the Author. (With a Plate), - 235

III. Tour to the South of France and the Pyrenees, in 1825. By G. A. Walker Arnott, Esq. A.M. F.L.S. & R. S. E. &c. In a letter to Professor Jameson. (Continued from the preceding Volume), - 241

IV. Account of a Visit to the Glaciers of Justedal, and to the Mantle of Lodal. By Mr G. Bohr, of Bergen, 255

V. Observations on Serpentine and Diallage Rocks. By Dr A. Boue'. In a Letter to Professor Jameson. Communicated by the Author, - - 265

VI. Observations on the Natural History of the Alligator. In a Letter to Sir William Jardine, Baronet, and Prideaux John Selby, Esq. By John J. Audubon, Esq. Member of the Wernerian Natural History Society, &c. - - - - 270

VII. Observations and Experiments on the different kinds of Coal. By M. Karsten, - - - 280

VIII. Considerations regarding the shining of the Eyes of the Cat, and several other Animals. By M. Benedict Prevost, - - - - 297

IX. Remarks on the Rhubarb of Commerce, the Purple-coned Fir of Nepal, and the Mustard Tree. By Mr David Don, Librarian of the Linnean Society, Member of the Imperial Academy Naturæ Curiosorum, of the Wernerian Society, &c. Communicated by the Author, - - - 304

ART. X. On the Structure and Characters of the Octopus ventricosus, Gr. (Sepia octopodia, Pent.), a rare species of Octopus from the Firth of Forth. By R. E. GRANT, M. D. F. R. S. E. &c. Fellow of the Royal College of Physicians of Edinburgh, Honorary Member of the Northern Institution, &c. Communicated by the Author, - - . 309

XI. Meteorological Observations made in Jamaica by the late JOHN LINDSAY, Esq. Surgeon, Jamaica. Communicated by W. C. TREVELYAN, Esq. M.W.S. &c. 317

XII. A Description of the genus Malesherbia of the Flora Peruviana; with Remarks on its Affinities. By Mr DAVID DON, Libr. L. S.; Member of the Imperial Academy Naturæ Curiosorum, of the Wernerian Nat. Hist. Society, &c. - - 320

XIII. Account of a Gelatinous Quartz or Siliceous Sinter, which forms the basis of varieties of Old Red Sandstone. By M. T. GUILLEMIN, - - 324

XIV. Experiments to compare the specific Heat of Air under a constant volume, with its specific Heat under a constant pressure. By Mr HENRY MEIKLE. Communicated by the Author, - - 328

XV. On the Detection of Arsenic in cases of Poisoning. By J. L. BERZELIUS, - - - 338

XVI. On a Chemical Composition of Zinkenite and Jamesonite. By H. ROSE, Member of the Royal Academy of Berlin. And Description and Analysis of Pyrochlore, a new Mineral. By F. WÖHLER, 341

XVII. The Law of the Preservation of Species, illustrated by the Phenomena of the seed of the Stipa pennata. By Mr JOHN MACVICAR, Lecturer on Natural History in St Andrew's. (With a Plate.) Communicated by the Author, - - - 343

XVIII. Account of the Observations and Experiments made on the Diurnal Variation and Intensity of the Magnetic Needle, by Captain Parry, Lieutenant Foster, and Lieutenant Ross, in Captain Parry's Third Voyage; with Remarks and Illustrations. By PETER BARLOW, F. R. S. Mem. of the Imperial Academy of St Petersburgh, &c. (With a Plate.) Communicated by the Author, - - 347

XIX. On the Use of a Simple Syphon as a Hydrometer. By Mr H. MEIKLE. Communicated by the Author, 366

Art. XX. On the Marine Live Cockles, said to have been found at a great distance from the Sea in Yorkshire. In a Letter to Professor Jameson. By W. C. Trevelyan, Esq. M. W. S. &c. - 367

XXI. Notice of Fresh Water found in the Sea at a great distance from the Land. By D. Buchanan, Esq. In a Letter to Professor Jameson, - 369

XXII. Description of Anatina villosiuscula, a new Species, and of Venerupis Nucleus, a Species new to the British Fauna. By Mr William Macgillivray, M. W. S. &c. With Figures. Communicated by the Author, - - 370

XXIII. Account of the Capture of a colossal Orang-Outang in the Island of Sumatra, and Description of its Appearances. By Dr Clark Abel, 371

XXIV. On the Lead-Mines in the South of Spain, 375

XXV. Letter of Professor Buckland to Professor Jameson, and of Captain Sykes to Professor Buckland, on the Interior of the Dens of Living Hyænas, - - - - 377

XXVI. On the growth and preparation of Straw used in the Tuscan trade, - - - 380

XXVII. Remarks on Dr Latta's Observations on the Arctic Sea and Ice. In a communication from the Rev. Mr Scoresby to Professor Jameson, 382

XXVIII. On the Coniometer. In a Letter from Professor Leslie to Professor Jameson, - - 384

XXIX. List of Rare Plants which have Flowered in the Royal Botanic Garden, Edinburgh, during the last three months; with Description of a new species of Euonymus. Communicated by Dr Graham, - - - - - 386

XXX. Celestial Phenomena from April 1. to July 1. 1827, calculated for the Meridian of Edinburgh, Mean Time. By Mr George Innes, Aberdeen, 387

XXXI. Proceedings of the Wernerian Natural History Society, - - - - 389

XXXII. Scientific Intelligence.

NATURAL PHILOSOPHY.

1. Repulsion of Heat inversely as the square of the distance. 2. The Beech-tree a Non-conductor of Lightning, 391, 392

HYDROGRAPHY.

3. Silica in Springs is dissolved by means of Carbonic Acid, 392

ZOOLOGY.

4. Tit-Lark caught at Sea. 5. Egyptian Antiquities in Liverpool Museum. 6. Notice regarding the Common Star-fish, Asterias rubens, - - - 393, 394

BOTANY.

7. Conclusions of M. Dureau de la Malle's Inquiries respecting the Ancient History, Origin, and Native Country of the Cereales, and especially Wheat (Triticum hibernum and æstivum), and Barley (Hordeum vulgare and hexastichon). 8. Instructions for Collecting and Preparing Fungi for Herbariums, and for Preserving them from the Attacks of Insects and their Larvæ. 9. Effects of certain Manures on the qualities of Plants, - - - 395–397

ARTS.

10. New mode of applying Graphite, or Black Lead, in Drawings. 11. On Etching and Dyeing at once figures on Ivory; by Mr J. Cathery, - - - 398, 399

NEW PUBLICATIONS.

1. Essay on the Theory of the Earth. By Baron George Cuvier; with Geological Illustrations by Professor Jameson. Fifth edition. Translated from the last French edition, with numerous additions by the Author and Translator. Eleven Plates. Blackwood, Edinburgh; Cadell, London. 14s. - - - 400
2. Illustrations of the Geology of Sussex, containing a general view of the Geological relations of the South Eastern part of England; with Figures and Descriptions of the Fossils of Tilgate Forest. By Gideon Mantell, Esq. F.R.S. Fellow of the Royal College of Surgeons, F.L.S. M.G.S. &c. One volume quarto, - - - 402
3. Mathematical and Astronomical Tables for the use of Students of Mathematics, Practical Astronomers, Surveyors, Engineers, and Navigators. By William Galbraith, M.A. Oliver & Boyd, Edinburgh. 9s. - 404

Art. XXXIII. List of Patents granted in England, from 8th December 1826 to 16th January 1827, 407

XXXIV. List of Patents granted in Scotland from 13th December 1826 to 24th February 1827, 409

List of Plates, - - - - 410

THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

Historical Eloge of the late Sir Joseph Banks, *Baronet, President of the Royal Society.* By Baron Cuvier *.

THE works which the distinguished individual of whom we have now to speak has left behind him, are confined to a few pages, and these of but little importance; yet his name will shine with lustre in the history of philosophy. Impelled by an ardent love of science, in his youth, abandoning the pleasures which an independent fortune held out to him, he braved the dangers of the sea, and the rigours of the most opposite climates. During a long series of years, he made use of all the advantages which affluent circumstances, and the friendship of men in power, afforded him, for its benefit; lastly, and it forms his chief claim to our respect, he always regarded those who laboured for its advancement, as having an acquired right to his interest and assistance. During the war of the revolution, which carried its ravages into almost every part of the two continents, the name of Sir Joseph Banks was every where a palladium for those of our countrymen who devoted themselves to useful researches. If their collections were seized, it was only necessary for them to apply to him to have them returned; if their persons were detained, the time

* Read to the Royal Academy of Sciences of France on the 2d April 1821.

necessary for transmitting them intelligence, was the only delay which their restoration to liberty experienced. When the seas were shut up against us, they opened at his voice for our scientific expeditions. Geography and Natural History are indebted to him for the preservation of precious labours; and, without him, our public collections would still, at the present day, and perhaps for ever, have been deprived of a part of the riches which adorn them. It will, without doubt, be admitted, that the benefit accruing to science from services like these, is fully equivalent to that resulting from the authorship of books; and if, in this discourse, it is principally the acknowledgment due to noble actions that we have to express, it is not too much to augur of our hearers, that this feeling will not be less intensely participated by them, than that of admiration for great discoveries would have been.

Sir Joseph Banks, Knight Baronet, Counsellor of State to the King of England, Grand Cross of the Order of the Bath, President of the Royal Society of London, and Foreign Associate of the Academy of Science of the Institute of France, was born in London, in Argyle Street, on the 13th February 1743. His father's name was William Banks Hodgenkson, and his mother's Marianne Bate. Some trace the origin of his family to one Simon Banks, a Swede, who settled in Yorkshire in the time of Edward III., and who would have been the eighteenth progenitor of Sir Joseph. Others say that his family came from Sweden only a century before, and had seen but two generations in England. It appears that Sir Joseph's grandfather practised medicine in Lincolnshire, and that the success which he met with in his profession, afforded him the means of acquiring a pretty large fortune. Having risen to considerable importance in the county, he was invested, in 1736, with the office of Sheriff, and sat in one or two Parliaments as representative of the town of Peterborough.

Joseph Banks, like the greater number of young Englishmen born in easy circumstances, after having been confided for some time to the care of a clergyman, was sent to a public seminary. His parents at first made choice of that of Harrow, near London, from whence they removed him to Christ's College, in the University of Oxford; and his father dying in 1761, he entered the world at the age of eighteen, master of himself and his fortune. This might have proved a dangerous shoal for so young a man; but henceforth Mr Banks was only sensible to the enjoyments attached to the labours of the mind, and the only use he made of his liberty was to devote himself exclusively to them.

About this period, Natural History began to raise itself from the low condition in which the more advanced sciences had kept it. The eloquent pictures of Buffon, and the ingenious classifications of Linnæus, afforded numerous attractions to the mind. In the steps of these celebrated men, there were seen to open paths alike new and full of interest; and it was in exploring these paths that a young man would naturally engage, who devoted himself to science only for the sake of gratifying his inclination. Mr Banks, therefore, at an early period, engaged in the examination of the productions of nature, and especially those of the vegetable kingdom. His taste for plants soon changed into a passion, and he made all the sacrifices to their investigation that it required. The first of these, as every body knows, is to travel much on foot; and this sacrifice is more disagreeable than any other in a country where this mode of travelling is so little in use, that it might of itself render a man liable to be suspected. Our young botanist was in fact more than once taken for a thief; and one day that he had fallen asleep from fatigue at a distance from the highway, he was violently seized by officers of police, and carried bound before a Magistrate, who was much amused with the adventure.

However, his ardour for study did not make him forget to take care of his affairs. From this time, also, he began to reflect, that the way in which he could be enabled to serve society with most ease, was to put himself in a condition for serving it, without demanding assistance from it. The most considerable part of his property was situated at Revesby, in Lincolnshire, upon the borders of that vast extent of marshy meadows which surrounds Boston Bay, the nature of which, in its characters, bears so close a resemblance to the province of Holland, that a portion of it has obtained the same name. He spent a part of the

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year in this country. Here he perfected the art of digging canals and raising dikes, so important for the improvement of land like this; he peopled the pools and small lakes of this fenny country, and sometimes amused himself with fishing. It is even said that it was in this exercise that he contracted a friendship with John Montagu, Earl of Sandwich, who afterwards became First Lord of the Admiralty, and who saw his name immortalized by the surprising advances in physical geography that took place during the time of his administration.

If this anecdote be true, it presents an additional example of the great effects that may result from a trivial cause; for it cannot be doubted that Mr Banks's influence contributed powerfully to multiply these discoveries. If he did not require to excite the Earl of Sandwich to expeditions which the will of the King sufficiently recommended to him, it is not the less true that he more than once pointed out to him the places to which it would be most advantageous to direct them, and acquainted him with the surest means of rendering them successful.

The example of this minister besides, became at length a sort of rule, and the numerous successors which he had in this elevated post, all thought themselves honoured by consulting the man whose advice had proved so beneficial.

Mr Banks, however, did not wait until he had acquired this degree of credit, to carry his views into execution. In 1766, one of his friends being captain of the vessel that was destined to protect the Newfoundland Fishery, he profited by the opportunity thus afforded of visiting that country. This was not indeed directing his first course toward the most attractive coast, but he soon had an opportunity of compensating for it.

The peace of 1763 came to restore tranquillity to Europe, and to open the seas again. The nations sought to repair, by new enterprises, the evils which their dissensions had caused. England especially, victorious in both hemispheres, and seeing unlimited careers present themselves on all sides to her fortune, shewed an energy, which, directed by an ambitious chief, might have proved highly injurious to humanity. Fortunately, at this period, a sceptre which was almost that of the ocean, passed into the hands of a young Monarch, pure in his morals, simple in his tastes, and who had early learned that useful discoveries might reflect as much lustre upon a reign as conquests. He was the first among princes who formed the idea of visiting new countries without carrying terror into them, and of making known his power only by his benefits. Whenever the historian records an example like this, it is his duty to shew it in all its beauty. It especially belongs to the historian of science, in fulfilling this duty, to raise himself above the wretched rivalships of nations: and although the nation which has merited this homage has been so often and so long at war with France, it is undoubtedly not before an assembly such as ours that I need apologise for having rendered it.

George III. was therefore eager, upon his coming to the throne, to send some vessels to the South Sea, with general instructions for extending geographical knowledge. Commodore Byron had been sent there in 1764. Two other officers, Captain Wallis and Captain Carteret, were sent out in 1766; they had not yet returned, when a fourth expedition was fitted out, under the command of James Cook, who, by this voyage, and the two others which he performed, contributed more to extend the knowledge of the globe, than any navigator who had preceded him for two centuries.

His voyage had in view at once the interests of geography and of astronomy; for Cook's principal commission was to observe the passage of Venus over the Sun's disc, which, having already taken place in 1761, was to occur again in 1769.

Mr Banks resolved to make it also contribute to the advantage of Natural History, and requested for this purpose to participate in its dangers, and devote to it a part of his fortune. He spared nothing to ensure its success, in as far as regarded himself; he provided at his own expence a great store of objects that might be useful to the people he was about to visit; he got all the apparatus necessary for physical observations, and the preservation of natural objects, placed in the vessel; he engaged a distinguished pupil of Linnæus, lately settled in England, Dr Solander, to prosecute with him the science which was the common object of their love; he took with him two painters, to make drawings of what could not be preserved; he engaged the necessary servants; in short, he provided all that might render his enterprise agreeable and successful.

We would remark here, that this period must be noted in the history of science, as that at which natural history began to extend its researches upon a large scale, by contracting an alliance with astronomy and navigation. It was also for the purpose of observing the same transit of Venus, that the Empress Catherine II. appointed the great expeditions into Siberia, under the direction of Pallas, and during which valuable collections were made by numerous naturalists. At the same time, Bougainville, by order of Louis XV., sailed round the world, taking with him Commerson, a man of boundless activity, and of almost universal knowledge. And it was truly in these three enterprises, which were nearly contemporaneous, that governments learned by what point the sciences are connected, and how the services which they confer are increased by combining their investigations.

I may be excused from relating, in detail, to the present auditory, the events of this first voyage of Captain Cook. Who is there among us that has not, from his childhood, read the account of it with a sort of delight? Who has not trembled for our travellers, when the cold threatened to chill them into a fatal sleep among the snows of Terra del Fuego? Who has not wished to live for a short time, like them, in the midst of the primitive people of Otaheite,—amid those beings so beautiful, so mild, happy in their innocence, enjoying, without disquietude, all the pleasures that are to be found under a serene sky, and upon a fertile soil? Whose heart has not palpitated for the fate of our navigators, when, having struck upon the coral rocks of New Holland, they saw the planks of their vessel come asunder, one by one; a leak opening which their pumps were unable to subdue; and when, after having no other prospect but death before them, for two days, they were suddenly saved by the expedient suggested by a man who was no mariner, of pushing, from without, bundles of wool into the gaps of the vessel?

All the circumstances of this expedition,—the perils and pleasures of the navigators, the varied manners of the tribes among which they landed, the caresses of the new Circes of Otaheite, the combats with the cannibals of New Zealand, with the general conflagration of the grass, in which the inhabitants of New South Wales were on the point of enveloping them,—seem to realise those amusing fables of the Odyssey, which have been the delight of so many nations and so many ages.

Now, it is incontestably to the presence of two men educated with other ideas than those of mere sailors; it is to their manner of observing and feeling, that this powerful interest is in a great measure due. Nothing was spared by them for enriching their collections, and satisfying their curiosity. Mr Banks especially, always manifested an astonishing activity; he was neither repulsed by fatigue, nor arrested by danger. He is seen at Brazil, gliding, like a smuggler, along the shore, in order to pick up some of the productions of that rich country, notwithstanding the stupid jealousy of the governor. At Otaheite, he has the patience to let himself be painted black, from head to foot, in order to be admitted to a funeral ceremony, which he could not otherwise have seen. And it is not only for seeing and observing that he displays his character: in every place, although destitute of legal authority, he seems naturally to assume the rank which in Europe would have been given him by the conventions of society. He is always foremost. He presides at the markets, and over negotiations. It is to him that both parties address themselves in any dispute. It is he who pursues the thief, and recovers the articles stolen. If he had not thus recovered the quadrant, which had been adroitly carried off by an islander, the principal object of the enterprise, the observation of the passage of Venus over the sun's disk, would not have been accomplished. Once only he did not dare to render himself justice; but it was when the Queen Oberea, having lodged too near him, stole away all his clothes through the night; and it will be allowed, that, in such a case, it would not have been gallant to have insisted too much on his rights.

This sort of magistracy, to which he found himself raised, depended upon the circumstances, that, while his figure and countenance were formed to inspire respect, his unremitting goodness laid claim to friendship. He gave to the savages instruments of agriculture, seeds of culinary vegetables, and domestic animals; he was watchful to prevent their being maltreated, and even to such a degree as to have them treated with indulgence when the fault was upon their side. If there exist a natural pre-eminence, it is that which is the offspring of intellect and beneficence.

His collections, during the three years which the voyage lasted, of objects of all descriptions, were immense, even although a part of them was lost, in consequence of an accident that befel the ship. It was for a long time hoped that Solander and himself would indulge the public with an account of them; and it is difficult to imagine what prevented them from doing so. Solander only died in 1782, and he could have employed ten years of his life in this undertaking. Besides their common journal, their notes, and all the drawings made under their inspection, still exist in the Banksian Library. The engraving of a splendid series of plates, intended to extend to two thousand, was begun; but, to the great regret of naturalists, nothing has appeared, at least under the auspices of the authors. Perhaps Mr Banks judged that his treasures would not be the less profitable to science, although he did not publish them himself. One of the most remarkable traits of his character was the generosity with which he communicated his scientific treasures to all who appeared to him worthy of perusing them. Fabricius described all his insects. He gave specimens of all his fishes to our colleague Broussonnet, for the ichthyology which he had commenced. Botanists who wished to see his plants, had free permission to consult his herbaria. Gærtner constantly profited by this indulgence for his admirable history of fruits and seeds, and Vahl for his Eclogues; and, in these later times, the excellent work of Mr Robert Brown on the Plants of New Holland, a work composed in Sir Joseph Banks's, and in the midst of his collections, has fulfilled, and more than fulfilled, all that could have been hoped from himself. Besides, he distributed, among all the gardens of Europe, the seeds of the South Sea, as in the South Sea he had distributed ours. Lastly, he was satisfied that, in all that could regard immediate utility, the object of his voyage had been as effectually accomplished as it could be. In fact, a multitude of beautiful shrubs, which he first introduced, now ornament our groves and grounds. The Otaheitean cane, which affords more sugar, and ripens more freely, has, in part, repaired the disasters of our colonies; the bread-fruit tree, carried to the warm countries of America, will repay the services which America formerly rendered to us, when it furnished us with the potato; the New Zealand flax, the fibres of which are more tenacious than those of any other plant, is cultivated among us, and will infallibly prove, one day, an important acquisition for our marine. Several of our ponds are embellished with the black swan; the kangaroo and phascolome are kept in some of our parks; and there is nothing to prevent their becoming animals of game in our woods, as useful as the fallow-deer or the rabbit, which were equally exotic animals. But these are results of little importance compared with the general knowledge which this voyage began to afford us of the Pacific Ocean; of the multitude of islands which nature has spread through it; and of the creatures, in some measure peculiar, with which they are peopled. New Holland especially, if we except man and the dog, (and these, without doubt, have arrived in it at a comparatively recent period, so miserable is the condition in which they occur there), bears no resemblance, in its organic nature, so to speak, to the rest of the world. It possesses other animals, often appearing to unite forms which are contrary to each other; vegetables which seem destined to subvert all our rules and systems. Within these thirty years, the English have formed an establishment in the middle of this continent, among this creation almost as new to Europe as that of another planet would be. What it has already furnished to science is prodigious, and is a source of general advantage to all nations. With regard to the advantages which it gives, and will give, to the mother country, it is not my business to detail them at length; but every one will perceive what commercial, political, and military importance a great European colony, in a temperate zone, in a healthy and fertile country, placed between Asia and America, and communicating as easily with Peru as with Bengal, must necessarily assume. This much is certain, that, before many years elapse, whether it become independent, or remain subject, it will have multiplied that race of the human species, the most susceptible of civilization, as extensively as the English colonies of North America have done.

Such will be, such already are, in a great measure, the results of the voyage of Cook, Banks, and Solander; and the reason is obvious, because the voyage in question, having men of scientific attainments embarked in it, was directed with more enlightened views, and conducted with more philosophy, than any that had been made for three centuries.

I need not say with what eagerness these new argonauts were received on their return. All classes of society were anxious to testify what they felt for them; the King, in particular, shewed them the greatest regard. Friend as he was to botany and agriculture, he received with great pleasure the seeds and plants which Mr Banks presented to him; and, from this time, conceived an affection for our young traveller, which was never afterwards interrupted.

This description of enterprize, so new and so generous, which originated in England, was so much lauded throughout Europe, that the British government could not but consider itself bound to repeat it. In 1772, Captain Cook was to set out upon his second voyage, of all nautical expeditions the most astonishing for the courage and perseverance of those who embarked in it. Mr Banks was also resolved to accompany him anew; Solander was again to be taken out; all the preparations were made; but they demanded, and it was certainly reasonable, to have the conveniency afforded them in the ship, which, without clogging the expedition, might render their exile more comfortable. It is difficult to comprehend how the Captain could resolve to deprive himself of their assistance. Was it jealousy or regret at having his glory divided by men who had so efficiently participated in his labours? Was it the remembrance of some restraints or inconveniences which the respect due to persons of their station in society had occasioned him during his former voyage? We do not pretend to decide. This, however, is certain, that he caused several arrangements which Mr Banks had made in the vessel to be destroyed; and that the latter, in a moment of irritation, renounced all his projects.

I shall not here seek to determine between them. If we reflect that Captain Cook fell out with the two Forsters, who were substituted for Mr Banks and Dr Solander,—that, on the third voyage, he refused to take any naturalist with him,—that there have been none employed since in the nautical expeditions of the English—and that those who have embarked in ours have very seldom been on good terms with their leaders, it will perhaps be found that the freedom of action, to which men of the closet are accustomed, can scarcely be reconciled to the severe discipline so necessary in a ship; and then we shall neither have to blame our two naturalists, nor the great navigator who could not ageee with them.

Mr Banks, however, as he could not accompany Cook, resolved to direct his ardour into another path. The northern countries, and especially Iceland, so remarkable for its volcanic phenomena, presented him with sufficient objects of research. In a few weeks a vessel was freighted, laden with every thing that was necessary for naturalists; and Mr Banks set out on the 12th July 1772, accompanied with his faithful Solander, a Swede, Uno de Troil, afterwards Bishop of Linkoping, and some other persons worthy of taking part in such an enterprise.

A fortunate opportunity occurred to them of visiting, in passing, the island of Staffa, so interesting for the immense mass of basaltic columns of which it is formed; and for the cave of two hundred and fifty feet in depth, entirely surrounded by these columns, the natural regularity of which equals the most surprising efforts of human art. It is singular that this wonder of nature, so near a populous country, had been so little known; but although the island had been named by Buchanan, no person had given any description of its extraordinary structure; and it may be regarded as a discovery of our voyagers.

They soon arrived in Iceland. Here they no longer met with the happy islanders of the South Sea, on whom nature had lavished her gifts. A soil, desolated alike by the fire of volcanoes, and by winters of nine months' duration, the low country bristled almost over its whole extent with naked and sharp rocks, mountains of ice floating in the sea, and which often, by their accumulation in the vicinity of the land, caused the winter to recommence; every thing seems to announce to the Icelanders the malediction of the celestial powers. They bear the impress of the climate; their gravity, their melancholy aspect, form as great a contrast with the gaiety of the South Sea Islanders, as the countries inhabited by the two nations; and yet the natives of Iceland have their enjoyments, and these enjoyments of a superior order. Study and reflection soften their lot. Those great natural edifices of basalt, and vast fountains of boiling water; the stony vegetations which this water produces; the northern lights of a thousand forms and hues, illuminating from time to time these imposing spectacles, afford them a recompence for their privations, and excite them to meditation. Iceland is perhaps the only colony in the world that has formed a more original literature than the mother country, or even modern Europe. It is asserted, that one of her navigators discovered America nearly five centuries before Columbus; and it is only by consulting her ancient annals, that documents of any authenticity have been found for the history of Scandinavia. Still at the present day, the meanest peasant is instructed in the history of his country; and it is in repeating from memory the songs of their ancient poets, that they pass their long winter evenings.

Our learned caravan employed a month in traversing the island; and Mr Von Troil published a very interesting account of what they observed. As to Mr Banks, always little solicitous about himself, he gave to Mr Pennant, for his Journey to Scotland, the drawings* which he had caused to be made of the island of Staffa and its cave, as well as the description which he had taken of them. In Iceland, as in the South Sea, and as at Newfoundland, it was sufficient for him that his observations were not lost to the public; and this consideration appears to have satisfied all his wishes. Here, also, he did better than describe; he became to the Icelanders a not less zealous and a more effective benefactor than to the Otaheiteans. Not only did he draw the attention of the court of Denmark to them, but watching over their welfare himself, he twice, at his own expence, when they were afflicted with famine, sent cargoes of grain to their island. Like the personages which were deified by the ancient mythology, it might be said of him, that he became a providence to the places which he had once visited.

On his return from two enterprises, in which he had given such splendid proofs of his disinterested love of science, Mr Banks would naturally find his place in the first ranks of those who cultivate it. Having long been a member of the Royal Society, he now took an active part in its administration and labours. His house, open with equal hospitality to men of science of his own and of other nations, became a sort of academy. The welcome of the master,—the pleasure of seeing

* These drawings are now preserved in the College Museum of Edinburgh. —Edit.

there the meritorious friends whom he had made,—a rich library, accessible to all,—collections which would in vain have been searched for even in public institutions, drew thither the lovers of science. Nowhere was such a point of union more precious, it might be said more necessary, than in a country where the barriers which separate the conditions of society are stronger than in any other, and where men of different ranks meet but rarely, unless some one, for the purpose of bringing them together, puts himself in some measure out of rank, or makes for himself a peculiar and extraordinary rank.

Mr Banks was the first who had the good feeling to give himself this honourable kind of existence, and thus to create a sort of institution, the utility of which was so striking, that it was promptly sanctioned by general opinion. The choice which the Royal Society made of him, some years after, for its president, gave to this sanction all the authenticity which it was capable of receiving. But as is but too common among men, it was at the moment when he obtained this honour, the greatest which he could desire, that the most bitter disputes arose.

Here it becomes necessary that we should give some explanation to our hearers.

The Royal Society of London, the oldest of the scientific academies that subsist at the present day, and, without dispute, one of the first for the discoveries of its members, receives no assistance from government, and is supported solely by the contributions of those who compose it. It is therefore necessary for it to be very numerous, and a not less necessary consequence, (as in all the political associations where the participation of the citizens in the government is in the inverse ratio of their number), the men to whom it confides its administration exercise over its labours, and to a certain point over the march and progress of science, a more considerable influence than we can easily fancy to ourselves in our continental academies. The situation of a minister in a representative constitution which obliges him to have guarantees in some measure official for all his acts, contributes still more to this influence, and extends it over the lot of individuals. In reality, a new election is made every year; but the functions of the president are of so delicate a nature that few are capable of executing them ; hence it very seldom happens, that he who has been once invested with them, is not re-elected so long as he consents to be so. A first choice is therefore a great affair in the learned world; and when it is disputed, it is with great keenness.

At the period of which we speak, the discussions that took place had their asperity increased by a singular, I would almost venture to say a ridiculous incident. The natural philosophers of the Royal Society having been consulted about the form that should be given to a lightning-rod that was to be placed upon some public building, had almost unanimously proposed to have it terminated in a point. A single individual among them of the name of Wilson, took it into his head to maintain that it should terminate in a round knob, and he delivered an incomprehensible harangue in support of this paradox. The thing was so clear, that, in any other country, or at any other time, people would not have listened to him, and the conductor would have been made as all others had hitherto been made. But England was then in the hottest part of her quarrel with her American colonies, and it was Franklin who had discovered the power which points have of drawing off lightning. A question of natural philosophy therefore became a question of politics. It was carried on not before learned men, but before party men. It was only the friends of the insurgents, it was said, that could be for points, and whoever did not support the knobs, was evidently without affection for the mother country. As is usual the multitude, and even the higher classes, were divided, before having examined the matter, and Wilson found protectors, just as protectors would have been found against the theorem of Pythagoras, if geometry had ever become an affair of party. It is even asserted that an august personage, on every other occasion the generous and enlightened friend of science, had, on this occasion, the weakness to make himself a solicitor, and the misfortune to plead against the points. He spoke to the then president, Sir John Pringle, a man of sound judgment and of elevated character. Pringle, it is said, respectfully represented, that the prerogatives of the President of the Royal Society did not go so far as to change the laws of nature. He might have added, that, if it be honourable for princes, not only to protect the sciences as they ought, but also to amuse their leisure, by informing themselves of the discussions to which they give rise, it can only be on condition that they do not make their rank interfere in support of the opinions which they adopt. The representations of Pringle were not received with the graciousness to which he was accustomed; and, as this unhappy quarrel had already, for three years, involved him in a thousand bickerings, he considered it advisable, for his peace, to give in his resignation. It was in his place that Mr Banks was chosen in the month of November 1778. On what side he had placed himself in the war of electrical points and knobs, we do not well know; but this much every body will comprehend, that, under such circumstances, it was impossible for him to attain the presidency, without encountering many enemies. The circumstance of Mr Banks enjoying the favour of the august personage, whom his predecessor had offended, was employed by his enemies against him; moreover he was rich and young, and although he had done more for science than many writers, he had written little. What motives and pretexts for attacking him! What disgrace (it was said) for England and the mathematics! a mere amateur to fill the seat of Newton! as if it could have been hoped that another Newton should ever occupy it. A naturalist to be put at the head of the mathematics! as if it were not just that each science should, in its turn, obtain honours proportioned to the fruits which it produced. By degrees these murmurs degenerated into animosities; at length, on the occasion of a law that required the secretaries to reside in London, and of which the consequence was the resignation of Dr Hutton, Professor of Mathematics in the school of Woolwich, these animosities burst forth into a violent tempest. Dr Horsley, a learned mathematician and ardent theologian, who was afterwards, successively, Bishop of St David's and of Rochester, became the principal organ of the opposition. He delivered discourses and published writings remarkable for their asperity; he predicted all the misfortunes imaginable to the society and to science; and, supported by some members of more consideration than himself, such as the astronomer Maskelyne, he thought himself at the point of overturning Mr Banks. Fortunately it was perceived that he also had in view to place himself in the chair, a discovery that proved a sedative to all the passions which he had excited. Such a chief appeared, even to his own friends, an evil more certain than any of those which he had predicted. He was abandoned, and some meetings after, the society, by a solemn deliberation, on the 8th January 1784, declared that it was satisfied with its choice. Horsley, and some violent men like himself, withdrew; and, since that period, Mr Banks, constantly re-elected, filled, in peace, this noble station during forty-one successive years, a duration longer than that of any of his predecessors. Newton himself only occupied the presidency during twenty-four years.

Assuredly, if we cast a glance over the history of the Royal Society during these forty-one years, we shall not find that it had cause to repent of its resolution.

During this epoch, so memorable in the history of the human mind, the cultivators of science in England,—it is honourable for us to say it, for us whose right to render this testimony cannot be disputed, and who can render it without fear for ourselves,—the cultivators of science in England have occupied as glorious a part as those of any other country in those labours which are common to all civilized nations. They have encountered the ice of both poles; they have left no region unvisited in either ocean; they have augmented the catalogue of the productions of nature in a tenfold degree; the heavens have been peopled by them with planets, satellites, and unheard of phenomena; they have counted, so to speak, the stars of the Milky Way; if chemistry has assumed a new aspect, the facts with which they have furnished it have essentially contributed to this metamorphosis; inflammable air, pure air, phlogisticated air, we owe to them; they discovered the decomposition of water; new and numerous metals are the results of their analyses; the nature of the fixed alkalies was demonstrated by their experiments; mechanics, at their voice, have brought forth miracles, and placed their country above others in almost every kind of manufacture: and if, as no reasonable person can doubt, such successes result from their personal energy and the general spirit of their nation, much more than from the influence of an individual, in whatever situation he may be; it must yet be always acknowledged, that Sir Joseph Banks did not abuse his situation, and that his influence was not exerted in a prejudicial manner. The very collection of the Memoirs of the Society, upon which the president might, without exaggeration, be supposed to possess a more effectual influence than upon the progress of science, has evidently assumed a greater degree of richness; it has appeared more regularly, and under a form more worthy of so beautiful a work. It was also in Sir Joseph's time that the Society itself began to be better treated by the government, and that it occupied, in one of the royal palaces, apartments worthy of a body which does so much honour to the nation.

It was impossible for services like these not to be at length acknowledged by impartial men: the public opinion proclaimed them, and the government was obliged to proclaim them also. Raised to the dignity of Baronet in 1781, decorated in 1795 with the Order of the Bath, one of the first among those who were neither peers of the realm, nor provided with great military offices, Sir Joseph was, in 1797, named Counsellor of State, which, in England, gives a distinguished rank, and the appellation of *Right Honourable*, which is not without some importance in a country where etiquette has its sway.

To him, however, it was merely a title, but this title was a favour, and it needed not more to awaken envy again. Already, on his return from Otaheite, a wag had addressed to him a heroic poem in the name of Queen Oberea; on another occasion, he was made to offer an urgent prayer to God to multiply insects, as at the time of the plagues of Egypt; and now, pretending that he was admitted to real political counsels, he was represented as running after butterflies, while his colleagues were deliberating upon the interests of Europe. The only remedy applicable to bites like these was to laugh at them, and it was this he employed.

If he did not act officially as a political counsellor, he was not the less a real and a very useful counsellor to the King. He partook in his rural occupations; he made him acquainted with the interesting productions of distant countries, and thus kept up in him that taste for nature, which had already brought so many acquisitions to science, and which continued to do more for it in proportion as the example of the prince was imitated by the great. It is thus that for thirty years England has been, in some measure, the centre of botany, and the mart of new plants and shrubs.

The confidence, arising from this community of occupations, gave Sir Joseph opportunities of still more directly serving his country; and it is said, that the minister sometimes employed his influence to make the monarch adopt resolutions which political circumstances rendered necessary, but which his natural affections rendered repugnant to him.

Any one who has an idea of the complicated and mysterious progress of the smallest affairs in a government, where intrigues of the heart mingle every moment with the interests of party, must at once conceive the importance that a man might acquire in a situation such as this. It is a thing to be wondered at, that Sir Joseph neither used it for increasing his fortune, nor for gratifying his vanity.

Whatever favour he possessed, he always made it reflect upon the sciences which had procured it for him. Wherever an association was formed for a useful enterprise, he hastened to take part in it; every work that required assistance in money, or patronage from authority, might reckon upon his support. Whenever any important inquiry was to be undertaken, he pointed it out, and made known the most efficacious means for accomplishing it. He was thus a party in forming the plans of all the great voyages undertaken after his own: he contributed much to the establishment of the Board of Agriculture: being one of the first and most active members of the African Association, he constantly obtained encouragement for those who have attempted to penetrate into that part of the world. It was in consequence of his repeated recommendations that the discovery of a North-west Passage round America was thought of being tried, and that the enterprise was persevered in, notwithstanding the bad success of a first attempt. All the operations referring to the measurement of the meridian, whether it was English or French that laboured in them, were favoured by him; in the time of war, as in peace, passports and hospitable treatment were assured to them by his exertions. But what we have already stated, and what it is especially our duty to celebrate in this discourse, is the indefatigable generosity with which, amidst the most violent national antipathies, he softened the evils of war toward those who were engaged in scientific researches.

The virtuous Louis XVI., at the opening of the American war, had, of his own accord, caused orders to be given to his vessels everywhere to respect Captain Cook and his companions. To the honour of our so much calumniated age, this beautiful example has become an article of the law of nations; but it was chiefly the unremitting zeal of Sir Joseph Banks that procured its being inscribed as such. Not only did he never neglect an opportunity of engaging the English government to conform to it, but also more than once preferred solicitations to foreign governments. At the commencement of the war, he had obtained similar orders to be given in favour of La Peyrouse, if he still existed, and had inquiries made for him in every sea. When discords had put an end to Entrecasteaux's expedition, and M. de la Billardiere's collections were transported to England, he succeeded in getting them restored to him; and he also added the delicacy of sending them without even having looked at them. He would have dreaded, he wrote to M. de Jussieu, to carry off a single botanical idea, from a man who had gone to obtain them at the peril of his life. Ten different times, collections addressed to the Jardin du Roi, and taken by English vessels, were recovered by him, and delivered up in the same manner. He even sent to the Cape of Good Hope, to release the cases belonging to M. de Humboldt, that had been taken by pirates, and would never receive any reimbursement. He considered himself, as it were, accountable for all the injuries that his countrymen might do to science and its cultivators; and still more, he thought himself obliged to repair the evil that other nations might cause them. Having learned by the public prints that our colleague Broussonet was obliged to flee from the executioners of his country, he immediately gave his correspondents in Spain an order to let him want nothing. His assistance reached him at Madrid and Lisbon, and followed him to Morocco. When the celebrated mineralogist Dolomieu, by the greatest violation of the right of nations, and to satisfy the vengeance of an enraged woman, was cast into the dungeons of Messina, it was the ingenious humanity of Sir Joseph Banks that first penetrated the subterranean abode where he groaned concealed from the whole world, and which gave him some relief by news of his country and family. If he did not accomplish his liberty, it was not for want of employing all the means imaginable with the government which detained him with so much injustice. And what he did for our countrymen, he was not less zealous to demand for his own. Every one is aware of that other violation of the right of nations, by which thousands of Englishmen residing, or peaceably travelling, in France, were declared prisoners of war. Sir Joseph hastened to find out all those in favour of whom some scientific occupation or title could be alleged; it was through the Institute that he was enabled to make the claim, and the Institute was not less eager than himself in the use of this pretext. Thus were several persons worthy of esteem rescued from a captivity which might perhaps have been fatal to them.

Assuredly he who thus uses his influence, has every right to watch that it remain untouched; it is even his duty to do so; and in this universal struggle for power, when chance has brought some portion into the hands of a man animated with such sentiments, should he neglect to preserve it, society in general would have a right to complain. This is the only answer which Sir Joseph's friends can have to make to what might be said against the jealous care with which he prevented whatever might weaken the consideration of his place, or excite discord in his Society. Sometimes, we admit, his precautions might have appeared extravagant; but, attacked so often by exasperated men, had he not reason to dread, that a moment of relaxation might grant them success? The mere fact of having replied with some politeness to the Institute, which in 1802 named him a foreign associate, reawoke all the fury of Dr Horsley, who seemed to have forgotten him for fifteen years, and whose age, and episcopal dignity, ought to have inspired more moderation. He wrote a virulent pamphlet against Sir Joseph Banks, and after his death, left inheritors of his hatred which the death of Sir Joseph himself could not calm.

Considering ourselves capable of forming as impartial a judgment as posterity, we think it our duty to offer the unreserved tribute of praise to the courage in Sir Joseph Banks, which engaged him in so many perilous enterprises; the whole use which he made of his influence in supporting whatever was useful; the exemplary assiduity with which he performed the duties of an honourable office; the amenity which he introduced into the intercourse of the lovers of science; and the generous solicitude he displayed for those pursued by misfortunes: And when we reflect how, in reality, and in spite of impotent attacks, he was recompensed by the esteem of the public, and how happy he must have been in the very exercise of so unremitting a benevolence, and to which he had given so wide a range, we consider it as an urgent duty, to present him as an example to many rich men, who pass in an indolence, fatiguing to themselves and to others, a life which their condition in the world might enable them so easily to render useful to mankind.

His domestic happiness equalled all his other sources of enjoyment. He did not lose his respectable mother till 1804; an accomplished and intelligent sister lived nearly as long as himself; an amiable wife always formed the charm of his society. Nature herself seemed to have been equally favourable to him as fortune. His person was tall and finely formed; his constitution vigorous; and if the gout troubled his latter years, and even deprived him for some time of the use of his limbs, it could neither alter his intellect nor his disposition.

The last moments of a life entirely devoted to the improvement of science, were employed in forwarding its interests after he should cease to live. In dying, he bequeathed to the British Museum his rich library of Natural History, a collection formed by fifty years of assiduous research, and which the Catalogue drawn up under the eye of Mr Dryander has rendered celebrated over all Europe, and even useful to those who have not the power of visiting the Library, from the regularity with which not only the works of which it is composed, but even the particular memoirs which enter into these works, are there enumerated and arranged under the different subjects to which they belong. He made rather a slender provision for the great botanist Mr Brown, who had sacrificed to him hopes greatly superior to all that he could expect from him, but who himself thought that science, and the friendship of a man like Sir Joseph Banks, merited such a sacrifice. He also assigned funds for continuing the execution of botanical drawings of new plants, that had been commenced in the Royal Gardens at Kew, by the excellent artist Mr Bauer.

Sir Joseph Banks died on the 19th May 1820, leaving no issue. The Royal Society elected for their President Sir Humphrey Davy, who will equal him in all his good qualities, and who will not give rise to the same objections; for, young as he still is, his discoveries are among the most admirable of the age. Sir Humphrey Davy was already before this a foreign member of the Institute; and the Academy of Science has named, in the place of Sir Joseph Banks, M. Gauss, Professor of Gottingen, to whom his excellent labours in the mathematics long gave a title to that honour.

Remarks and Experiments relating to Hygrometers and Evaporation. By Mr Henry Meikle. Communicated by the Author.

It is now pretty generally admitted, that hygrometers, formed of absorbent substances, being necessarily of a changing or perishable nature, are extremely liable to have their sensibility impaired through length of time; so that little confidence can be placed in them, however accurately they may have been at first constructed. Nor is there much reason to expect that two such hygrometers will agree, unless the one have been made from the other, or both have been graduated from some less vague instrument; but even admitting that they did agree, what security have we that such accordance shall continue? Professor Leslie's hygrometer is entirely free from this objection, as likewise Mr Daniell's, and some modifications of it proposed by Mr Jones and others. The principle of the latter sort is to cool down an even or polished surface exposed to the air, till a deposition of moisture begin to adhere to it; and if we could easily and accurately ascertain this reduced temperature, we should be enabled to determine the state of the air with regard to moisture. The cooling principle here employed, as the most convenient, is the evaporation of ether; and for that purpose, a supply of this costly liquid, of rather a superior quality, must be constantly carried along with the instrument.

By means of his ingenious researches, and particularly his valuable "Essays," Mr Daniell has contributed greatly to improve and extend the science of hygrometry. But without meaning at all to detract from the undoubted merit of these labours, I am not convinced that his hygrometer is either the most convenient and distinct, or even susceptible of being rendered so. Whoever has attended to such instruments, must have remarked, that the instant of incipient deposition is not well defined. This defect, to be sure, is not so conspicuous when the instrument is small, and the temperature changing rapidly; but if a cold liquid be put into a pretty large vessel, along with a sensible thermometer, it will be found, that even then the temperature of deposition cannot be ascertained with much nicety; and, of course, the uncertainty must be greater with a small fickle instrument moving by starts. Besides, good light and acute eyes are quite indispensable, simultaneously to observe the fleeting temperature, and the corresponding but ill defined commencement of the formation of dew.

On the other hand, when we use a thermometer depressed by the evaporation of water, as is the case with Professor Leslie's hygrometer, this may be observed with the greatest nicety and deliberation. A more legible indication is unnecessary; and its certainty and sensibility are placed beyond a doubt, by the exact agreement of several such instruments. Nothing, indeed, is wanting to remove prejudices, and give perfect confidence to this simplest of all hygrometers deserving the name, but a greater number of experiments by different observers. Even supposing that some imperfection did attach to its theory, yet more extensive observations could soon settle or correct this; but an infinite number of observations could not make the instant of deposition *well defined*, whilst in the nature of things it is otherwise.

It is much to be wished, that accurate experiments were made by different individuals, to ascertain the quantity of moisture which can exist in the air at low temperatures. Authors of great celebrity differ so widely on this head, that it is doubtful if any of them be quite correct. To attempt to ascertain the force of vapour at low temperatures by means of a column of mercury, is out of the question; because such a method is liable to so many errors, that no confidence can be put in it. Mr Dalton, to whom this department of science owes so much, has made many experiments in this way to ascertain the force of aqueous vapour at the freezing point; and these seem to have been very inconsistent, as Mr Dalton only concludes from them, that this force is not greater than three, nor less than two tenths of an inch of mercury.* The latter is Dr Ure's estimate; and Mr Southern makes it 0.16 inch. At lower temperatures, I suspect our tables are little else than a guess.

But it is not less remarkable, that as great a diversity of opinion should exist regarding the density of steam at the boiling point, or still higher temperatures. Thus M. Gay Lussac makes it to that of air, of the same temperature and pressure, as 5 to 8. Sir Humphrey Davy again alleges, that steam just occupies the same volume as a mixture of its constituent gases does under like circumstances. Its specific gravity would thus be to that of air as 5 to 12, if not rather lower †.

I shall now proceed to give an account of some experiments of a different sort from those just mentioned, but connected with this subject; and which I should be glad to find carefully repeated by others. In order to determine how far the depression of a wet thermometer inclosed with some drying substance, is affected by the capacity of the vessel, I made the following experiments. Into a wide mouthed bottle capable of holding an imperial gallon, I put a quantity of sulphuric acid sufficient to cover its bottom to a small depth; and from the middle of the cork I suspended two thermometers mounted upon one broad scale. Their balls were about an inch separate, and on the same level; the one was covered with wet linen, and the other naked. At the time of putting in the acid, the whole interior surface of the bottle had been wetted with it; and after the moist thermometer became considerably depressed, I wetted the interior surface afresh with acid, and then moved the bottle gently, so as to agitate the thermometers considerably. This I had also done from the beginning. After fully half an hour, the dry thermo-

* Manchester Memoirs, Second Series, iii. 473.

† Annales de Chimie, lxxx. 218; Supp. Encyc. Britan. Art. Steam Engine, p. 535.

meter indicated 53°.5 Fahr. and the moist 40°.4, giving a depression of 13°.1. The height of the barometer was nearly 30 inches; but exactness in this, as we shall shortly see, was of no moment.

There is, however, reason to think, that a quantity of air, confined in a vessel along with a drying substance, such as sulphuric acid, can never be rendered perfectly dry, if it, at same time, contain the bulb of a thermometer covered with wet linen; because this, to a certain extent, will continually supply it with moisture, which must require some time to pass to the acid and be there absorbed, and the more so as the vessel is larger *.

To try the effects of a smaller vessel, I put a little sulphuric acid into a small spheroidal flask having about the 27th of the capacity of the former; and introducing a single thermometer with its ball moistened as before, I fastened its stem in the neck of the flask. To note the temperature of the included air, I kept the flask and another thermometer immersed in a jar of water, which was frequently stirred. The flask was often turned on its side, rolling it round to keep the interior surface wetted with acid. At the end of about $\frac{3}{4}$ths of an hour, the full effect seemed to have been attained. The thermometer, in the water, stood, as from the beginning, at 53° Fahr. and that within the flask at 39°.9, giving a depression of 13°.1 as before. This and the first experiment were repeated some days after, with the same result †.

From these experiments I was almost led to the conclusion, that if the interior surface of a bottle be kept wet with acid, its size should be of no consequence. But reflecting, that the balls of the thermometers, in the larger bottle, had been kept in motion, and that within an inch of the acid in the bottom, I was induced to try what effect it would have to fasten the moist ball as nearly as possible in the centre of the larger bottle. Upon doing so,

* Various liquids are known to produce greater cold in the surface from which they evaporate than water does. Yet it is curious, that so volatile a fluid as oil of turpentine should have no effect in this way; and a covered thermometer, first dipped in oil of turpentine, and then in water, undergoes the same depression as if no turpentine were present.

† The like coincidence I find, obtains at 80° Fahr., the depression then amounts to 24.°3.

the effect was considerably less, especially when the sides of the bottle were dry: as the depression, in that case, was only 53°—41°.2=11.°8; and by repeatedly wetting the sides with acid, as was done with the small flask, the utmost effect was only 53°.1—40°.4=12°.7. But by suspending the thermometers, and making them vibrate near the bottom as before, the depression reached 53°—39°.9=13°.1, as in the former experiments; though such perfect coincidence may have been a little accidental.

In the small flask again, with acid only in its bottom, and its sides dry, the result was 52°.6—42°.4=10°.2. To do justice to such experiments, a considerable time must be spent on them; for though, in the open air, the wet thermometer soon attain its utmost depression, yet, in a close vessel, particularly a small one, it proceeds with extreme slowness, and at a retarded rate. Those, who are not aware of this circumstance, are apt to obtain deficient results. Motion, in the free air, hastens the depression, but unless it be rapid, it scarcely affects its amount. On the other hand, a dry thermometer rises a little, by being moved swiftly through the air.

Wishing to try the effects of different atmospheric pressures on the depression, I placed the double thermometer over a broad saucer of sulphuric acid on the plate of an air-pump, and covered the whole with a receiver. The following are the results at different pressures:

Inches.	°	°	°
29.7	48.2	36.6	11.6
19.4	47.3	33.2	14.1
17.2	47.2	32.5	14.7
13.3	47.0	31.2	15.8
8.8	46.4	27.2	19.2

The first column is the barometric pressure in inches; the second the Fahrenheit temperature of the dry thermometer; the third that of the moist, and the fourth their difference or the depression *.

* Experiments of this sort take such a length of time, that I only, at first, intended to have tried three different pressures, the 1st, 2d, and 5th, differing about ten inches, but before concluding, I added the other two, to come close upon the freezing point; though both, as we shall shortly see, should, when corrected, be above 32°.

On comparing this with Mr Anderson's results, *Edinburgh Encyclopædia*, art. *Hygrometry*, a remarkable disagreement will be perceived, both as to the quantity of the depression, and the rate at which it is influenced by pressure. The following are the results which Mr Anderson obtained by placing Leslie's hygrometer under a receiver along with sulphuric acid; the temperature of the air being 48°.5 Fahrenheit.

Inches.		
29.6	27°	4°.86
23.6	34	6.12
17.6	44	7.92
11.6	62	11.16
5.6	91	16.38

The first column is the pressure; the second the depression in degrees of Leslie's hygrometer, which, for the sake of comparison, I have reduced to degrees of Fahrenheit in the third.

The temperature and pressure in Mr Anderson's first case, are nearly the same as mine, but our depressions are very different; his being only 4°.86, whilst mine is 11°.6, which is more than twice as great. This discordance led me, at first, to suspect, that as, in Mr Anderson's experiments, the wet ball of the hygrometer would, from its construction, be six or eight inches above the surface of the acid, whilst in mine it did not exceed one inch, this might be the reason why his depressions were so small. But on trying this, the result was 49°—39°=10°, still double of Mr Anderson's numbers; even though the surface of sulphuric acid did not exceed half of that in the former experiments, so that this does not appear to have been the reason why Mr A.'s numbers are so small. Indeed I have repeatedly obtained greater depressions than 4°.86, by merely suspending the instrument in a room where no means were used to dry the air, or raise its temperature *; such as 46°.5 — 40°.5 = 6°; 45°8. — 40.°5 = 5°.3; 47°.5—41°=6°.5. The barometer was rather higher than Mr Anderson's; and had the temperature been raised to 48°.5 Fahrenheit, the depression would have been a little increased.

The difference surely could not proceed from any defect in

* For, as is well known, very cold air, by being heated, without additional moisture, becomes comparatively dry.

Mr Anderson's air-pump, as I understand he has an excellent one, and knows as well how to use it. But it is curious that he seems scarcely to have reached the freezing point, even under greater exhaustions than I have yet employed. My experiments were made by a very powerful double barrelled air-pump, made by Mr Dunn, optician in Edinburgh, a very ingenious artist, who, to great practical skill in the workmanship, joins a corresponding acquaintance with the scientific principles of his profession. The barrels of his pumps are considerably larger than those commonly made in London; so that a few turns of the handle can freeze the wet thermometer under a receiver perfectly white. Most air-pumps are very defective in not having the plate ground truly flat. This, indeed, is reckoned so easily done, that it is too often neglected, to the great detriment of the instrument. The attention of Mr Dunn to this most important part of an air-pump, forms no small recommendation to his instruments; though, I believe, he is equally careful in the execution of all his work.

Since the foregoing account was written, I have made another set of experiments on the effects of pressure at rather higher temperatures. The following are the results:

Inches.	°	°	°
29.9	60·6	45.5	15.1
20.0	59.5	41.0	18.5
10.0	58.9	34.1	24.8
5.6	58.5	28.0	30.5

Here, as before, the first column is the pressure; the second the temperature of the dry thermometer; the third that of the moist, and the fourth the depression. The greatest exhaustion is here the same as Mr Anderson's, but the temperature of the moist ball is somewhat lower, even though the dry one be 10° higher than his. The depression, in the fourth column, follows a law very different from the reciprocal of the pressure.

The conclusion drawn by Mr Anderson from his experiments is, that, in air of the same dryness and temperature, the depression is inversely as the barometric pressure. Mr Ivory again, from his investigation, Phil. Mag. lx. 85, has brought out a very different result, that when the temperature, not of the air, but of the moist bulb, is the same, the depression is inversely as the pressure. This, no doubt, comes much nearer to my results than to those of Mr Anderson, though it is not very easy to make the comparison, on account of the different temperatures of the moist ball, at the various pressures in the foregoing tables.

I must not omit to mention, that, in these tables, the temperatures themselves still require a small correction; because the thermometers were, as is usual, sealed or close at top, and would, therefore, stand a little too low when under the reduced pressure. For, on placing them in a dry state, under a receiver, and exhausting to the utmost, both stood 1°.5 Fahr. lower when the former temperature was restored. Hence, as the entire barometric pressure is to the reduction of pressure, so is 1°.5 to the correction sought. Other thermometers put in with them did not all undergo the same change. For this, there are no doubt various reasons. It is easily shewn, that, within a moderate range, the error will, *cæteris paribus*, be nearly as the change of pressure, multiplied by the diameter of the bulb, divided by the thickness of the glass. But the sinking of the dry thermometer a little, in these experiments, was partly the influence of the cold wet ball on the still confined air.

It has been long known, that thermometers were affected by pressure; and to avoid this, a very effectual method, when applicable, was adopted by Professor Leslie, who employed thermometers open at top, when he had occasion to use them under a variable pressure. Some, however, give themselves no concern about the matter. In experiments on the force of steam, the ball of the thermometer is often included in the boiler with the stem projecting outward. The pressure on the ball may then vary from a small fraction of an inch of mercury to many atmospheres; and, in such cases, the temperatures must be erroneous enough *.

Mr Crichton has already pointed out some serious oversights of a different kind in the Memoir of MM. Dulong and Petit on

* Large flasks and receivers, if thin, must have their capacities somewhat altered, by varying the pressure. This alteration in similar shaped vessels, will be, *cæteris paribus*, nearly as the fourth power of the diameter divided by the thickness.

Expansions *; and I have some suspicion, that, in their very elaborate experiments on the cooling of large thermometers, they have overlooked the influence of change of pressure; the effects of which were the more to be feared, on account of the gigantic size of the bulbs, and the great range through which they operated. The glass of large thermometers is usually thinner, especially in proportion to their diameters, than of small ones; and if it was so in their case, the errors would be so much the greater; but these learned authors have given us no data from which the amount of such an effect could be estimated. This, however, they might still do, if the instruments be preserved.

Farther experiments are perhaps wanted, regarding the depression of wet thermometers; but at present, I may mention that the two sets which I have given above, especially the first, make the depression, through a range which will seldom be exceeded, nearly proportional to $\frac{57}{B+27}$, where B is the height of the barometer in inches; and probably a still more exact number might be found, by which the observed depression being divided, will be reduced to what it would have been under the standard pressure. As a temperature of 60° rarely occurs at great elevations, the last table is not suited to their case; and, therefore, its deviating a little from this formula, when the pressure is small, becomes a matter of no moment. From these experiments, it appears, that the variations of pressure have much less influence on evaporation than is commonly supposed; and that, on the same spot, variations of atmospheric pressure may, without much danger of error, be neglected.

According to Professor Leslie and Mr Ivory, δ the depression of the moistened thermometer, under the same pressure, is proportional to the drying quality of the air after its temperature is so reduced. Or, a given volume at that reduced temperature, can still retain $c\,\delta$ more grains of moisture than is already contained in the like bulk of surrounding air; c being a constant coefficient to be determined by experiment. Hence, if $w =$ actual weight of moisture in the given volume, at the existing tem-

* Annales de Chim. et de Phys. tome vii.; Annals Phil. xiii.; and for Mr Crichton's remarks, see Annals Phil. xxiii.

perature of the air t, and u the maximum at the temperature m of the moist bulb; also $t - m$ being $= \delta$, we have $w = u - c\delta$.

But if the temperature τ, at which w grains would saturate the original volume, be wanted, it may be found from the thermometers only, without the aid of any tables, by the following approximate formula, which, however, comes very close to the foregoing, between the temperatures of 25° and 90° Fahrenheit. Put k for the temperature at which the variation in the weight of moisture in the given volume for a change of 1° is c grain, then the temperature sought will be

$$\tau = t - \delta \left(\frac{\delta + 2k}{m}\right).$$

If the volume be a cubic foot, and if, as appears from a mean of various experiments, $c = .15$, then $k = 53°$ Fahr., and

$$\tau = t - \delta \left(\frac{\delta + 106°}{m}\right).$$

If the centigrade thermometer be used, $c = .27$, and both k and m must be increased about 18°. Hence

$$\tau = t - \delta \left(\frac{\delta + 59°}{m + 18°}\right).$$

The maximum forces of vapour for different temperatures follow a law very similar, and nearly related, to the law of the density. So that the actual force of vapour in the air may be represented by $f = \mathrm{F} - g\delta$; where F = maximum force at the temperature m, and g a constant, which will $= .0125$ or $\frac{1}{80}$ when $c = .15$. Hence the temperature at which aqueous vapour having the force f, would be in a state of saturation, and which temperature is usually called the *dewing point*, will be

$$\mathrm{D} = t - \delta \left(\frac{\delta + 99°}{m}\right).$$

The number substituted for k in this case being 49°.5 Fahr. the temperature at which the variation of force for 1° is .0125. By means of this formula, the point of deposition, or dewing point, may be readily obtained without the aid of tables. With the centigrade thermometer,

$$\mathrm{D} = t - \delta \left(\frac{\delta + 55°}{m + 18°}\right).$$

These formulæ are adapted to the ordinary pressure, and are by much the simplest I have ever seen for the purpose.

The dewing point, or point of deposition, is the temperature of saturation under the original pressure. The temperature τ is the point of saturation under the original volume. The want of attention to this distinction frequently leads to important errors.

My object in the preceding pages, has been rather to state what appeared to be matter of fact, than to throw out a mass of random hypotheses. But this paper, having been drawn up before the article on the air-thermometer in the last Number of this Journal, is more conformable to the common theory of that instrument. It is only the formulæ near the end that could be affected by this circumstance; and within the limited range of atmospheric temperatures, the difference on these formulæ would not be material. At any rate, till the weight of moisture which can exist in the air at different temperatures be better determined, it is impossible to construct either rules or formulæ which can be depended on with perfect confidence.

On Coloured Shadows. By Messrs Zschokke and Treschsel *Junior* *.

THERE appeared at Arau, at the commencement of the present year, a memoir upon coloured shadows, read by Mr Zschokke to the Society of Natural Sciences of that city. It was received with the interest which attaches to all the productions of its author, productions so numerous and so varied that one can scarcely believe them to proceed from the same pen. Nor was this the first time that Mr Zschokke, the historian, politician, economist, novelist, &c. bestowed some moments upon the Sciences properly so called; several scientific memoirs form partof the collection of his works, and bear testimony in favour of the general nature of his acquirements.

The opinion entertained by Mr Zschokke on the subject of coloured shadows, was destined to meet with opposition. Mr Treschsel, son of the learned professor of Berne, to whom we owe the triangulation of a portion of our territory, and several other

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* Extract of a Memoir of M. Zschokke, entitled, "Die farbigen Schatten, &c. Arau 1826;" and of a refutation of that memoir, by Mr F. Treschsel *jun.*

valuable performances, has charged himself with this task in a memoir which he has latterly communicated to us.

The subject is delicate and contestible. We shall give in succession the explanations of the phenomenon in question given by the two authors, announcing at the same time that we do no hesitate to adopt, at least in its fundamental parts, the opinion of Mr Trechsel.

M. Zschokke, at the beginning of his memoir, gives an account of the authors who have observed coloured shadows, and attempted to explain them. It will not be uninteresting to go over this ground. Shadows coloured in blue are those which have been most frequently remarked, because in fact nature presents them oftenest to us. Priestley, in his History of Optics, states that this phenomenon was for the first time observed and described, about the middle of the seventeenth century, by Otto Guerick, the celebrated inventor of the air-pump; but he is wrong, for Leonardo da Vinci speaks of it in his Treatise on Painting, written in the fifteenth century. This able artist sought to discover, with all the interest excited by a subject of so much importance to his art, to what was owing the colouring of shadows in blue. He only saw in it a reflection of the colour of the sky, or rather of the atmosphere, having recourse for this phenomenon to the same explanation as for the purple tints, which colour rocks and buildings, before the rising and after the setting of the sun, or for the greenish reflection which diffuses itself upon the sides of a vessel, or upon the piles of a bridge above a deep and limpid body of water. Bouguer, in his Optics (1729), Buffon, in his Memoirs of the Academie des Sciences for 1743; Begnelin in those of the Berlin Academy for 1767; Monge in 1789, and other natural philosophers, have more or less adopted the opinion of the celebrated painter.

Buffon had the merit of contributing powerfully to direct the attention of observers toward the coloured shadows that form in the solar light. "I observed," says he, "during the summer of the year 1743, more than thirty sun risings and as many settings. All the shadows that fell upon white, as upon a white wall, were sometimes green, but most commonly blue, and of a blue, as lively as the most beautiful azure. I shewed the phenomenon to several persons, who were as much surprised as myself. Difference of season has no effect upon it, for there are not eight hours (15th November 1743) since I have seen blue shadows; and whoever will give himself the trouble of looking to the shadow of his fingers at sun-rise and sun-set, upon a bit of white paper, will see like me this blue shadow," &c. The illustrious naturalist also cites a letter of the Abbe Millot, in which he announces to him that at noon, with a cloudy sky, in which some openings were seen here and there in the clouds, he had observed shadows of a beautiful blue upon white paper; and further, that, under certain particular circumstances, he had remarked green, violet, or yellowish shadows, or shadows surrounded with a coloured margin of these different tints. Buffon, recapitulating these various observations made in 1743, adds in 1773: "This blue colour of shadows is nothing else than the colour of the air itself *."

M. de Schrank, in the Memoirs of the Academy of Munich for 1812, brought forward again the opinion proposed in 1783 by Opoix, a French naturalist little known, supporting it by new arguments. The blue shadows, according to him, come from the inflection of the rays' tangent to the edges of the solid, from which the shadow proceeds. As the blue rays are very refrangible, they are more strongly attracted than the others by bodies, and thus come to colour the interior of their shadows. Opoix, as well as M. de Schrank, knew well that the violet rays are more refrangible than the blue rays; and they reply to the objection which arises from this circumstance, the one that, in the shadows of thin bodies, the violet rays are sufficiently deflected to pass beyond the opposite edge of the shadow, and enter into the open light; the other, that, in the case where the body has a sufficient breadth to prevent the application of such an explanation, the rays fall, it is true, into the interior of the shadow, but that the tint which they carry there is too obscure to be perceived.

Rumford observed not only the coloured shadows formed in the pure solar light, but also the various shadows resulting from several sorts of coloured lights combined with each other and with the solar light; and thinking that he had remarked that,

* Buffon, Hist. Nat. d'Min., Memoire viii.

when seen through a tube, which excluded all comparison of one shadow with another, all these shadows appeared black, he concluded from thence that all these effects are mere optical deceptions *.

M. de Grotthuss arrived at nearly the same conclusion, but by a different process †. He knew the phenomenon of the blue and yellow shadows, which are produced by the concurrence of the light of a candle and that of the twilight; he also knew the impression which the long continued observation of coloured plates produces upon the retina; an impression which afterwards reproduces in the organ spots tinged with colours exactly complementary, in the scale of the spectrum, to those on which the eye has been fixed; and he in like manner considers the phenomenon of coloured shadows as a physiological deception, as the result of the fatigue caused by an effort of the organ in the same direction, and of the disturbance of an equilibrium of sensibility in it.

After giving this historical narration, Mr Zschokke remarks, that none of the hypotheses explains all the cases in which shadows appear coloured, and he proceeds to the exposition of a new theory. Let us first give an account of the fundamental phenomena, the causes of which form the subject of inquiry.

Coloured shadows are produced in the solar light, when it is refracted by the vapours of the lower strata of the atmosphere, or reflected by the clouds. Thus, 1*st*, the colouring is perceptible chiefly at sunrise and sunset, when the sun is not higher than from ten to twenty degrees above the horizon. 2*d*, In winter, the shadows are sometimes coloured at noon, because at that season in our latitude the sun scarcely rises to the height of twenty degrees. In summer, they are only coloured in full day when the sky is overcast, and the clouds reflect a strongly coloured light. 3*d*, The more deeply the rays penetrate into the lower strata, the more strongly are the shadows coloured,

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* See Philosophical Transactions 1794; or in the Biblioth. Britann. vol. i. p. 339, an extract of Count Rumford's paper, terminated by a note (p. 372) upon coloured shadows, and the authors who have treated of them.

† See in Schweigger's Beytrag. zur Chemie und Physik, vol. iii. p. 148. an abridgment of M. de Grotthus's Paper on the Accidental Colours of Shadows, and on Newton's Theory of Colours.

and the farther may the opaque body which projects them, the hand, for instance, be removed from the white surface which receives them. The distance, therefore, cannot be assigned at which the opaque body should be from the surface. According to the greater or less intensity of the light, this distance may vary from five or eight feet to as many lines. At the moment of twilight, or in very dark days, the end of the finger from which the shadow projects, requires to be held at the most two or three lines from the white surface. 4*th*, The same opaque body projects shadows variously coloured, according as the surrounding surfaces, such as the walls of the chamber, or the clouds, if it be in the open air, reflect one colour or another.

Coloured shadows also form in a light, coloured by refraction or by reflection. This colouring of the shadows, however, does not take place, if the light so modified penetrates into a chamber otherwise perfectly dark, for in that case the shadows are black. The more intensely the light is coloured, the more distinct is the tint of the colour.

Lastly, the artificial light of a candle, combined with that of the sun, gives rise to coloured shadows. Thus, according to Rumford's experiments, if, in the day-time, the shutter of a dark room be opened about half an inch, and there be placed upon a table a lighted candle (situated in such a manner, that its rays falling upon a piece of white paper, which is presented to it, as well as to the opening of the shutter, make with those coming from this opening an angle of about forty degrees), and the finger be then held at the distance of two or three inches before the paper, this opaque body will project two shadows, of which that proceeding from the day-light will be yellow, and that from the candle-light of a very beautiful blue. In proportion as the finger is carried nearer the candle, the blue will become deeper, and the yellow fainter, and the contrary will take place if it be removed from the light.

Such being the facts to be accounted for, Mr *Z*. proposes to establish, *a priori*, that the shadows produced by the interception of a coloured light must also be coloured. "It is known," says he, "that, in the solar spectrum, the white light of the sun is decomposed into coloured rays; on the other hand, the shadow produced by the interception of white and undecomposed light, is black; if only one of the coloured rays of which it is composed is intercepted, the part cannot produce the same effect as the whole; the coloured ray cannot therefore project a black shadow; this shadow must itself be coloured."

Now, what will be the colour of the shadow projected by a ray of a given colour? To find this, M. Zschokke made the solar rays pass through disks of glass variously coloured; and receiving the light by this procedure upon a white surface, he presented before this surface an opaque body, in order to form shadows with it. He took care to make the experiment when the sun was at a great height upon the horizon, to prevent any natural colouring of the shadows mingling with that which he produced artificially. He then found, that, in the

Red rays, the shadow is	pale blue.
Orange,	a little deeper blue.
Yellow,	a violet blue.
Green,	a purple violet.
Pale blue,	red.
Deep blue,	orange.
Violet,	green.

and that thus to each colour of the ray there corresponds, in the shadow which it projects, a colour which would itself project a shadow of the same tint as the ray.

Such is Mr Zschokke's theory in brief; we regret that we cannot follow him in developments from which his style, always animated and descriptive, takes away the dryness of a scientific dissertation.

"The hypothesis of Mr Zschokke," says Mr Trechsel, "recommends itself at first sight by its precision, and, if one may so speak, by its paradoxical nature. One fancies he sees in it the great law of polarity, which appears to manifest itself in almost all the branches of natural philosophy. Besides, the most important discoveries have been in fact but gleams of light emitted by geniuses superior to their age, hypotheses imagined *a priori*, which have been recognised as true by observations and researches made afterwards." These considerations, which ought to recommend the hypothesis in question to the attention of natural philosophers, have engaged Mr Trechsel the younger, to repeat with his father the experiments of Mr Zschokke, and to add to them others which he deemed necessary for completing the examination of the question.

He contests first the fundamental proposition of the preceding theory, remarking, that if the shadow is the local absence of light, the light may be partial or total, without this necessarily producing any change in the nature of the shadow in question. The interception of the light can only produce shade, but not coloured shade, at least unless the colouring be imparted to it from some other source.

The experiment which we have related, in which black shadows are seen to form in a light decomposed by the prism, or coloured in any other manner, provided the chamber be dark, furnishes another argument against this hypothesis. Mr Trechsel has obtained nearly the same results as M. Zschokke, with reference to this class of shadows. He has made his experiments by passing the light of the sun or of a candle, through disks of coloured glass*, as well in a lightened apartment as in a large drawing camera obscura, in which the object-glass was replaced by differently coloured glasses, in such a manner as to produce the tint desired upon a piece of white paper placed in the bottom. In the camera obscura the shadows are always black, if the light be excluded from all parts; they immediately become coloured when some other light is allowed to penetrate, and the tints which they then assume are always complementary of those of the light transmitted; thus in the red light the shadow is blue or greenish, in the green light it is pale red, &c.

These observations naturally lead us to conclude, that the colouring of shadows does not depend upon the nature of the intercepted light, but rather upon the day-light which mingles with them. This conclusion is enforced by an experiment which does not appear to have been hitherto made, and which is of great weight in the question. If the day light, introduced with proper management, for example, by raising the curtain a little, be made to fall upon the bottom of the camera obscura, when it is coloured green by an object-glass of that colour, the place

* The author had for this purpose large squares of coloured glass furnished by the brothers Müller, young artists known by their success in the attempts which they have made, especially of late, to rediscover the art of painting glass, which had been lost for several centuries.

shone upon by the light will assume a pale red colour, *without there being any shadow;* if the object-glass is red, the light will make the place where it falls appear of a greenish blue.

The following facts come also in support of Mr Trechsel's fundamental opinion.

1*st,* The natural bluish shadows are more distinctly observed in winter, with an overcast sky and a hazy atmosphere. Now, in these circumstances, the blue light predominates, on account of its greater refrangibility. According to Mr Zschokke's hypothesis, the shadows projected in this blue light would not be blue, but red or orange; it is seen, on the contrary, that the blue tint which they really have, comes from the reflection of the predominant blue light of the day.

2*d,* If this bluish shadow be illuminated by the yellowish light of a burning candle, it assumes, at the very moment, a yellowish tint.

3*d,* On the other hand, the black or greyish shadow of the light of a candle assumes a blue colour, whenever some rays of the light of day are made to fall upon it. This is Rumford's experiment.

4*th,* If there be placed behind the shadow projected by this day light when it is weak, an object painted red, yellow, or any other colour, the shadow immediately assumes a tint similar to that of the object which sent reflected light to it.

5*th,* The shadows coming from the interception of the light of a candle, are always of a more or less deep black, provided there has been only one candle burning; they appear yellowish when two are lighted, of which the one shines upon the shadow produced by the interception of the light of the other.

"It is easily seen," says Mr Trechsel, "that there can be no question here of the inflection of the light in the shadow, either according to the ordinary explanation of this phenomenon, or according to Mr Fresnel's theory of interferences; for, 1*st,* The coloured shadows are homogeneous, and not composed of alternate bands; 2*dly,* They are obtained of any breadth that one pleases; 3*dly,* They preserve, in general, the same colour, although they change their intensity at each variation produced in the distances which separate the plane that receives the light, the opaque body and the source of light."

Mr Trechsel, in consequence, proposes to distinguish two sorts of coloured shadows, one of which may be termed *objective*, and the other *subjective*. Among the former would range themselves, 1*st*, The shadows, whose bluish colouring is owing to the reflection of the day light; 2*d*, The shadows that are coloured yellow by the direct light of a candle; 3*d*, Those which are obtained from the reflection of the light by a neighbouring coloured body. To the subjective shadows would be referred those which are produced in the light coloured either by prismatic decomposition, or by its transmission through coloured glass. In this latter class would also be placed the remarkable phenomenon of the coloration by day-light in the camera obscura, and some other similar phenomena.

The shadows, whose colouring is produced by direct or objective means, do not require further explanation; but the case is different with those whose colouring is only subjective. "With regard to these latter," says Mr Trechsel, "Mr Grotthuss's hypothesis appears to me the most probable. It accords not only with ordinary observation, but also with the experiment of the camera obscura which has been described above, and which was not known to Mr Grotthuss. According to this author, when our eye receives the impression of any colour whatever, for example, orange light, transmitted in large quantity, the sensibility of the organ for this light is diminished, and perhaps the sensibility for the complementary blue light increases. If we now make the day light, or any other white light, fall upon a shadow projected in this coloured light, or simply upon a ground tinged with this same light, the orange ray disappears *subjectively* of the day-light, and we then only perceive the united sensation of the other rays contained in the fasciculus, rays which, by their combination, produce a greenish blue tint, complementary of the orange in the scale of Newton.

No doubt can be entertained of the subjectiveness of the phenomenon of the camera obscura, which I have already several times mentioned, if it be brought to mind that the day-light sometimes produces the red tint in it, sometimes the green, according to the colouring of the ground. Another experiment may be added, which, although not new, is yet not the less striking. Let two candles be placed, so as that two shadows may be projected from the same opaque body, and the shadow formed in the light of one of the candles be lighted by that of the other. These shadows, as is known, will both be yellowish. Let one of the lights now be coloured red, by making it pass through a plate of glass of that colour; the shadow coming from the interception of the other light, will immediately assume a red tint, (*objective* colouring); but, at the very instant, the other shadow, which is only shone upon by the pure light of the other candle, will become green, (*subjective* colouring, produced in the organ of the observer itself, from the defect of the perception of the red ray); and *vice versa*, if one of the shadows is objectively and directly coloured green, the other will be subjectively coloured red.

Mr Trechsel here remarks, that the phenomenon observed by several members of the Helvetic Society of Natural Science, in a chapel near Soleure, appears to be of an analogous nature to the subjective coloration of shadows, in particular to the phenomenon last cited, and to that of the colouring of the bottom of the camera obscura by the light of the day. It will not be useless to recall here the description of this phenomenon, such as we have already given it in our account of the tenth session of the Helvetic Society *. All the panes of the windows of the chapel, without exception, are of pale yellow glass; the frames of these windows, which are of iron, are perforated here and there with small holes of about a line in diameter; the light which penetrates by these holes, is of the most beautiful blue, even when through them the view is carried upon perfectly white clouds. The same effect is also produced when one of the windows is opened, and the slit thus formed is blue until the opening attains a certain width. We had explained this phenomenon, as probably arising from the psychological effect of contrast. Now this effect, which in general cannot be contested, may be owing to the momentary paralysation in the organ of the faculty of perceiving one of the partial sensations which compose the total impression.

Mr Trechsel concludes his memoir with the following brief review:

* See Bibl. Univers. tom. xxix. p. 326.

"1. Coloured shadows may be distinguished into *objective* and *subjective*.

"2. The former owe their colouring to the light which arrives at them either directly or by reflection; they are not therefore total shadows, but are rather, to use the scientific term, *penumbræ*.

"3. The shadows whose colouring is subjective, are the effect of a particular disposition of our organ, which, when it is fatigued by the impression of a single colour, no longer perceives that ray in a fasciculus of white light; so that the complementary ray predominates and communicates its tint to the shadow projected in the primitive light.

"4. So far as we have been able to observe, the eye follows in this process the scale of Newton. If the corresponding colours are not always exactly complementary, it must be attributed to the difficulty of obtaining artificial tints so pure as those of the solar spectrum.

"5. There follows from this, that the colouring of shadows is impossible, if there be no other light than that by the interception of which the shadow is formed. The presence of a light coming from another part, for example, from the sky, or the clouds, is an indispensable condition to the formation of coloured shadows.

"6. Lastly, the shadow is not necessary to make the complementary colours appear. A small quantity of white light, put in prominent contrast with a large mass of coloured light, assumes, in certain circumstances which we cannot well determine, the complementary tint corresponding to the colour of this latter light."

Mr Trechsel's explanation appears to us satisfactory; it introduces, it is true, two causes for a phenomenon which has usually been considered as one; but this is not the first case where a careful analysis has obliged us to admit several agents in an effect single in appearance. Without doubt, in the number of the very varied experiments which may be made on the subject of coloured shadows, there will still present themselves many details which will not be immediately explained; but it is probable that their origin will be found in the peculiar circumstances of

1. Skull of the Andaman Hog. 2. Inhabitant of the Little Andaman Island. 3. Hut. 4 Fishing Net. 5 Conical Bask

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these experiments, and in the state of the bodies employed by the philosopher in his observations.

Bibliotheque Universelle, May 1826.

Notice regarding the Little Andaman Island, Bay of Bengal. Communicated by Cornet J. E. ALEXANDER, H. M. 13th Light Dragoons. With a Plate.

ON the 12th November 1825, the Honourable Company's transport, Earl Kellie, having on board 4 companies of H. M. 45th regiment, and 100 Madras pioneers, destined for foreign service in the Birman Empire, steering a S.E. course, hove in sight of the Little Andaman Island, in latitude 10° 45′ N., and longitude 92° 12′ E., bearing from E. to E.S E., and distant 4 leagues. At 10 A. M. bore up, and stood in for the land to get a supply of water, our stock of which was almost exhausted, from the unusual length of the voyage, occasioned by the baffling winds we experienced in the middle of the Bay. At 11 saw a brig, hull down, bearing N. W., steering to the S. E. At 12 sounded on a coral reef 8, 9, 10, 12, and 16 fathoms, patches, the bottom seen plainly under the ship, with numerous sharks following the vessel, one of which we succeeded in killing. Observed a *muræna ophis* or sea-serpent; length about 3 feet; back brownish, belly white, tail rounded, a row of black spots along the sides, and without the caudal fin. A monstrous fish likewise made its appearance near the vessel, seemingly of the genus *Raia* or ray; its length about 20 or 25 feet, very broad, and colour of back reddish. A very heavy swell on the bank; steering from N.N.E. to N.W. to haul off it, ran a distance of 4 knots, when the water deepened to 20 fathoms. When on the coral shoal, in 8 fathoms water, the extremes of the island from E. ½ W. to N.N.E., and a small bay in the centre of the island;—at 11 P. M. saw a light on shore; brought up off the N.W. point, and anchored in 8½ fathoms, at 2½ miles from shore.

13th November.—At daylight proceeded in one of the cutters along with the chief mate in search of water. On approaching the shore, observed a woman and child on the beach, who, upon perceiving the boat, ran into the jungle; they appeared to be employed in collecting shell-fish. Found a small sandy bay (which I took the liberty of naming after the ship), with coral reefs running out from both extremes, over which a tremendous surf was breaking; inside the water was quite smooth. Anchored the boat a few fathoms' length from shore; and, leaving a couple of hands in her, landed with the remainder of the Lascar crew, six in number, who were armed with muskets.

We found the island (which in length is 28 miles, by 15 in breadth), to be of coral formation, entirely flat, and covered with lofty and thick jungle to within a few yards of the water's edge. Proceeded along-shore towards the N. W. point in search of two rills of water mentioned by Horsburgh in his "Directory." At an angle of the jungle came suddenly upon a party of the natives lying on their bellies behind the bushes, armed with spears, arrows, and long bows, which they bent at us in a threatening manner. The moment the Lascars saw them they fell back in great consternation, levelling their muskets; and it was with great difficulty we could prevent them from firing; only the tyndal or coxswain (a Malay) stood by us. We went within a few paces of the natives, and made signs of drinking. The tyndal salaamed to them according to the different oriental modes of salutation. He spoke to them in Malays and other languages. They returned no answer, but continued crouching in their menacing attitude; and to whichever side we turned, they pointed their weapons towards us. I held out my handkerchief towards them, but they would not come from behind the bushes to take it. I placed it upon the ground, and we retired, in order to allow them to pick it up. Still they moved not. I counted 16 strong and able bodied men opposite to us, many of them very lusty; and further on another party six or eight in number. Those in front of us were lying in two ranks, with two or three women in the rear; the whole of them completely naked, with the exception of a stout man, about six feet in height, who was standing up along with the women. He wore on his head a red cloth, with white spots, and probably was their chief. They were the most ferocious and wild looking beings that I ever saw; their hair was frizzled, noses flat, and small red eyes; those parts of their skin which were not besmeared with mud (probably to shield them from the attacks of insects) were a sooty black; their hideous faces seemed to be painted with red ochre. I may here remark, that the inhabitants of the Andaman Islands, decidedly a negro race, and differing widely from those of the neighbouring continent, are supposed to be the descendants of the survivors from the wreck of an Arab slave ship, said to have been lost here some centuries ago. The Chinese, who occasionally resort to these islands to collect the edible nests of the *Hirundo esculenta*, affirm that the natives are anthropophagi. One thing, however, is certain, that several boats' crews have fallen into their hands, and have never since been heard of.

At the above stage of the rencontre, the other cutter, with two or three of the officers on board, neared the beach, and seeing what we were about, they called to us to retire a short distance, and allow the tyndal to go up and speak to the savages, for perhaps they were afraid of Europeans. We fell back to the water's edge, and having caused the tyndal to strip to shew them that he was unarmed, he went up to within a few paces of them, and offered them a couple of handkerchiefs, making at the same time signs of drinking; but upon his attempting to approach nearer, they drew their bows and threatened him. Seeing this we called him off; and not knowing how to act in this emergency, without advice from the ship, as we had been requested not to use any violence, both cutters returned to the vessel; and upon reporting what we had seen relative to the hostile disposition evinced by the natives, a subaltern's party of the 45th, with a couple of buglers, and pioneers to fill the water-casks, were ordered to accompany us, in order that we might force our way to the water if necessary. We landed at the same spot we had formerly done, and not seeing any thing of the natives, we advanced along the beach towards the southward; and, upon turning a point, saw flocks of sand-larks, curlews, &c. Further on we discovered a hut on the edge of the jungle: we went to it, and found it to be about 20 feet in height, of a conical shape, thatched to within a foot and a-half of the ground with rattan leaves, with just room to crawl in underneath. The floor inside was strewed with leaves, and there were several cots or sleeping places in different parts; they consisted of four sticks driven into the ground, on which was fixed a bamboo grating. Ranged in a row round the walls were the smoked skulls of a diminutive hog; the canine teeth shorter than in the other species of *sus* in eastern countries, the jaws fastened together by strips of rattan, (Plate I. fig. 1.) From the roof a piece of red and white chequered cloth was suspended, seemingly of Madras manufacture. In conical baskets pieces of jack-fruit were found, and a nut resembling a chesnut, besides several roots. In a corner I found several large mangroves. At a fire the following shells were roasting: The green *Murex tribulus*, *Trochus telescopium*, *Cypræa caurica*, and several varieties of mussel. The drinking cups seemed to be the nautilus. The weapons were a bow from 6 to 7 feet in length, which is pulled with the feet, and a hand-bow of 4 feet; the strings are made of the dark red fibres of a tree. The arrows are 3 and 4 feet in length, the upper part of a very hard white wood, inserted in a stock of cane. The soldiers shot several of them at a tree; they penetrated a couple of inches into the solid timber, and it required the joint strength of two men to pull them out, and even then the points were uninjured. Several arrows were found with two, three, and four prongs. No canoes or rafts were seen, and no idols of any description. The hand-nets were formed of the black filaments of a tree. In one of the baskets, carefully wrapped up in a cloth, were the head of a harpoon with two barbs, a Malay chopping knife, and several spike-nails and ring-bolts; these last were probably from the American ship Dover, Captain Duffin, which was wrecked here several years ago.

Naturally concluding that there was water near the hut, we penetrated into the jungle, consisting of Dammer trees, red-wood, the Alexandrian laurel, aloes, rattans, and a very lofty and straight tree, about 15 feet in girth, which, if not too heavy, would answer admirably for masts. Having advanced about 30 or 40 yards from the beach, came to a pool of good water; but, from its being at an inconvenient distance from the vessel, we retraced our steps, and, on coming opposite the boats, discovered a party of 50 or 60 natives waiting our approach in ambush. We advanced to them, in order to get them to point out a more convenient watering place. So little intention had we of molesting or injuring them, that we had brought with us several looking-glasses, cloth, and baubles to give them. However, we had no sooner got within 15 yards of them, than we were assailed with a shower of arrows, which struck several of us. Our files were then extended to skirmishing order, and we returned with a round of musketry, killed and wounded several of them, fixed bayonets and charged them; but they knowing the intricacies of the jungle, and being extremely nimble, succeeded in not only effecting their own escape, but also in carrying off the disabled of their party. We were brought up by a deep pool, and saw them making off on the other side, and heard them calling out *Yahun, Yahun.*

We then continued our march along the beach, and discovered another pool of very good and sweet water immediately opposite the vessel, and just within the skirts of the jungle. The water casks were sent for, a jack was hoisted at the pool (being a preconcerted signal to those on board; left half of the party there, and proceeded with the remainder along a path into the jungle, expecting that it would lead to a village, where we might get some fresh stock. We advanced about a couple of miles without seeing any more huts or natives, and no quadrupeds of any description.

The wood into which we penetrated, and in which the bugle alone kept us together, was one of the most gloomy and dismal that can possibly be conceived. It was indeed,

"Nemus atrum horrenti umbra."

The trees were of vast height, and in many places thickly interwoven with rattans and bushrope. The sun-beams were unable to penetrate the entangled foliage, the atmosphere in consequence bore the semblance of twilight. The air was loaded with a damp and pestilential odour, occasioned by the rotten twigs, leaves, and fruit, with which the ground was thickly strewed, which, besides, was exceedingly swampy. The death-like stillness was occasionally interrupted by a solitary parrot winging its noisy flight over-head; but owing to the richness of our vegetable canopy, it was almost impossible to gain even an imperfect view of him. Numerous snakes were observed stealing along amongst the bushes. From several we had narrow escapes. Those that we succeeded in killing were all furnished with the poisonous fangs; and many of them bore a striking resemblance to the *Coluber prester* or Viper, but they were all spotted.

Tired with our unprofitable excursion, we returned to the watering pool, and the casks having been rolled up to it, we sat down to dinner before we commenced filling. Whilst engaged with our repast a strong party of the natives came down upon us, and threw in a shower of arrows, which killed one and wounded severely three of the soldiers. We quickly formed, charged them, and killed and wounded several by our fire, and continued skirmishing with them till sunset; for they seemed to be exceedingly cunning and revengeful, and made some desperate attempts to cut off the pioneers engaged in filling. After they had completed the watering, we pulled off from *Kellie Bay* for the ship, with the four boats; but a current at that time setting to the N.E. at the rate of 3 or 4 knots an hour, we found that we could not reach her. The water-boats were anchored in consequence, and the two others went alongside. The ship's anchor was weighed, and dropping down to the long-boat and cutter, brought up in 13 fathoms water, and by midnight got on board, laden with bows, arrows, specimens of ambergris, shells, &c.

14*th November*.—During the night heard the savages shouting and yelling on the beach, seemingly in defiance. At daylight weighed, and stood through Duncan's Great Passage. At 10. A. M. got on a coral reef, not laid down in any chart; least water 5 fathoms, with the following bearings: North end of the Little Andaman S.S.E.; the N.W. point S.W. by S.; the centre of the South Brother S.E. by E. ½ E., distant 4 miles; and the centre of the North Brother E. ½ N. Both these islands, like the Little Andaman, are flat, and covered with high trees, without a rising ground of any sort on them. Kept away to the northward, and got twelve fathoms all the way between the South Brother and Sisters, and in a few days arrived safely at Rangoon.

PROME, BIRMAN EMPIRE,
15*th December* 1825.

Some particulars relative to the Tides in the upper part of the River Thames, and of the obstructions caused by the present London Bridge. By P. Barlow, F.R.S., Mem. Imp. Acad. Petrop., &c. (Communicated by the Author).

London Bridge, which has for so many years bestrided the Thames, is now doomed within a very short time to be removed, and a considerable change will be, there can be no doubt, effected in the state of the River from the present site of the Bridge upwards. It may not therefore be uninteresting to record some particulars relative to the present state of the tides, and of the river, in order hereafter the better to compare the change which the removal of the bridge may occasion. When this question was before Parliament, I was summoned to attend the Committee to state my opinion relative to some points connected with these probable changes, and it was on that occasion that I collected together the several facts given in the following pages, and which, if they should not be found to furnish any present important information, may hereafter be referred to as matters of interest by the curious inquirer. Some doubts having been suggested as to the damage which might be sustained by the wharfs, &c. above bridge, by the rising of the river above its present level at high water, and the exposure of the sewers at low water, the data here given are such as are connected more particularly with these questions; they consist,

1. Of the sectional area of water-way at the different bridges, at various states of the tide.

2. Of the hourly rise and fall of the tide, and the difference of level at different times of the tide, immediately above and below London Bridge.

3. The rise and fall, and interval between the time of high and low water, at Woolwich, and at several other places on the river, ascertained by observations made on the same days.

4. Experiments and observations made on the velocity of the tide at ebb and flood at Woolwich, and other places on the river.

5. The difference of level between the high and low water, at several places on the river, and other miscellaneous particulars.

1. *Sectional areas of water-way at London Bridge, and at Southwark, Blackfriars, Waterloo, and Westminster Bridges, at different periods and states of the tide.*

	London Bridge.	Southwark Bridge.	Blackfriars Bridge.	Waterloo Bridge.	Westminster Bridge.
At an extraordinary high tide, 2 feet above the usual average spring tide high water-mark, the water-way through the different bridges is,	8130	15,260	15,460	19,822	16,750
At the Trinity, high water mark or datum,	7360	13,940	14,117	17,707	15,198
At an average spring tide, high water below London Bridge, -	7122				
Do. above Bridge, -	6837	13,170	12,975	16,447	14,015
Average neap tide, high water above Bridge,	5293	11,135	10,590	13,116	11,380
Spring and neap tide, low water above Bridge,	1488	5,012	3,724	3,382	3,720
Neap tide low water below Bridge, - -	1030				
Spring tide low water below Bridge, -	540				

	Ft.	In.
The linear water-way at London Bridge between the Piers above the Starlings, - - - - -	524	2
Linear distance occupied by the Piers, - - -	406	10
Total distance between the abutments, - - -	931	0
Linear water-way below the Starlings at low water, -	230	11
Linear distance occupied by the Starlings, - -	700	1

From this table it appears, that, at low water spring-tide, the sectional area of the water-way at London Bridge is not more than about two-fifths of that at Waterloo Bridge, which has the least water-way at low water of the other four bridges ; this contraction acts as a dam, and causes the water to accumulate so much above bridge, that the sectional area below bridge is very little more than one-third of that above bridge.

And at high water spring-tide, the water-way at London Bridge is, at a medium, about half that at Southwark, which has the least section of the other four bridges at high water, and this again causes an accumulation below bridge, but by no means so great as in the former case.

The effect of this blockage on the hourly rise and fall of the water at the bridge is shewn in the following table:

2. TABLE of the Ebbing and Flowing of the tide at London Bridge, taken above and below on the 29th of July 1821.

Low Water 50 minutes past 9 o'clock in the Morning.

Flood Tide.	Feet.	Inches.
Depth of water when flood commenced, - -	6	0
1st Hour, rise - -	2	11
2d Hour, - - -	3	0
3d Hour, - - -	2	10
4th Hour, - - -	2	8
45 Minutes, - - -	1	0
4 Hours and 45 Minutes	18	5

High Water 35 minutes past 2 o'clock in the Afternoon.

Ebb Tide.	Feet.	Inches.
1st Hour, fall - -	2	1
2d Hour, - . -	2	7
3d Hour, - - -	2	0
4th Hour, - - -	1	9
5th Hour, - -	1	5
6th Hour, - -	1	2
7th Hour, - -	1	0
55 Minutes - -	0	11
Depth at Low Water,	5	6
7 Hours and 55 Minutes	18	5

Low Water 30 minutes past 9 o'clock in the Morning.

Flood Tide.	Feet.	Inches.
Depth of Water when Flood commenced, - -	1	3
1st Hour, rise - -	5	9
2d Hour, - - -	5	4
3d Hour, - - -	2	9
4th Hour, - - -	2	5
48 Minutes, - -	1	4
4 Hours and 48 Minutes	18	10

High Water 18 minutes past 2 o'clock in the Afternoon.

Ebb Tide.	Feet.	Inches.
1st Hour, Fall - -	2	1
2d Hour, - -	4	4
3d Hour, - -	3	1
4th Hour, - -	2	7
5th Hour, - -	2	3
6th Hour, - -	1	9
7th Hour, - -	1	6
59 Minutes, - -	0	11
Depth left, - -	0	4
7 Hours and 59 Minutes	18	10

By means of this table we readily find the head of water above and below bridge at each successive hour of the tide, viz. by subtracting from the depth of water on one side, the depth on the other. Thus it appears that, on the day in question,

THE FLOOD TIDE.	Feet.	Inches.	THE EBB TIDE.	Feet.	Inches.
The head at low water above bridge was	4	9	The head below bridge, high water,	0	5
1st hour of flood	1	11	1st hour do.	0	5
2d hour, head below bridge,	0	5	2d hour above bridge	1	4
3d hour do.	0	4	3d hour do.	2	5
4th hour do.	0	0	4th hour do.	3	3
High water	0	7	5th hour do.	4	1
			6th hour do.	4	8
			7th hour do.	5	2
			Low water do.	5	2

The above deductions are from the observations of a particular day, and are not quite the mean results even for a day, because the high water above and below bridge does not happen exactly at the same time. From a mean, however, of several days, it appears, that the average fall

	Feet.	Inches.		Feet.	Inches.
High water spring tide is	0	8	greatest	1	1
Average fall low water Do.	4	4	greatest	5	7
High water neap-tides	0	5			
Low water do.	2	1	least	1	1

3. *Some other particulars relative to the periods of Rise and Fall, and of High and Low Water, above and below Bridge, may be stated as follows:*

1. The flood of spring-tides, of October 21st and 23d, produced slack water through the bridge in about 40 minutes after low water below bridge; from which time a-head gradually increased below bridge to 1 foot 10 inches at half flood, and then regularly decreased to about 8 inches at high water.

The first flow of these tides, nevertheless, began above bridge about 20 minutes after low water below bridge, although the water was then about 2 feet 6 inches higher above than below bridge; the time of low water below bridge averages 10 minutes earlier than above bridge.

The ebb of these tides produced slack water at the bridge about 30 minutes after high water, and then gradually sunk to their greatest fall at low water.

The time of high water, October 21st and 23d, was the same below as above bridge; but the average time of high water spring tides is 9 minutes earlier below than above bridge.

The flood of neap-tide, October 30th, produced slack water through the bridge, in about two hours after low water below bridge, when there was some land-flood in the river; from which time a head gradually increased below bridge to 1 foot 3 inches at two-thirds flood, and then regularly decreased to 4 inches at high water.

The first flow of this tide, nevertheless, began above bridge about 1 hour after low water below bridge, although the water was then 1 foot higher above than below bridge; but the average time of low water below bridge is 32 minutes earlier than above bridge.

The ebb of this tide produced slack water at the bridge about 15 minutes after high water above bridge, and then gradually sunk to its greatest fall at low water.

The time of high water, October 30th, was 15 minutes earlier below than above bridge; and the average time of high water neap tides is 15 minutes earlier below than above bridge.

4. *Observations on the Rise of the Tides at Woolwich, Deptford, Billinsgate, Old Swan Stairs, and Westminster Bridge, May 25th and 26th* 1823. *Full Moon May 23d.*

MAY 25th.

WOOLWICH.						DEPTFORD.						BILLINSGATE.						OLD SWAN STAIRS.						WESTMINSTER BRIDGE.					
Time.		Hourly rise.		Total rise.		Time.		Hourly rise.		Total rise.		Time.		Hourly rise.		Total rise.		Time.		Hourly rise.		Total rise.		Time.		Hourly rise.		Total rise.	
A.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
8	45	0	0	0	0	9	25	0	0	0	0	9	45	0	0	0	0	10	5	0	0	0	0	10	30	0	0	0	0
9	45	3	4	3	4	10	25	5	6½	5	6½	10	45	5	9	5	9	11	5	2	9	2	9	11	30	2	8	2	8
10.	45	5	9	9	1	11	25	5	0	10	6½	11	45	4	2½	9	11½	12	5	3	7	6	4	12	30	3	1	5	9
11	45	4	2	13	3	12	25	3	6	14	0½	12	45	3	2½	13	2	1	5	3	1½	9	5½	1	30	3	4	9	1
12	45	3	4	16	7	1	25	3	6	17	6½	1	45	3	2½	16	4½	2	5	3	1½	12	7	2	30	2	8	11	9
2	0	3	0	19	7	2	25	1	5	18	11½	2	45	0	10½	17	3	2	30	0	7	13	2	2	50	0	3	12	0

MAY 26th.

WOOLWICH.						DEPTFORD.						BILLINSGATE.						OLD SWAN STAIRS.						WESTMINSTER BRIDGE.					
Time.		Hourly rise.		Total rise.		Time.		Hourly rise.		Total rise.		Time.		Hourly rise.		Total rise.		Time.		Hourly rise.		Total rise.		Time.		Hourly rise.		Total rise.	
H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
9	20	0	0	0	0	9	55	0	0	0	0	10	20	0	0	0	0	10	40	0	0	0	0	11	0	0	0	0	0
10	20	4	0	4	0	10	55	5	7	5	7	11	20	6	10	6	10	11	40	3	5	3	5	12	0	2	7	2	7
11	20	5	2	9	2	11	55	5	1	10	8	12	20	4	4	11	2	12	40	3	5	6	10	1	0	3	5	6	0
12	20	4	0	13	2	12	55	3	8	14	4	1	20	3	2	14	4	1	40	3	2	10	0	2	0	3	4	9	4
1	20	3	4	16	6	1	55	3	2	17	6	2	20	3	0	17	4	2	40	2	0	12	0	3	0	2	5	11	9
2	30	2	2	18	8	2	47	1	4	18	10	3	0	0	7½	17	11½	3	10	1	5	13	5	3	20	0	6	12	3

From these observations we learn, that the relative time of the flood at these places, from a mean of the two days, is,

		H.	M.
Time of flowing at	Woolwich, -	5	12½
	Deptford, -	4	48½
	Billinsgate, -	4	40
	Old Swan Stairs,	4	27½
	Westminster Bridge,	4	20

And that the low water at Woolwich precedes that at

	H.	M.
Deptford by - -	0	37½
Deptford precedes that at Billinsgate by	0	22½
Billinsgate Old Swan Stairs by -	0	20
Old Swan Stairs Westminster Bridge	0	22½

And the mean rise of the tides at these stations is,

	Feet.	In.
At Woolwich, - -	19	1½
Deptford, - -	18	10¾
Billinsgate, - -	17	7¼
Old Swan Stairs, -	13	3½
Westminster Bridge, -	12	1½

5. *Mean of Six Weeks' Observations on the velocity of the Ebb and Flood, Neap and Spring Tides, at Woolwich.*

	SOUTH SHORE.		CENTRE.		NORTH SHORE.		
	Flood.	*Ebb.*	*Flood.*	*Ebb.*	*Flood.*	*Ebb.*	
	Feet per second.	Feet per second.	Feet per second.	Feet per second.	Feet per second.	Feet per second.	
Mean of 3 days.	2.78	3.00	3.21	3.42	2.78	3.85	Neap
Do.	2.55	2.55	3.00	3.00	2.55	2.78	
Do.	2.36	2.36	2.78	2.78	2.55	2.55	Tides.
Mean in feet per second,	2.56	2,64	2·99	3.06	2.63	3.06	
Miles per hour,	1.74	1.80	2.04	2,09	1.79	2.09	
Mean of 3 days,	2.55	3.21	3.00	3.85	2.55	3.64	
Do.	2.36	2.78	2.78	3.21	2.55	3.21	Spring
Do.	2,78	3.42	3.21	3.85	3.21	3.42	
Mean in feet per second,	2.56	3.14	2.99	3.64	2.77	3.42	Tides.
Miles per hour,	1.74	2.14	2.04	2.48	1.99	2.33	

The tabulated observations, from which the above abstract has been made, were taken by Mr Pullman, superintendant master at Woolwich Dockyard, and may be confided in for their accuracy. They were taken at about mid-tide with a ship's log, and with every possible care and attention.

The following experimental results, as to the velocity at ebb-tide above bridge, were furnished by Mr Jessop, civil engineer. The velocity was ascertained by throwing into the stream turnips and potatoes every 10 minutes for 45 minutes during low water, in the middle, and on each side, of the river. The greatest velocity thus deduced, was 21 feet in 5·17 seconds or about 2¾ miles per hour, and the mean of each series gave as follows:

Near the London shore,	21 feet in	8.4 seconds.
In the middle, . .	21	6.5
Surry side, . . .	21	9.3
General mean,	21	8.1

Or 1¾ miles per hour nearly.

6.—*Line of High and Low Water.*

The mean low water-line has a fall of 12 inches between Westminster and London Bridge, and from London Bridge to the London Docks at spring-tides, a fall of 3 inches; at neap-tides, 2 inches. Mean 2½ inches.

The high water-line has a fall, in the contrary direction, from London Docks to London Bridge, of 1½ inch at spring-tides, but it is a dead level at high-water neap-tides, as it is also between the London Docks and Blackwall. And from London Bridge to Richmond the high water-mark is, according to the survey of Mr Giles, the city surveyor, one dead level; and this gentleman informs me, that he has found the same circumstance to obtain in several tide rivers; although the Severn and some others observe very different laws.

7. *Experiments to ascertain the Velocity of the general body of Waters of the Thames.*

As the velocity, found as above, was obviously that of the surface of the water, I thought it desirable to ascertain whether it was the same to any considerable depth. For this determination, I procured at the dock-yard, by the permission of the Navy Board, ten pieces of oak a foot long, and about six inches in diameter, which were specifically heavier than water, and ten similar pieces of larch, which had a much less specific gravity than water. These were connected, two and two together, by small chains of different lengths, from fourteen feet long to two feet, so that each pair acted like a hook and quill, and they were so adjusted, by small weights of lead, that only the upper surface of the larch cylinders was above water; there were, moreover, two larch cylinders, which floated merely on the surface without any appending oak cylinders. The upper part of the larch cylinders were painted of different colours and forms, so that each might be distinguished from the rest.

These were all thrown into the middle of the stream opposite Woolwich Dock-yard, at about one hour after low water; they, of course, immediately proceeded with the current, and I accompanied them in a boat to register their progress. It was presumed, that, if the upper and lower parts of the stream had different velocities, that the deeper floats would be left behind those which were less deep; and these latter behind those which were merely on the surface: but that if the whole body of water had a common velocity, they would all proceed together.

It was soon found that the effect of currents at different depths, caused the floats to separate considerably from each other, but still their progressive velocity up the river was nearly the same; so nearly, indeed, that after following them for more than two hours, they all passed the same line, opposite Greenwich Hospital, within one minute of each other; although in their progress, some of them had passed under the keels of vessels, which intercepted their path.

We now waited till the time of high-water, and then immersed them again opposite the Hospital. The case was now very different; for we found the deeper floats still ascending the river, others descending, and others nearly motionless; so that we had some difficulty to collect them. This, however, we did, in about half an hour, when they were again set afloat, and they now, as before, proceeded pretty uniformly, and passed a line of the river at Woolwich (except two which had gone ashore) within about the same interval as before.

It follows, therefore, that, except for a short interval about the time of ebb and flood, the whole body of water is moving with the same, or very nearly the same, velocity; and hence the quantity which passes any section of the river during ebb and flood may be pretty accurately estimated, the section being given.

Without entering into a minute examination of all the preceding particulars, some of the consequences of the removal of the bridge may be easily foreseen.

For example, since the high water-mark is a dead level from Blackwall to the London Docks, and thence to the bridge, abstracting only 1½ inch at the bridge (which is unquestionably attributable to the fall at that place); and since it is also a dead level from the bridge to Richmond, there can be no doubt that the same law will obtain when the bridge is removed; so that at a medium spring-tide, we may expect the high water-mark from the bridge upwards to Richmond to be higher by about 13 inches than it is at present, and from Richmond towards Teddington this rise will gradually diminish, till it is lost in the general ascent of the bed of the river to that place.

With respect to the low water-line, it will fall very considerably below its present mark immediately above bridge, but not, perhaps, to the amount of the present head, viz. 5 feet 4 at a medium spring-tide, because the quantity of water which will pass the bridge, during the ebb, will be considerably greater than at present, and will, of course, acquire a new velocity consistent with the new circumstances, and consequently a new slope; so that it is possible the new low water-line, at the site of the bridge, will fall between the present low water-mark above, and that below the bridge, but much nearer to the latter than the former.

The additional quantity of water which will pass and repass the new bridge each tide, will consist of all that which will be admitted upwards, more than at present, at high-water, and of the greater part of that which is now dammed up above bridge at low water, which will together amount, perhaps, to about one-seventh of that which now passes. This, of course, will increase the velocity both of the flood and ebb tides, and have a tendency to deepen the river from the bridge upwards; but the navigation for large barges, it is presumed, will, notwithstanding, be impeded for an hour or two each tide, at and during the time of low-water, particularly at spring-tides.

It was not, however, my intention, in this paper, to do more than record the preceding particulars, for the purpose of comparison hereafter. I shall not, therefore, enter farther upon the probable changes which the removal of the bridge may occasion; a short time will decide the question, by the best of all tests, actual experience.

On the Affinities of the Empetreæ, a natural Group of Plants. By Mr David Don, Libr. L. S. &c. Communicated by the Author.

I am aware that it has already been proposed to separate *Empetrum* from the *Ericeæ* *; but the mere removal of it from that family, was nothing more than what Jussieu himself had previously done. That its relative affinities have hitherto been entirely overlooked, no one who has given the least attention to the investigation will for a moment question; and it would only be a waste of time to attempt to point out the discrepances between the *Empetreæ* and *Ericeæ*, or between them and *Coniferæ*, of which Nuttall is disposed to consider them as a section †; for, with the exception of a slight resemblance in habit, there is really neither analogy nor affinity between them; nor do the *Empetreæ* even belong to the same natural class with either of these families. I have, however, lately discovered a remarkable affinity between this group and *Euphorbiaceæ*, as well as *Celastrinæ*, which it is my principal object in this paper to point out; but, as they appear to me to be more intimately allied to the former, the comparison will be chiefly confined to these two tribes. The *Euphorbiaceæ* and *Empetreæ* agree, therefore, in the imbricate æstivation of their calyx; in the stamens being opposite to the divisions of the calyx, and both these being of an

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* Nutt. *Gen.* 2. p. 233.

† Nutt. l. c.

equal and definite number; in having bilocular anthers; in their superior ovarium; in the plurality of styles; in their divided stigmas; and, lastly, in the arrangement of the ovula, and presence of a copious albumen. The embryo is also nearly the length of the albumen, and its cylindrical form brings it close to that of *Phyllanthus*. The male inflorescence of *Empetrum album* has a striking analogy to that of *Buxus* *, whose calyx consists of 3 or 4 leafets, with the stamens equal in number, and placed opposite to, not alternating with them;—a circumstance which proves that this organ in *Buxus* is a true calyx, and not, as Linnæus regarded it, a corolla. In separating the *Empetreæ* from *Euphorbiaceæ*, the principal character relied on is their erect embryo; for in habit they are not far removed from *Micranthea* of Desfontaines, some species of *Phyllanthus*, or even of *Euphorbia* itself. In *Phyllanthus*, the calyx consists of 6 segments: the filaments are 3, closely united together; and the anthers are 4 in number, 3 of which are lateral and alternate with the inner divisions of the calyx, which are probably to be regarded as petals. The fourth anther, which may be considered as spurious, is placed directly in the centre of the 3 lateral ones. In a decandrous species of this genus from Mexico, each of the filaments is trichotomous, and each

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* In the *Prodromus Floræ Nepalensis*, I have very briefly noticed a plant under the name of *Buxus Saligna*, and which I then suspected would eventually prove a distinct genus; but materials are still wanting to determine this point satisfactorily. From the very imperfect description given by me, Mr Lindley, in a late number of the Botanical Register, has been induced to suspect its being only a variety of his *Sarcoccoca pruniformis;* but the following description will shew that it has very little affinity to that plant.

BUXUS SALIGNA, Don, *Prodr. Fl. Nep.* p. 63.

Flores dioici? *Fœm.*—*Calyx* squamis pluribus (6–8). *Ovarium* ellipticum, 3-loculare: *ovulis* solitariis. *Stigmata* 3 (raro 4) lanceolato-subulata, acuta, revoluta, suprà convexa, tomentosa, sulco exarata, subtùs nuda. *Fructus* (immaturum tantùm vidi) 3-locularis (raró 4-locularis), stigmatibus persistentibus rostratis, et inter rostra foramine dehiscens: *loculis* monospermis. *Dissepimenta* membranacea. *Frutex* erectus, ramosissimus, frondosus, sempervirens. *Folia* alterna, nunc raró subopposita, petiolata, angustè lanceolata, acuminata, integerrima, basi acuta, margine reflectente, paginâ utraque diversâ (ut in *Buxo*), coriacea, enervia, glaberrima, nitida, subtùs venis parum conspicuis, 3-pollicaria, semiunciam lata. *Pedunculi* axillares, breves, divisi, pluriflori, subracemosi, cernui.

branch bears an anther of the usual structure, which, together with the central one, augments the number to 10. In the female flower, the styles are 3, united at the base, and the stigmas are divided into two lobes. The fruit is 3-sided and 3-celled, each cell containing two seeds placed parallel, and opening at the angle by a longitudinal suture; these sutures are immediately perpendicular to the styles, and placed opposite the exterior segments of the calyx. I ought to have before remarked, that the form and structure of the anthers of *Euphorbia* and *Empetreæ* are exactly similar. The monophyllous calyx; the non-separation of the sexes; the presence of a perigynous disk; and the flat, somewhat foliaceous cotyledons,—appear to separate sufficiently the *Celastrinæ* from the *Empetreæ.* The distinctions between them and the *Rhamneæ* are still more apparent, however; for in them, the stamens are placed opposite the petals, and the æstivation of the calyx is valvular,—characters of primary importance in a natural classification. The embryo in *Rhamneæ* and *Celastrinæ* agrees exactly in form and structure. Mr Brown has very properly placed *Phylica* among the *Rhamneæ,* although I have known some who, merely from the fruit being inferior, were disposed to remove it from that family. It is evidently intimately allied to *Pomaderris,* both in habit and characters, and it is equally evident, that the fruit being inferior, is a distinction more apparent than real; for in *Pomaderris,* and even in some species of *Rhamnus,* the tube of the calyx coheres with the ovarium; and could we, for example, suppose an equal elongation of the tube of the calyx in these, as in *Phylica,* we should then have the situation of the fruit precisely the same. The apparently simple stigma in *Phylica* is not very different from the triple one of *Pomaderris;* for there is evidently an indication of three distinct lobes.

EMPETREÆ, *Nutt.*

Ericeis affinia, *Juss.*

Flores dioici.

Masc.—*Calyx* 3- (rarò 2-) phyllus, æstivatione imbricatâ, basi nudus v. squamis (4–6) duplici ordine imbricatis munitus. *Petala* 3 (rarò 2) hypogyna, foliolis calycinis alterna, ungui brevi, limbo obovato concavo erosè crenulato, marcescentia. *Stamina* totidem, iisdemque alterna, hypogyna, exserta, paululum interiùs seposita, pariter marcescentia: *filamenta* longiuscula, angustissima, compressa, glabra: *antheræ* subrotundæ, biloculares, subdidymæ, ad medium peltæ modo filamentis impositæ: *loculis* ventricosis, ferè omnino solutis, rimâ longitudinali exteriùs dehiscentes. *Ovarii* rudimentum.

Fœm.—*Calyx* maris. *Petala* totidem, sed breviora et vix unguiculata. *Staminum* rudimentis rarò ullis. *Pistillum: ovarium* globosum, sessile, disco carnoso impositum, 3, 6, v. 9-loculare, ovulis solitariis: *styli* 3, brevissimi, in unum corpus triangulare coaliti: *stigmata* radiato-multifida: *lobis* 6 v. 9, patulis, basi dilatatis, subtùs percurrenti-carinatis, suprà sulco perangusto exaratis, pruinosis, apice truncatis, emarginatis v. bicorniculatis. *Bacca* sphærica, nunc depressa, apice leviter umbilicata, basi calyce persistente cincta, 2, 3, 6 v. 9-pyrena: *caro* parca: *pyrenæ* testâ osseâ monospermæ, erectæ, collaterales, elliptico-trigonæ, compressiusculæ, columellæ demum evanescentis angulis numero æqualibus per totam longitudinem adnatæ, dorso convexo sulcato, ad apicem puncto exiguo ferè perviæ. *Semen* ovoideum, cavitati pyrenæ conformis, basi chalazâ tuberculiformi atro-fuscâ instructum: *testa* simplici, membranaceâ, spadiceâ, reticulato-vasculari, apice puncto notatâ: *albumen* copiosissimum, densum, carnosum, aqueo-pallidum, hinc facie planiusculâ, inde convexum. *Embryo* teres, erectus, axilis, lacteus, albuminis ferè longitudine: *cotyledones* semicylindricæ, obtusæ, arctè applicatæ: *radicula* infera, recta, cylindracea, obtusa, cotyledonibus ferè triplo longior.

Frutices (utriusque orbis zonis temperatis proprii) *humillimi, sempervirentes, facie ericoideâ. Folia alterna, petiolo exigui complanato suffulta, margine revoluta, integerrima, exstipulata.* Flores *parvi, axillares solitarii, v. terminales glomerati.*

EMPETRUM.

Empetri sp. *Linn. Juss.*

Calyx 3-phyllus, coriaceus, basi squamis 6 imbricatis munitus. *Petala* 3. *Stamina* 3. *Stigma* 6–9-fidum. *Bacca* depressa, 6–9-pyrena.

Fruticuli (Europ. bor. et Magellan.) *ramosissimi, procumbentes.* Folia *alterna, lineari-lingulata, obtusa, suprà plana, subtùs convexa et lineâ membranaceâ exarata, atro-viridia, nitida.* Flores *axillares, solitarii, sessiles, atro-sanguinei.* Baccæ *nigræ v. rubræ.*

Hùc E. nigrum, *L.* et E. rubrum, *Vahl.*

COREMA.

EMPETRI sp. *Linn. Juss.*

Calyx 3-phyllus, membranaceus, basi nudus. *Petala* 3. *Stamina* 3. *Stigma* 6-fidum. *Bacca* globosa, 3-pyrena

Suffrutex (Europ. austr.) *erectus, ramosissimus, rigidus, punctis resinosis adspersus.* Folia *undique sparsa, linearia, obtusa, patula, suprà planiuscula, margine revoluta.* Flores *terminales, glomerati, sessiles, disco piloso impositi, albi, majores.* Capitula *squamis villosis bracteolata.* Baccæ *albæ.*

Hùc E. album, *L.*

CERATIOLA, *Rich. in Mich. Fl. Amer. bor.*

Calyx 2-phyllus, membranaceus, basi squamis 4 munitus. *Petala* 2, in tubum conniventia. *Stamina* 2. *Stigma* 6-fidum. *Bacca* globosa, 2-pyrena.

Suffrutex (Amer. bor.) *adscendens, ramosissimus, rigidus.* Rami *stricti, simplices.* Folia *alterna, patentia, acerosa, obtusa, glabra, nitida, viridia, subtùs sulco angustissimo exarata, suprà leviter canaliculata, semipollicem longa; nunc plurima approximata, quasi verticillata.* Flores *axillares, sessiles, plures* (2–4), *rarò solitarii; nunc (ad folia approximata scilicet) verticilli modo dispositi.* Baccæ *rubræ?*

Hùc Ceratiola ericoides, *Rich. in* l. c. 2. p. 221.

In order to render this treatise as complete as possible, besides giving a description of the group itself, I thought it important to add the characters of the genera. It is immaterial whether the *Empetreæ* are to be regarded as a section of the *Euphorbiaceæ*, or as constituting a separate family. Their intimate affinity has, I trust, been satisfactorily shewn; and it also appears clearly evident, that the *Euphorbiaceæ*, *Stackhouseæ*, *Celastrinæ*, and *Rhamneæ*, must follow each other in a natural arrangement, as Mr Brown seems disposed to think *.

* General Remarks on the Botany of Terra Australis.

Establishment of Vegetation at the Surface of the Globe *.

WE have seen vegetation covering, with verdure and flowers, all parts of our globe; we have seen it extending itself from the bottom of the valleys to the most elevated places, resisting, in the plains, the burning rays of the sun, struggling upon the mountains with the frosts, bursting forth every summer from beneath the snows, and only stopping short at the zone of perpetual ice. But how does this vegetation come to cover the nakedness of rocks, to fix the mobility of sands, to implant itself in the strong gravel, to convert immense lakes into marshes, and these again into forests and fields? for such was, and such still is, the surface of the globe, in all places destitute of vegetation, whether in islands which have newly sprung from the bosom of the waters, or in tracts where the soil has been overturned by particular accidents, or deprived, by other circumstances, of their ancient verdure; such, also, do we find it, if we remove the layer, more or less thick, of earth which clothes it. This earth is, therefore, of new formation, as well as the vegetation which it supports; it has not been formed simultaneously with the rock on which it rests, or with the bed of sand which it covers.

This important observation is commonly overlooked. Accustomed to see the same flowers re-appear at each return of spring, the same meadows clothed again in fresh verdure, we scarcely

* Of all the branches of Natural History, undoubtedly Botany is that which has hitherto (mineralogy and geology now dividing with it the public attention), in Britain, been the most generally cultivated: hence every where we find splendid gardens and conservatories; and numerous works on botany are daily issuing from the press. Distinguished botanists have not been wanting in England: and Scotland, although behind in this science, has given to England several young, intelligent, and active botanists,—to Europe its greatest botanist, our illustrious countryman Brown: but, strange to say, the only naturalists who have actively embarked in the botany of Scotland, have been principally Englishmen or foreigners. Scotland offers still a fine and unexplored field to the philosophic botanist,—in the investigation of the physical and geographical distribution of its land and aquatic plants. He who shall undertake this highly interesting investigation, must be intimately acquainted with the facts and reasonings of meteorology and hydrography,—with the details and views of geology; and the ardent inquirer into the geography of plants cannot expect to illustrate it, without also knowing the natural history of animals; and, finally, he must be familiar with the use of the barometer, and other instruments.—EDIT.

reflect upon the origin of this beautiful and abundant vegetation, or rather referring it to the period of the general creation of beings, it seems to us to lose itself in the mysterious obscurity of the formation of the universe; and we thus find ourselves discharged, as it were, from the task of inquiring, by what means nature has everywhere diffused this precious mould, the source of riches and of life, and which yet is but the residue of generations heaped upon generations. Here an objection presents itself, which appears, in part, to destroy what I have advanced. If vegetable earth, it may be said, is necessary to the existence of plants, it must have been created previously to their existence, and can only receive what it had itself furnished them.

Such has been the error, which, during a long series of ages, has prevented our understanding one of the greatest operations of nature, and which, although continually before our eyes, has only escaped our observation from the little attention which we have bestowed upon an order of plants considered as little worthy of regard from their homeliness of aspect, their diminutive size, and the simplicity of their composition; but when the piercing eye of genius determined their relations in the natural order of things, when it recognised the functions which they had to fulfil, and the rank which they occupy in the general system of vegetation, they assumed a character of grandeur, which directed the attention toward their existence. It has been discovered, that, so far from requiring vegetable earth for their subsistence, they have furnished it by their decomposition, in small quantity it is true, but yet sufficient for the reception of plants of an order somewhat higher, and to which, in proportion as the vegetable earth increases, succeed vegetables much more vigorous.

To explain what we have to say upon this subject, we must fix our notice, for a moment, upon those plants which I have said to be the basis of vegetation. Although very common throughout nature, they have scarcely been remarked. They everywhere invest walls, rocks, humid places, and the trunks of trees; they attach themselves to all substances, however little they may be favoured by circumstances. The rays of the sun, and dry and cold winds, are as much inimical to them, as shade and humidity are favourable. These plants bear the names of *confervæ*, *byssi*, and *lichens*. To them succeed *mosses*, *hepaticæ*, *lycopo-*

diaceæ, *fungi*, &c. They constitute a great and important family in the natural order of vegetation. Linnæus has named them *cryptogamous* plants, from the circumstance that the mode of fecundation, by which they are reproduced, is very little known.

The *byssi* are plants which present themselves only under the form of a powdery tissue, or of a filamentous down, variously coloured; they attach themselves chiefly to moist substances, dry up in the rays of an ardent sun, and leave behind them only formless and blackish spots. The *confervæ* belong to stagnant waters and inundated lands; they are composed of capillary elongated filaments, simple or articulated. The *lichens* are sometimes nothing else than prominent blackish points, scattered upon a greenish or greyish ground; at other times they are simple or branched lines, which have the semblance either of alphabetical characters, or of a sort of geographical chart, marked upon a very thin smooth membrane, applied to the bark of trees. Other species attach themselves to rocks, forming plats of various colours, leprous, granular, or powdery crusts; or assuming a greater degree of development, spread out into rosaceous expansions of a foliaceous aspect, with laciniated or lobated margins. Some of them rise from a scaly crust, in the form of simple stems, or ramify into small elegant shrubs, dilated at their summits into little cups, which are either simple or proliferous, and which are furnished upon their edges with fungous tubercles, of a brown or blackish colour, or of a beautiful scarlet red. Others present themselves under a very different form, falling from the trees in long intermingled filaments, like horse's hair or tufted locks; some of a greyish green, others of a beautiful gold yellow, orange or lemon. I shall not extend my remarks upon this class of plants, with which we shall have to form an acquaintance in another place, when we come to treat of the natural families. Here we shall speak of them only with relation to the great functions which nature has confided to them for the establishment of vegetation.

When we remark the hardness, the dryness, and the bareness of rocks, we should scarcely imagine that their summit might one day be crowned with forests; and yet this great work is carried on every day under our eyes, and even in the midst of our habitations. We observe the walls covered with greenish spots, which grow from humidity, and which the light and heat reduce to black and tenacious spots ; these are so many *byssi* which have essayed to establish vegetation there, as well as upon the most polished statues and marbles ; it is they which impress the seal of age upon our old castles and gothic edifices. Elsewhere, particularly upon rough stones, we see spreading out into broad plats those lichens of various colours, like the ulcerous crusts which corrode the skin of animals ; they scoop out and corrode the surface of rocks, and deposit in the vacuities which they have formed, the portion of earth produced by their destruction. Although in very small quantity, this earth suffices to administer to the development of lichens of a higher order. Their debris, added to those of the former, furnish a small layer of earth sufficient for the existence of mosses of an inferior order, to which, in like manner, succeed more vigorous species *.

Already a turfy layer invests the tops of walls and the surface of rocks ; it increases from year to year by the remains of the vegetables which it nourishes ; its pulverulent particles are retained by the dense and tufted roots, and stems of mosses ; the moisture is long preserved in it ; the layer of earth grows thicker ; gramineæ, and other herbaceous plants, with low stems, begin to establish themselves, such as semperviva, drabæ, saxifrages, dandelions, some gerania, &c. The soil increases in proportion as the generations succeed each other ; it is converted, through time, into a meadow, visited by a great number of animals. Plants, with ligneous stems, announce that this newly formed soil will quickly receive larger vegetables, the multipli-

* Those who have not directed their attention to the study of nature, will, perhaps, be very much astonished to be told, that all those black or greenish spots which invest the surface of statues and walls exposed to humidity, are true plants. These plats are formed by a *byssus*, to which Linnæus has given the name of *Byssus antiquitatis*. Stones which are constantly shaded and moist are covered with another byssus, of a beautiful deep green ; it is the *Byssus velutina*, L.

The *lichens*, which ordinarily occur upon walls and rocks, are the *Lichen calcareus*, *pertusus*, *tartareus*, *candelarius*, *parellus*, *saxatilis*, *centrifugus*, *crispus*, *omphalodes*, *parietinus*, *pustulatus*, &c.

The *mosses* which occur upon old walls are the *Mnium setaceum*, *capillare*, &c. ; *Bryum apocarpum*, *striatum*, *rurale*, *truncatulum*, *murale*, *cæspititium* ; *Hypnum sericeum*, *serpens*, *myosuroides*, &c.

cation of which must ultimately establish immense forests in a soil which might be thought to have been condemned to perpetual sterility.

Such, upon these arid rocks, is the development of vegetation, begun by simple byssi, and some lichens, propagated by tufts of mosses, augmented by herbaceous plants. Their accumulated remains have formed this vegetable mould, now sufficiently thick that the most vigorous trees may drive their roots into it. Following in this manner the progress of vegetation, we have convinced ourselves, that vegetable earth is nothing else than the result of the annual decomposition of vegetables, and that without them it could not have existed ; that nature alone, and not human industry, could have deposited it upon the rock, or the old wall where we have observed it, and where its formation is in a manner executed under our eyes.

We shall not yet leave those forests, whose establishment we have followed, from the humble grass or the creeping moss, to the production of the largest vegetables. What an abundance of earth is furnished every year, by the fall of their leaves, and the other remains of vegetation ! It is from this vast magazine, incessantly renewed, that nature derives the substances necessary for fertilizing the plains and valleys. To transport these materials, she makes use of the vehicle of water, of those tempestuous rains which precipitate themselves in torrents, or descend in sheets from the summits of the mountains into the deepest valleys. These waters carry with them the spoils of vegetation, and cover with them the plains which are frequently sterile, cretaceous, sandy, or stony ; their fertilization, without this means, might have cost Nature ages of labour.

But the plants which lay the foundations of vegetation upon the rocks, being destitute of roots, could not exist upon arid and mobile sand, to fix the mobility of which, another order of vegetables is required ; this also has been produced. In place of byssi and lichens, which require a fixed and solid base, we find, as the first plants, several species of gramineæ and cyperaceæ, whose filiform and cespitose roots are interlaced with one another, bury themselves in the sand, bind it together, mingle their remains with it, and render it adapted for the reception of vegetables suitable to the temperature of the localities, provided they be frequently watered by rain.

The circumstances which subject sand to the power of vegetation do not everywhere exist; there are even vast countries where the earth appears condemned to present to its inhabitants nothing but a dry and burnt surface. Such are those immense plains of Africa, those dreadful deserts, the countries of silence and of death, which man traverses only with fear, but which Nature may yet, by means of certain local circumstances, bring to a state of life, as she has done in many other places. The most efficacious, in fact the only means of doing this, is the presence of water. We already know, that several great rivers carry their waters through them, such as the Nile in Egypt, and the Niger in a part of the Sahara. The springs which feed them, enlarged by the rains, occasion, every year, considerable overflowings. These superabundant waters deposit, upon the lands which have been inundated by them, a mud which, by being mingled with sand, acquires a great degree of fertility; in other places they form seas, lakes, and pools, which carry the principles of life into those countries of death.

A new order of plants meets us upon the edges, and at the surface of these lakes. We can easily imagine, that those which have established vegetation upon the sandy or stony soils could not here fulfil the same object, and we shall see this all-powerful Nature overcoming with time, the obstacles which oppose themselves to its operation. When the waters have covered a piece of ground, plants almost immediately begin to appear; they are more or less abundant, according to circumstances If these waters are running like those of rivers, or agitated like those of great lakes, vegetation only exists upon their edges; but if they be tranquil, stagnant, and of little depth, plants grow in them more numerously, and with more rapidity; they at first cover the surface of the waters, and occupy, from the simplicity of their organisation, the same order as those which grow upon rocks; they are merely very delicate, interwoven filaments, without roots, and without apparent fructification. They precede the growth of more perfect vegetables, and prepare the soil which is to receive them,—an operation which we may equally observe without leaving our houses. If we examine neglected or abandoned basins of water, we find them covered with a greenish scum, which, for a long time, was considered as consisting of impurities thrown out to the surface of the water, but which, if observed with more attention, we shall easily be convinced, belongs to the vegetable kingdom. The substances of which this scum consists are designated by the names of *confervæ* and *byssi*. Duckweeds (lemnæ) and callitriches accompany or succeed them. These plants, which are destitute of roots, form, by their interlacement, a sort of floating sward, the remains of which are precipitated to the bottom of the water, and constitute the soil destined to receive plants of a superior rank. After this potamogetons, charæ, and myriophylla line the interior of basins and lakes, extend themselves into meadows constantly covered with water, and reserved for the nourishment of a great number of aquatic animals.

In proportion as the bottom is raised, more vigorous species appear above the water, and develope those beautiful corollas, the brilliancy of which vies with that of the flowers of our gardens. The liquid plain is converted into a parterre embellished with tufts of floating ranunculi, naiads, hydrocharides, vallisneriæ, surmounted by the ample calices of silver, gold or azure of the nelumbos, and nuphars, with broad and varnished leaves, while the sagittariæ, flowering junci, menyantheses, huttoniæ, &c. form upon their edges an elegant and varied border, to which are joined beautiful veronicæ, œnanthæ, phyllandræ, surmounted by salicariæ, bidentes, eupatoriæ, &c.

Thus the waters, as well as the bare and stony part of the globe, are peopled with vegetables, which convert into marshes those liquid plains upon which have formerly floated the barks of fishermen. These waters gain in surface what they lose in depth, and carry fertility to all the surrounding grounds. In proportion as they are lowered, we see beginning to grow those species which in some measure hold an intermediate place between aquatic and terrestrial plants, such as large gramineæ, reeds, poas, carices, scirpi, rushes, typhæ, &c., but no plant contributes more to the conversion of these marshes into pasture grounds, than the prevalence of certain species of mosses, especially sphagna, which rise in yearly layers above one another, and daily increase in thickness as well as in extent. If these waters, absorbed by the power of vegetation, are not fed by springs in proportion to their loss, this marshy soil will by degrees be dried up, and will be covered in time with fertile meadows and trees of all sorts, and will then be fit for cultivation.

What I have here said with respect to the gradual progress of vegetation is in no degree conjectural: we find its proof at almost every step, as well in the bosom of the earth as at its surface, especially in soil which has not been overturned by recent revolutions. In how many places do we not meet, beneath the bed of vegetable or argillaceous earth, ancient peat-bogs extended over strata of sand or heaps of rolled stones; an evident proof that this soil has formerly been traversed by the waters of rivers, or occupied by those of lakes. The vast marshes of the Somme furnish us with one example among a thousand. The soil is often covered, as M. Girard has observed, with a layer of earth adapted for vegetation, about two feet in its greatest thickness; the height of the bed of peat on which it rests is from six to ten feet thick between Amiens and Pecquigny; it increases to thirty feet opposite the villages of L'Etoile and Long, beyond which it gradually diminishes. The low part of the city of Amiens, according to the observations of M. Sellier, is built upon a bed of peat, which is sometimes more than twelve feet thick; it rests upon a bed of marl, which is itself supported by a bed of sand and pebbles, mixed with marine shells. This vast formation has therefore been long occupied by great lakes, as is proved by the discovery which has been made of several boats and Roman arms preserved in the peat at different depths.

We are not permitted to follow the establishment of vegetation in the depths of the ocean; but if marine plants, like land or fresh-water ones, required to be implanted in an earthy or muddy soil, we should scarcely conceive how they could resist the destructive action of those roaring waves which incessantly overturn and drive before them every obstacle that comes in their way, sweeps the bottom of the seas, and heaps upon the shores the debris of rocks. To struggle with impediments so powerful, marine plants would require a peculiar mode of existence: nature has therefore awarded them a more solid base than that of a mobile sand, continually tossed about by the impetuous movements of the waters; it has fixed their abode upon the hardest bodies, upon stones and rocks, to which they adhere by a base of great tenacity, or rather are cramped by means of a sort of branched claw, very different from a root, although having its appearance. These claws are not destined to draw from a soil which they cannot penetrate, alimentary juices which are to be carried to the upper parts of these vegetables; for these parts, being entirely immersed in the same medium, equally absorb, by the whole of their surface, the principles of their nutrition, and we have not as yet been able to discover the ascent of any liquid, such as sap, &c. Marine plants have, besides a foliage which is plane or divided into filaments, of a pliant texture, a coriaceous or membranaceous structure, susceptible of accommodating itself to all the motions of the water in which it is immersed, without receiving any injury.

Although their mode of fructification is still little known, it appears that their seeds, or what they have in place of them, are very glutinous; that they attach themselves indifferently to all solid bodies, and cover the rocks with a vegetation equally abundant, and not less agreeable than that of the swards which carpet our mountains. It is true they do not expand brilliant corollæ, nor fill the air with their perfumes, but they often present, in the form, variety and mixture of the colours of their foliage, an aspect not less seducing.

It would be difficult to say what are the circumstances favourable or hurtful to their multiplication; but if we examine the rocks which it is permitted us to approach, we shall find them covered with a rich vegetation. It is to be supposed that these plants, although placed in the same general medium, are, equally with terrestrial plants, subjected to the influence of localities, depths and temperature, since there are some which only shew themselves in certain seas, which are met with, for instance in the Atlantic, while they are not to be seen in the Mediterranean, which occur in the Indian Ocean, while they are denied to the frozen seas of the north, &c. Others grow at such depths that we are only acquainted with them by means of their fragments.

I shall not follow further in her great works, Nature incessantly occupied in laying everywhere the foundations of vegetation. What I have said will suffice to present an idea of all the resources which she employs to overcome obstacles, and diffuse motion and life throughout. We have followed her in the plains, upon the mountains, in the moving sands, and in the very bosom of the waters. If we now descend into the cavities where the light never penetrates, we shall there find peculiar plants, destined to dwell in darkness, such as certain species of rhizomorphæ, byssi, &c. In short there are no substances, whether contained in the open air, or in the waters, laid open to the light, or concealed in the most obscure recesses, exposed to humidity or to dryness, which are not occupied by plants adapted for these different localities. The moulds attack all our alimentary provisions, when they are left undisturbed and kept in damp places; numerous fungi, enormous boleti, grow in the shade upon plants in a state of putrefaction; lichens and mosses penetrate the wrinkled bark of trees; a multitude of animals of a very inferior order, such as larvæ of insects, worms, mollusca, whether naked or testaceous, crustacea, arachnidæ, establish their abode in the midst of this growing vegetation; they deposit their offspring there, live in abundance, like our herds in the pastures, enjoy the coolness and the shade, like the great animals in their forests. In this manner is propagated the sublime work of creation in those organic beings which contribute, during their life, by their secretions, and after their death by their spoils, to the augmentation of vegetable earth, and of many other inorganic substances.

Observations made during a Visit to Madeira, and a Residence in the Canary Islands. By Baron Leopold Von Buch. (Continued from former volume, p. 380.)

At this we were much surprised. We did not imagine we had climbed to such a height, and we thought that it was impossible to ascend so high in Madeira. The accounts of the height of Pico Ruivo, which is by far the highest mountain on the island, stood far below our calculation of the height of Toringas. Dr Thomas Heberden (a brother of Dr William Heberden, to whom we are indebted for the remarkable observations upon the increasing quantity of rain accumulated near the surface, in other respects an accurate individual) mentions that he, by barometrical observations, according to De Luc's formula, had calculated the height of Pica Ruivo at 4825 French feet. The barometer was not observed by himself, however, but by some English travellers, whom he does not name. He does not give the barometrical height, but merely the result, (*Phil. Trans.* lv. 126). This measurement may, therefore, be considered somewhat doubtful. Two later observers, instead of removing this doubt, have only increased it. The celebrated Captain Sabine saw the barometer on the summit of Pico Ruivo on 13th June 1822, 23° In., 4.54 Lin. par. therm. 1°.8 R : In Funchal $7\frac{1}{2}$ feet above the sea, 28.6,–33,–13.1 ; which gives the mountain an elevation of 5011 French feet.

Bowdich had ascended the mountain about the same time, and had seen the barometer at a height of 22° In., 10°.7 Lin. par therm., 7°.5 R : In the house of the Consul Veitch, at Funchal, 28.–5,6,–16.4. This house lies 145 feet above the sea; the top of the mountain is therefore 5788 French feet, 304 feet more than Cima de Toringa, according to one account, (*Jameson's Edin. Journal*, xviii. 317.) There can be no doubt of the greater height of Pico Ruivo ; and there being little probability of error in the continued series of our observations, I consider that Bowdich's measurement, contained in his letter to Jameson, is to be preferred.

Towards the evening of Tuesday 2d May, we left Funchal and Madeira. The wind carried us tediously along. The captain, however, on the 4th, told us that he saw the Peak. He saw it with a seaman's eye from the tint of the atmosphere above it. It was not visible to us; but early on the 5th, Teneriffe was completely spread out before us. At the distance of about twenty-seven miles, the Peak rose above the clouds, vast and majestic; and the snow was seen lying upon its declivity, and descending almost to the woods; while the people were busily engaged with the wheat harvest, on the gently sloping shore of Tacaronte. At length Orotava appeared beneath the clouds of the Peak, as Frascati does from Rome, and a distinct stream of lava stretching from the Peak towards the harbour, could be seen by the eye, among plants and layers of white pumice.

On 6th May, at 10 A. M., we landed at Puerto Orotava. To render our stay on this island ever worthy of remembrance, it was scarcely necessary to be admitted to the hospitality of (Barry and Bruce), one of the most intelligent, amiable, and polite families in the town. When evening recalled us from our excursions in the neighbourhood, we hastened home, to find there united every thing that genius, intelligence, fine feeling, and Spanish warmth of temperament, could produce. Having thus explored the woods above Villa Orotava, the rocks of St Ursula, Ria Lejo, La Rambla, the environs of Garachico and Icod, we at length, on the 18th May, undertook to ascend the Peak.

Being tolerably intimate with the works of other travellers, we did not stop by the way to discover new phenomena unobserved by others, but to discover some traces of what we found related in these old accounts. We hence expected, after leaving the beautiful chesnut wood above Villa Orotava, to meet with the woods of pines, which Humboldt supposed were certainly a new species, hitherto undescribed, (Rel i. 186.) We saw only the celebrated *Pino del Dornajito*, the only one that appeared the whole way. Still it is certain, that their way to the foot of the peak was through a thick wood of trees of this description. This was the case at the beginning of the last century; and according to the observation of Edens and P. Feuillé, the ascent in this wood, through pine trees of striking shape and size, was divided into several sections, the *Pino de la Caravela*, and higher, the *Pino de la Merienda.* These the destructive axe has not spared; and the *Pino del Dornajito*, the only one the whole way up, owes its preservation solely to the spring which it overshadows. At present there is no trace of the pine-trees, and the ground is covered with small bushes of heath and plants of fern. At present, we meet with no object, which, like a pillar, could point out the path; and we perceive, with surprise, that we have spent a number of hours in climbing from the chesnuts to Portillo, by a road over which we do not appear to make the least progress, by reason of the uniformity of the objects around it.

It is otherwise, when we actually arrive at the foot of the Peak, through the defiles of Portillo. Here we felt as if again placed amidst the sublime stillness and solitude of the glaciers of the Alps, and, as in the Alpine glaciers, the traveller, in wandering over the boundless and gently rising acclivities of pumice, becomes bewildered. What seemed mere blocks at a distance, became rocks when we approached them; and crater hills were transformed into imposing mountains. No scale of the plain could yet be applied. The mass of the peak stood still higher above this level than we had yet seen it; and black streams of glass descended from the summit like ribbands upon the declivity. Continually occupied with the vast spectacle, we were not sensible that we were obliged to travel three hours longer to reach the margin of the stream of lava. Some of the large blocks that compose this margin, are so thrown together as to form benches and apartments of a rude description, among which people commonly wait till the following morning, before they prosecute their journey farther. It is the lower Estancia de los Ingleses.

The ascent from this is difficult; and still more so, when, at an additional elevation of 2000 feet, we must actually cross a black sharp field of glass; although it is never to be compared to the labour of climbing to some of the summits of the Alps. Upwards, above Cueva del Hielo, about 10,300 feet above the sea, we observed the first flakes of snow upon the declivity. They were but small; and in our farther approach towards the summit, we saw no more of them. Bewildered in looking upon the boundless prospect, which astonishes, rather than delights or elevates, because the imagination, unsatisfied with the surrounding shapeless horizon, looks back on it with horror; we had been already some hours upon the margin, and in the interior of the crater, when Mrs Hammond, a Scotch lady, with her company, appeared above, the first female, who, in the memory of the inhabitants, ever ascended the peak. They went round the whole crater, and likewise round that side towards Chahorro, which is so seldom visited; and although the sharp obsidian cut their shoes and feet in a dreadful manner, they did not hesitate to visit along with us the natural ice-pits between the blocks of obsidian and the Cueva del Hielo, which, during the whole summer, supplies the towns Sta Cruz, Orotava, and Laguna with ice, which to them is a necessary of life. In the afternoon, we hastened down the declivity, to reach Orotava before dark. The guides and mule-drivers sung strophes of alternate rhyme upon the adventures of the day, beat time with sticks upon a cane; and to mark the rhythm, kept a leaden bullet rolling in a wine-glass. At eight in the evening, we once more reached Orotava.

On the 27th May, we again began our ascent towards the peak; but missing the way, after arriving at the plain of the Retama, we went round the circuit of the peak, beneath the perpendicular rocks of which it is composed, spent a few hours more in a deep gulf in which these retama bushes (Spartium nubigenum) blossom magnificently in countless numbers, climbed the rocks at the Pass of Guaxara, and at dark arrived at the village of Chasna, which stands at the height of 4013 feet upon the southern declivity of the island. At this place, we, for the first time, passed through a wood of lofty Canary pines (Pinus canariensis). We also observed it to be more extensive than when we, on another morning, had ascended to an agreeable but weak acid mineral spring, which is the only one upon the island, and which issues forth from rocks of white tuffa. Chasna itself, by far the highest village on the island, was very pleasantly surrounded with a great abundance of pear and plum trees, and with almond-trees, growing on the neighbouring heights. Here we might almost have expected meadows and European plants. In the evening, we reached Chiuama, lying far below; and were there received with polite cordiality by Teniente Don Antonio Gonsalez. He conducted us in a westerly direction to a defile very steep on all sides, and at no great distance, in which were many Guanches caves among the high volcanic rocks, that were inaccessible without a ladder. Bones of mummies, thrown forth and destroyed, were lying like little hillocks upon the ground. We stopped in Rio; on the following day visited the Barancos of the neighbourhood, las Virgas and Granadilla, and returned in the evening to Chinama.

Here Don Antonio first let us taste the honey which the bees upon the Peak prepare from the retama. Every village in the neighbourhood, Chasna, Chinama, Granadilla, and Rio, in the month of May, carry their bee-hives, which are hollow stems of the dragon-tree, to the circus of the peak, and place them in the crevices of the rocks. Millions of bees then swarm around the large and fragrant white bushes of (*Spartium nubigenum*) the white retama, and very soon fill their hive. The honey is taken from them twice every summer, always in great abundance, and neither Hymettus nor Chamouny have ever produced any thing equal to it:—it is so pure and transparent, and the taste so aromatic and delicious. Whoever, indeed, would import this bush to the bees of Europe, would deserve as well of his countrymen, as he who introduced the vine and fruit-trees. And that would be by no means difficult, for spartium grows perfectly well here, where snow lies almost continually from December till the middle of April, and even where the lowness of the temperature checks the vegetation of every kind of tree. It might thrive extremely well in the interior of Norway, where the summer is warm and dry; and equally upon heaths in Austria and Poland. But no one has hitherto been successful in rearing it in Europe; and every thing that has been said of its flourishing in botanical gardens is erroneous.

On Wednesday 31st May, we descended to the sea-coast, to Puerto de los Christianos, one of the best harbours, and the southernmost part of the island. It was far from agreeable, however. The drought was dreadful. For miles round, not a single habitation was to be seen, only one house upon Puerto for ships, which, during summer, carry wheat from Santa Cruz for the villages upon the height. Upon the white far-shining surface of the layers of pumice, not a single particle of soil is to be found, and every bush that grows on it is small-leaved and grey, or entirely leafless, and covered with long prickles. The fantastic *Euphorbia canariensis* creeps along the surface, in the most whimsical forms, and *Plocama pendula* droops its thin branches, like the weeping willow. Not a drop of water is to be seen in the whole neighbourhood. In such a place, the soul is seized with an indescribable feeling of depression, and we gladly and hastily ascended from the desert to Adexe. A long vista of blooming agave, upon both sides of the road, led us to this friendly spot. We thence proceeded through a long row of houses to the large castles of the Marquis de Adexe, Conde de Pomera, Don Antonio de Herrera, and then to the hospitable abode of the Governor Don Baltasar Bal Cazar.

The Baranco above Adexe was well deserving of our stay. The largest stream in the island runs in it, branches off in various directions through innumerable gardens and plantations, and carries along with it every thing that, in such a climate, has power to refresh and quicken vegetation. For we found among the ravines, where the rocks, approaching near to one another, hang over, and frequently appear to close, almost every plant that we had not before discovered, and also many withered and decayed, which might certainly at one time have been recognized as new species. This Baranco del Infierno is equally calculated to interest the botanist and the geologist, for, besides their splendid vegetable clothing, the rocks being rent asunder to a depth greater than in any other place, leave room for examining the interior of the Peak.

Adexe lies upon rocks 923 feet above the sea. We descended upon soft layers of tuffa, where small bushes of *Justicia hyssopifolia*, *cistus*, *conyza*, *artimesia*, *thymus* and *lavender*, afford rich and excellent pasture for the goats that feed there. At no great distance from one another stood little well built goat farms. The milk of these animals was as refreshing to us, as it was wholesome and agreeable. Each goat yields the astonishing quantity of one and a half quarts daily, and even more. It is as rich as the milk of the rein-deer, and entirely pure and free from flavour. Such delicious milk we could never discover to be the milk of the goat, which, among the mountains of the north, is held in so little estimation. There the goats do not feed on leaves of *justicia*, *cistus*, and *lavender*. Truly the goat of this island itself is a quite different animal. For agility and elegance, it may be compared with the gazelle. The short smooth horns fall back from the forehead, and the black hair is not wiry and rough, but smooth and fine, and glancing like ebony. It is certainly a different species. No other kind of milk is made use of in the whole of Teneriffe. It is also probably much superior to what cow's milk would be here; hence the reason why there is not perhaps a single cow to be found on the whole island. The fresh cheese made from this goat's milk is equal in excellence to the serac of Switzerland.

We descended the declivity of Chahorra, over a wide and desolate field of lava, on which the poor villages Guia, Chio, and Arguaio, are but miserably supported, into the valley of St Jago, which joins the north and west sides of the island. Smith at length found the beautiful *Euphorbia atro-purpurea*, in tall beautiful bushes, a species which was first discovered and described by Broussonet. We would cheerfully have examined the numerous hills of volcanic ashes upon the height, from which so vast a mass of lava has flowed down through the valley to the sea; but a dense fog and rain prevented us. We took a full half hour in crossing the great stream of lava, which in 1705 destroyed Garachico. The road led us, with a rapid descent, to Icod los Vinos, a place surrounded with verdure, beautiful, extensive, and opulent. It is one of the most famous wine districts. The harbour of Garachico, before the lava destroyed it, was indebted for its principal trade to Icod, whose *malmsey was* celebrated and in demand a hundred years ago. It is still the same, and is shipped at Orotava for England.

A vast extent of obsidian, flowing from the Peak, and extending miles in breadth, has filled up the Barancos, and levelled the declivity. The pines of Pinar, from the pine-woods above, descend along with these streams; and some trees of that kind are found near the sea-coast. This is remarkable; for, in such an extension of zone of temperature, no other kind of pine resembles that beautiful tree. Far up on the Peak, it grows to perfection in a climate which can be compared only with that of Norway; while, on the sea-coast below, it thrives in the climate of Mogador and Morocco. Its form in the latter situation is somewhat different and singular. The *Pino Santo*, a single tree between Icod and Guanches, with a figure of the Virgin Mary, is, by reason of this figure, visible to a great distance. The branches do not rise high, but spread out to a great extent, and occupy a large space. Cones of one and a half and even of two feet long, are observed hanging from them, and in great abundance, drooping towards the ground like inclined heads, with long hair descending from the crown. Above, in

Pinas, the cones are shorter; and farther up on the Peak, they are scarcely equal in length to the pines of Germany. In that situation, they also lose their singular appearance.

On the 4th June, we were in Puerto Orotava again.

On Monday, the 12th June, we repaired to Laguna. We came here into an entirely new world. The rich cultivated declivity on which the streets are built, every where recalled to our recollection the southern situation. St Ursula is entirely surrounded with palms, and Tacaronte is concealed among vineyards. Upon the high lying plains of Laguna, we enter into fog and clouds, that ascend daily from the sea. Corn-fields stretch along the flat hills, as in Thuringia; but neither orchards nor vineyards, and but few palms, are to be seen. Laguna is the principal place of the country. It is extensive and beautiful; and the residence of most of the landed proprietors, of Marquises and Counts, who are chiefly descended from the ancient conquistadores. We took possession of a large unoccupied house, with numerous balconies and windows, like an old castle. At the windows, Smith made a discovery that he did not anticipate, from so many travelling botanists having before climbed from Sta Cruz to Laguna. Every botanist, and every traveller, visiting Laguna for the first time, has been struck with the singular appearance of the town; for, all the roofs being closely covered with bushes of Sempervivum, have the appearance of hanging woods. Who would think that this plant, which has so much and so frequently excited attention, has never been examined, far less described. Very different from the Sempervivum canariense, for which it has been commonly taken. Smith thought himself fully entitled to consider it a new species, and to call it Sempervivum urbicum, after the singular place where it chiefly abounds. The heated air on the sea-coast rises, towards mid-day, on both sides, diffuses itself over the plains of Laguna, and cools there to the point of condensation of the vapour that rises with it from the sea, and thus thick fog is formed. Moisture, heat, and shelter from the too powerful rays of the sun, the chief promoters of the growth of Sempervivum, act with combined influence on the roofs of Laguna; and to these causes does the town owe the peculiarity which it shares with no other place in the Canary Islands, of having its walls covered and ornamented in so remarkable a manner. But why these fogs surround Laguna more than the other parts of the neighbouring plain, is owing to the town's being situated exactly in the place where we again begin to descend towards the south coast. When the north-east summer trade wind passes Laguna, it is turned to the north-west by the mountains. On the contrary, the sea-breeze below, blows during the day from the south. The air, on both sides, meets exactly where the town lies, and the decrease of heat is accordingly greater. Above, a little way down the declivity, stands a windmill, whose wings are continually turned towards the north-west. Below, half way to Sta Cruz, at an elevation of about 900 feet, stands another wind-mill, with its wings continually presented to the south; for the sea breeze rises to this height; and both mills are commonly in motion at the same time.

These fogs, and the beautiful springs which they produce, have a powerful influence on the vegetation of the hills. Lovelier trees than those in the splendid wood of Obispo, to the east of Laguna, were never seen; and here is found every tree that the woody region of the island produces. There is a glorious place at the Aqua de la mercede in the middle of the wood. Laurels of inaccessible height form a close and lofty arch above the source of these bright and translucent springs that run along the plains like copious rivulets. The elegant leaves and flowers of the Cinereria populifolia rankle so luxuriantly and delusively above the soil, that they must be narrowly inspected before we are convinced that they are not young copses of black populars.

Benches are placed around; and here we almost continually meet with company from Laguna, amusing themselves in the refreshing coolness of the place. This wood, the Barancos, the rocks on the height towards Punta di Naga, Tagauana curiously concealed among the cliffs, Tegueste and Tacaronte, detained us for a long time in this neighbourhood. We abandoned our large deserted habitation in Laguna, not without regret; and, on the 24th June, went down to Sta Cruz. Social life had its attractions also. M. Le Gros (Humboldt, Rel. i. 113), had instituted a school of arts, which had contributed much to the diffusion of taste among the inhabitants; and we found him with some thirty scholars, who were drawing from life. Dr Lavione possessed a considerable collection of excellent philosophical instruments; and that modest individual was acquainted with their practical application, and discoursed intelligently upon them. The Marquis di Nava united literature with numerous scientific acquirements, and his library would do honour to any town. The judge of the tribunal Don Nicolas de las Torres was practically acquainted with every department of physical science, and very industriously collected every observation relative to it. We felt equal interest in the amiable family Canatho, and in many others.

At the advanced season of the year, Sta Cruz could scarcely offer any thing to the botanist which he had not seen before, and to greater advantage. Our meeting with Don Francisca Escolar was greatly in our favour, however. He had examined all the islands geognostically, and had made elegant, accurate, and spirited observations upon the whole of them. His collections and his information form an important part of the knowledge we obtained of these islands.

A large boat comes from Gran Canaria to Sta Cruz, two or three times a week, with fruit and cattle. This is the most common communication between the two islands. We went on board one of these boats, on the 26th June, at 5 o'clock in the evening. We were led to expect that we would reach Canaria on the following morning; but the winds between the islands were two weak and variable. It was 4 P. M. before we could land on the coast, in the lonely and desolate creek De la Sardinia. Galdas, the nearest place, lay at the distance of a league, upon a flat hill of tuff. We were well received by the inhabitants of that place, and in a particularly hospitable manner by Don Joaquim, an old, wealthy, good-natured, benevolent man.

Upon the following day, a journey of about six leagues to Las Palmas, the chief town, was well calculated to make us acquainted with the peculiar character of this island. It was no longer Teneriffe. The features of Africa, and of eastern countries, were every where presented to us. The villages were surrounded with palms, that appear to grow extremely well. Water runs in every direction; and the lowlands are covered with rich plantations of Indian corn. We went through many valleys, the Valley of Moja and that of Teror, which are very conspicuous for their verdure and their stately palms; and when we descend into the valley to Palmas, the first houses and streets resemble those of Tunis and Algiers. The long, parched declivity of the mountain of St Nicolas stretches out along the side; and, under it, the inhabitants live in cellars and caverns; a street of swallows' nests. Next rise houses like walls, without roof or window; then lofty and spacious buildings. Every house in Sta Cruz itself, upon Teneriffe, had a roof, and above it a balcony. Every thing here is flat; every thing is divided by horizontal lines, which are but little relieved from the bare white back-ground of the hills. Palms shoot up on all sides, and many other trees that bear no resemblance to those of Europe, such as tamarinds, and Carica papaia, in great abundance. But every thing is Spanish: no oriental forms are met with in the streets.

Las Palmas, a town of greater magnitude than Orotava or Sta Cruz, is almost as large as Laguna, and contains 8096 inhabitants. Like Seville, it is divided into two very unequal parts, by the copious rivulet Guinegada. In the lesser division, De la Vegueta, stands the beautiful and handsome cathedral (Justicia), the court-house, the palace of the bishop, likewise all the houses of the canons, and their families, and of the (Majoratsherren) on the island. Hence the sable robes and the roof-like hats of the priests are by far the most numerous here. The tradesmen and the merchants live in La Triana, the greater division, and all the merchants' shops are in the same quarter. Between those two divisions, like an island, stand the two nunneries of the Clara and S. Bernando, and a monastery of Franciscans. Upon the top of the mountain rises the solitary Castello del Rey, which, by means of a wall on a steep precipice towards the sea, joins with the little Castello de Casa Mata, which again is connected with the Castello de Sta Anna, immediately on the seashore.

The Bishop shares the landed revenue with the king and the chapter, and his own income is estimated at 100,000 piastres. He is also understood to be the prime mover of all the affairs of the island. All who aim at spiritual promotion in the island flock to him; and his palace is surrounded by the establishments in which the youth destined to clerical offices are trained and educated. Hence, whatever relates to the Bishop is the chief concern of the inhabitants. They trouble themselves but little about what is going on in Europe, and even in Spain itself, and for the most part know but little about it. With them, the battle of Waterloo, even at the moment of receiving the first intelligence, had but a kind of historical interest, such as a battle, that decided the fate of the sovereignty of China or Bucharest over the plains of Asia, would have among ourselves.

The Bishop, Don Nicholas de Berdugo, received us in a friendly manner, and assured us of his substantial protection during our stay on the island. He sent his body physician Don Juan Bandini Gatti along with us, and, in him, furnished us with one of the most agreeable and instructive companions we could have wished. Dr Bandini, many years ago, in confidential intimacy with the very deserving Viera, had followed him as successor. His very judicious collections comprehended every thing on the island that was useful or interesting; and his manuscripts contained many remarkable observations upon numerous natural phenomena. Such knowledge was not confined to himself alone. We saw, with surprise, the young people of the seminary, directed by his influence and example, disputing upon subjects which we could not readily expect to find treated upon here; namely, the sleep, motion, and irritability of plants, of nurseries, and their advantage to the island, the influence of light and heat on the life and growth of vegetation. To all these things the Bishop gives his most zealous support.

On the 5th July, after having seen many rocks and valleys in the neighbourhood of the town, we hastened towards the dry parched sea-coast at Telde, a place that, like many others clothed with verdure, and abounding in palms, resembles an *oase* in tuffa. From this, we ascended the valley to Val Sequillo, still nearer the rocks of the interior. Here the country expands into a plain, and is covered with fruitful corn-fields. Water tumbles down the defiles, and when it gushes out, is delightfully enclosed with gourds and large colocasia leaves. Above the village stands a high rock, Roque del Sancillo, in the cliffs of which Smith discovered a new and very beautiful Sempervivum, (S. cæspitosum), which is now an ornament of every botanical garden in Europe, and of many private gardens. From this we ascended to the greatest height, Pico del Pozo de las Nieves, 5842 feet high: but our expectation of surveying the whole island was not fulfilled. During the whole day, the atmosphere was loaded with very dense vapour, which was not aqueous, but which, on all sides, obstructed our vision. The nearest valleys were scarcely discernible, and the sea-coast was perfectly invisible. The summit itself was not much involved. It is a plain covered with small stones, with no plants upon it. The beautiful Peucedanum aureum is the only plant upon the height to reward the botanist for the labour of climbing. On the contrary, S. Matheo, which commenced near the top, welcomed us in a very pleasing and friendly manner. For, in the midst of rushing waters, there are tall broad leaved chesnut and nut trees; and fruit trees of every kind are scattered over the green fields in great abundance. In Lecheguillo, the first place in the valley, and yet 3103 feet high, the inhabitants met us in a very friendly manner. Their habitations, surrounded with large galleries, and lying scattered on the declivity, had quite a pastoral appearance, and the houses round the church of S. Matheo were charmingly situated. We then come to the vineyards and the villas of the inhabitants of Palmas. The Vega de Sta Brigita, down to the scorching and violent heat of the inferior region, permits the growth of nothing but prickly small leaved shrubs.

(To be continued.)

Observations on the Arctic Sea and Ice, and the intended Expedition of Captain Parry to the North Pole. By Thomas Latta, M. D. (Communicated by the Author.)

In earlier ages, when science was in its infancy, very erroneous opinions were entertained, in regard to the nature of our globe. It is scarce 300 years since its spherical shape was acknowledged; and, prior to that period, a very considerable proportion of it was deemed uninhabitable; for, those countries situated under the Line, were considered an arid waste, burnt up by the fiery beams of a tropical sun, whilst it was supposed that far to the north lay regions of eternal frost, entirely destitute of organization. But these errors have disappeared with the progress of science, and the bright career of discovery has made us acquainted with almost the whole of the terraqueous globe. The only regions which, from their physical peculiarities, have hitherto resisted our attempts, are those immediately surrounding the Poles; for the Antarctic Regions, notwithstanding the exertions of Cook, Billinghausen and Weddell, are but little known; and the Arctic Regions, although the investigation of their nature has engaged the enterprise of Europe for a long series of years, have not been explored beyond the 80° of latitude. Already upwards of forty expeditions have failed in exploring a North-West Passage into the Pacific; and the last navigator, after repeated failures, has, for the present, relinquished the enterprise, although convinced of the existence of the disputed passage. Comparatively few attempts have been made to sail directly towards the Pole, or through the North Eastern Seas to India; and the expeditions in these directions have been so inefficient, that an almost untrodden field of discovery remains for the mariner.

The chief obstacle to the progress of discovery in the Frigid Zone, is the vast accumulation of ice which floats on the surface of the ocean, rendering all the efforts of navigation abortive. To overcome this opposition, a novel method has been suggested, the merits of which are to be tried during the approaching summer, by a party under the command of Captain Parry, in an attempt to reach the North Pole. They are to be conveyed to the north western extremity of Spitzbergen, in the Hecla, and from thence are to set out in boats made of light materials, so constructed that they may be converted into sledges, thus suited to the nature of the tract, whether it be water or ice. With these slender means, our brave navigators will endeavour to unfold the secrets of the Pole. The skill and daring they have already shewn, prove that they are worthy of the confidence reposed in them. Whilst they were employed on their former hazardous voyages, we felt solicitous about their welfare, and were not sanguine of success; we cannot but harbour unpropitious auguries, when we glance at the scene of their future toils, which, though holding out a fairer prospect of success, is nevertheless pregnant with peril. The enterprise is so striking in its nature, that we, who have personally visited the

Arctic Regions, presume to lay before the public at this time a few observations.

In these it is intended, *first*, to delineate the general effects of the different seasons, on the Arctic Sea; and, from the phenomena which occur in those parts, which are familiar to us, to form a few conjectures in regard to what may be the condition of the unexplored regions, north and east from Spitzbergen; and, *secondly*, To consider the possibility of exploring these.

Probable State of the Globe at the Pole.—It may be premised, that an erroneous opinion has long been cherished,—that the vicinity of land is necessary, ere ice can be formed on the sea, an opinion which seems still to bias the minds of a few, notwithstanding the incontrovertible evidence of men of science, who have spent almost half their lives in the inhospitable regions of the polar seas. On this groundless opinion some ingenious speculations have been framed, the purport of which was, to demonstrate, that, if the Hyperborean Regions are covered with water, that this sea must be navigable; for, there being no sheltering shores to aid the formation of ice, it must be but sparingly produced, and easily dissipated. by the warmth of a nightless summer. Although we are satisfied that such a conclusion is erroneous, it cannot be denied that windward islands, mural coasts, or sheltering promontories, may facilitate the freezing process; yet undoubtedly the wide ocean, with all its disadvantages, may, under the rigours of a long winter, receive its firm covering of ice. No doubt, preparation for such an event is requisite, for the effects of many arctic winters would be required to reduce the temperature of such an immense body of water sufficiently, to admit of its surface being frozen; an event which, if the present motions in the ocean existed from the beginning, must have been much procrastinated, as the perpetual efflux of cold water from the north is replaced by streams of higher temperature from southern seas. It is probable, however, that the extent of these interchanges are much circumscribed, and that the water of the Pole is beyond their limits,—a conclusion authorised by their apparent course and magnitude: for, the water which runs through Behring's Strait into the Frozen Ocean, and that which constitutes the northern branch of the Gulph Stream, which passes towards Greenland, along the coast of Norway, together with the produce of rivers, and melting ice and snow, replaces what is carried off by the broad stream which flows westward through the Siberian Sea, by the coast of Old Greenland, into the Atlantic, and, by the current which runs southward, through Davis' Straits. Now, if we find that the surface of the sea, in the course of these outflowings, is annually frozen over, surely in circumpolar latitude it must be more completely so; for, in the former, the temperature must be influenced by the water which comes from warmer seas; whereas the latter is far beyond its reach. Then, if it is the case that there are no currents of importance, either coming from the Pole, or flowing towards it, the whole of this currentless sea, if sea it is, must be covered with immoveable ice.

The influence of the various agents which every season destroy the ice in the accessible regions of the Greenland Seas, is very widely extended; but far towards the north, it may be so inconsiderable, that the ice may remain solid, thus precluding the possibility of reaching the Pole through a navigable sea.

Summer and winter are the only seasons that occur in Greenland. The former possesses none of those charms so congenial to sense in happier climes; and the latter is clad in tenfold terrors. At the close of the year the frost, which a summer solstice scarce can soften, sets in with terrible violence, and scatters thick the icy particles on the face of the deep, which counteract the efforts of the rudest tempest, smooth down the billows, and prepare a quiet surface for their coalescence. A continued augmentation takes place, scale with scale coheres; mass becomes glued to mass; and field to field: till the dark waters of the ocean are buried under an interminable wilderness, stretching from the dark regions of the north far to the south, till arrested by a latitude which, though almost too cold for the habitation of man, is too mild for the formation of these gelid productions.

The line of arrestment extends from the coast of Labrador, by Cape Farewell and Iceland, and after retiring to form a deep bay, about the 7° or 8° of eastern longitude, it stretches across to Nova Zembla, and is much modified by temperature and prevailing winds.

On the approach of spring the seaward limits of this mighty frozen plain are broken up, and the fragments are gradually dissolved, as they are carried by the currents down the Atlantic. Thousands of square leagues disappear in the course of a few weeks, a free course is opened to the fishermen, even to the northern shores of Spitzbergen; and, as the season advances, the same process evidently goes on to a certain extent, in the unexplored North Eastern Seas. Their fields, too, are destroyed, and the ruins, borne past Nova Zembla, disappear in their drift to the southward.

Thus, the reign of winter in these forlorn regions is relaxed by the returning sun, and the slumbering deep roused by the storm, rends in fragments the frozen loads, dashes mass on mass, and hurls the whole to ruin. On the shores of Spitzbergen a thawing temperature prevails during the summer, and the flowerets on the warm bank, disburdened of its snowy cover, flourish for a time, whilst the inland country, buried under the snow of ages, is scarcely visited by a thawing beam.

It is by reasoning on the causes of this mighty havoc, and contemplating the effects produced by them, that conjectures on the state of the untraversed seas, north and east from Spitzbergen, have been conceived.

The chief agents in destroying the ice seem to be, *the Sun's rays*, *the tempest*, *the currents*, *attrition*, and *the wind-lipper*.

Action of the Sun's Rays.—The *sun's rays* exert a double influence; 1*st*, By *expansion*: and, 2*dly*, By *solution*.

The effects of *expansion* are of the first magnitude. But for this, the ice of the north, having acquired its usual thickness, might bid defiance to the efforts of every other agent, and remain almost immoveably the same. The storm may break up the detached fields; attrition may comminute their fragments, the wind-lipper may wash them out of existence: or the currents may carry them into other seas; but until the frozen continent is broken up, and reduced to fields, all these can make but little impression.

Authors have published accounts of the various forms which the ice of Greenland assumes, and have theorized on their mode of formation; but concerning the detachment of fields, they have all been silent, so far as I know. This very important process is accomplished, I apprehend, in the following way. It is a well known fact, that fresh water, at the temperature of $39\frac{1}{2}°$, is specifically heaviest; and that it possesses the strange peculiarity of becoming lighter by the farther reduction of temperature; and at that point where it passes into ice, its expansibility, if we except its vaporous state, is at its maximum. The same law, a little modified, regulates the freezing of salt water; the points of greatest density and consolidation being probably a little lower than in fresh water.

When water is completely frozen, it, like other bodies, contracts by a continued abstraction of caloric. Now, if a body of ice, twenty or thirty feet thick, floats in water at the freezing point, the under surface of that ice will be nearly of the same temperature as the water, and the upper surface may correspond with the temperature of the superjacent atmosphere, which, during winter, in high latitudes, depresses the thermometer to 40° or 50° below zero. Such a difference of temperature must produce a very great difference in specific gravity, and the upper surface must be much more contracted than the under; but as the cold increased progressively, it might happen that no evident effect would be produced by this great difference, as the accumulating mass accommodated itself to the gradual change: but as soon as the summer returns, the temperature of the air is speedily raised, communicating its caloric to the surface of the ice, which begins to expand, and ultimately exerts energy sufficient to overcome the cohesive force of the frozen particles, and a rent is the consequence; which, as soon as it has commenced, runs unrestrained in all directions; and the advancing summer, modifying the winter's sway, prevents reunion, till the attachment is set loose by the currents, or drifted off by the winds.

The effects originating in the influence of the vicissitudes of temperature in tearing asunder the ice, are awfully illustrated by the aspect of the polar glaciers, which are found in the valleys on shore *. The ice being upwards of 200 feet thick, the hideous chasm yawns horribly to the very bottom, from the brink of which the beholder turns away with indescribable feelings of horror.

* See Icebergs, Phil. Journ. 1819.

The second effect produced on the ice by the solar rays is *solution*. When the sun has withdrawn his influence, and the long winter night has spread its shades over the regions of the north, all the dark domain is fettered in tenfold frost,—all is silent and dead,—the torpid bear doses in his icy cave,—and the stunted productions of the soil, shrivelled by the cold, shrink into the earth beneath the cover of snow. Ocean is no more; and, except when the changing moon agitates the keen ether, the forlorn scene is never ruffled by the gale. The thermometer, which, during summer, ranged some ten degrees above the freezing point, now sinks to 50° below zero; and half a moon of such intensity produces enough of ice to replace the whole dissolved by the sun's rays. Indeed, that amounts to little; as a thawing temperature is felt only at intervals during a month or two in summer, and can scarce effect the solution of the snow covering the ice-field.

The feeble action of the sun in thawing the polar ice, is abundantly illustrated by the permanency of those ice-shoals which have so long shut up the followers of Eric on the eastern shores of Greenland,—by the annual augmentation of the polar glaciers, reared in ravines on the shores of Spitzbergen, Beerenberg, and even the more southern coasts of Iceland and Cape Farewell.

The presence of these frigid accumulations in so low a latitude, is apt to bias the judgment, leading to an inaccurate estimate of the polar climate; for if, during summer, in a latitude so low as 60°, we find land surrounded by a frozen sea, hills perpetually covered with snow, and valleys filled with solid ice, what picture can our imagination form of those regions 600 leagues farther north? None other surely, than that they are in all probability ever in a frozen state.

If, however, during a summer noon, we visit some sheltered bay in Spitzbergen, whilst, through an unclouded atmosphere, shine the bright beams of a never-setting sun, where the calm ether leaves no impress on the placid main, gently murmuring along the shore, from which rises the earthy slope covered with verdure, interspersed with flowers, watered by the streamlet from the mountain rock, which echoes the uncouth screams of myriads of the feathered tribes which annually nestle there,

—amidst a scene like this (and many such there are), heedless of the frowns of huge adjacent icebergs, which diffuse winter around, and often fill the atmosphere with clouds, despite the conviction that, in inland scenes, valleys are filled, and hills buried, with never-melting snow, we would be disposed to esteem the climate mild, and extend the same character to regions still more remote. The impression formed by such Elysian mildness may have divested the ingenious Mr Scoresby of his accustomed acuteness, whilst treating of the "Climate of Spitzbergen," in his "Account of the Arctic Regions;" for, biassed by the indications of the thermometer, he reasons himself into the supposition, that the climate, during summer, is more temperate than even in Scotland, and gives to the circle of perpetual congelation, an altitude of 7791 feet,—a statement contradicted by facts.

2. *Action of Tempests.*—Having noticed the effects of the sun's direct influence on the ice, I shall next make a few remarks on the action of the *tempest.* Scarce has the sun risen over the polar horizon, and shed his oblique rays on the hoary regions of the north, than the tempest begins to raise up the billows of the ocean, whose heavings rend the detached ice into fragments, and the west setting current carries off the ruins to be dissolved in a lower latitude.

This process often exhibits a scene truly awful. The mass of thousands of millions of tons, whose farthest verge rounds off the horizon, floats strong and deep, darkening the abyss, and filling the atmosphere with its effulgence, till the storm heaves up the deep. At first, the waves ineffectually dash along the icy barrier, mingling their spray with the drift, but gathering strength, sea rolls after sea; the ice-field labours on its undulating bed; and the reiterated thundering crash proclaims its disruption; and, mixed with the foam, mass reels on mass till the wreck is complete, and the ruins spread along the main.

3. *Action of Currents.*—The *current* is a powerful agent in destroying the ice in the North Sea, and is of such importance that, if it did not exert its influence, all the surface of the ocean, within the Frigid Zone, would be crowded with the separated pieces. The currents are rendered very conspicuous in the Greenland Seas, by the drift of the floating substances. They may be divided into two kinds, *accidental* and *permanent.* Ac-

cidental currents are partial motions in the water, occasioned by the action of the winds, or the movement of the larger bodies of ice. Thus when fields and icebergs are driven from the sea into deep bays, by strong gales, the dammed up water is sometimes forced many feet above its usual level. Such a phenomenon has been noticed by many navigators. I myself saw decided testimony of such, when on shore at Spitzbergen, near Cross Bay, in the vicinity of the Seven Icebergs. All the low land in that neighbourhood, lying behind Fair Foreland, from its local situation, must be much exposed to inundation. The flat on which I landed, was, in general, ten or fourteen feet above the level of the sea, and some leagues in circumference. All this bore testimony of having been recently covered by the sea, from the pools of salt water, and the remnants of salt water ice, from the drift timber, and the bones of marine animals, which had been bleaching on the beach. Nearly a mile from the shore, I also found a chest made of rough deals, lying high among the gravel, which appeared to have been lashed by the waves, and considerably chafed. On opening it, I found it to contain a human skeleton, which had, in all probability, been swept from its superficial grave by the same cause which had transported it thither. On the north of Spitzbergen, Captain Phipps found large fir-trees lying at a distance from the shore, 16 or 18 feet above the level of the sea. And Leonin, who was sent to ascertain the nature of this island by the Grand Marshals of Denmark, found a ship's mizen, about a league inland. The tide there does not rise above four feet.

The *permanent current* is that which is of most consequence in opening the sea. This, coming through Behring's Straits, doubles Skelatskoi Noss; runs along the north of Asia, by Nova Zembla; and, meeting a feeble remnant of the Gulph Stream, which had crept BY the Islands of Scotland, and along the Norwegian coast *, flows towards Spitzbergen; and, having passed

* Reasoning on the existence of the North-east Passage, some have laid much stress on the nature and condition of the drift timber found in the North Sea, fancying that it cannot reach Greenland but through the Frozen Ocean; but if we reflect on the direction of the northern branch of the Gulph Stream, we can, without having recourse to unsatisfactory reasoning, account for the mahogany of Honduras being found on the coast of Greenland. In like manner, the worm-eaten timber may be conveyed thither, although such a condi-

that island, sends off a branch towards the north. It then trends to the southward, carrying all the detached ice, throughout its course, in that direction. The quantity thus annually disposed of, has been estimated by Mr Scoresby at 20,000 square leagues, which he notices is three-fourths greater than the area of the sea accessible to the whale-fisher. The opportunity of observation afforded this intelligent gentleman, entitles his remarks to every respect. I do not think he has exaggerated in this calculation. Nay, some are of opinion that if we were possessed of means to ascertain the precise amount, it would be found considerably to exceed his estimate. But though the area of the drifting ice much exceeds that of the fishing ground, I would not consider all the surplus as the produce of unexplored regions. Such an assertion might indeed be consistent, if the sea frequented by the whale-hunter was only once frozen during the year, and if this annual coat alone were broken up, and drifted away; but we must recollect that, by November, the water again begins to freeze, and that the early produce,

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tion does not testify its being a tropical production; for, lately examining the bottom of a fishing sloop which had been entirely confined to the banks of Shetland, I found the Teredo navalis rioting in a more fearful extent than I ever observed in the uncoppered planks of vessels which had long traded in the Mediterranean and West Indian Seas. Some specimens of this worm were a foot long, and the largest of their canals were seven-eighths of an inch in diameter.

This northern branch is also the cause of the Whale-fishers' Bight, which is a very deep bay in the ice, found during the early part of the season, extending northward towards Spitzbergen, between the meridian of London and 12° or 13° of eastern longitude. There the sea does not freeze so readily, as the temperature of the water is higher than the adjoining sea. It likewise, with the currents coming from the north, accounts for another anomaly, which, even in our day, has been considered unaccountable. M. de Capel Brook wondered why no ice was formed in the harbour of Hammerfest, in Lat. 70° N. though the temperature of the air was 13° below 0. Others have esteemed it an unaccountable circumstance, that the coast of Newfoundland should be strewed with ice, and the sheltered places on the coast frozen up, whilst the shores of Iceland, and even those of Norway, remained free. Now, it is easily to be accounted for, if we bear in mind the course of the currents. The remnant of the Gulph Stream is continually passing from Iceland along the coast of Norway, on which the intensity of winter has no influence: and, if the currents from Greenland carry not only a great body of cold water, but much frozen ice over to Newfoundland, the climate and temperature of the sea must be much colder than on similar latitudes on the opposite side of the Atlantic.

from its fragility, must be the sport of the waves and the currents; and, as one portion drifts away, another, formed on the same spot, succeeds. Similar revolutions take place after the breaking up of the firmer produce of winter, and continue even till late in May: hence masses of ice are met with, of various strength and magnitude, some being only a foot or two thick, which, formed by the spring frosts, are only seen in lower latitudes, during the early months; whilst others are fathoms thick, forming immense fields, which have been the produce of many winters, in more remote regions. Now, if such revolutions take place, much more ice than is sufficient to cover the Greenland Seas must be annually formed on their surface; and no doubt this is the case, demonstrated by the difference of latitude which exists in the winter limits of the northern ice; for the current, coming down through the east, carries along its course all the new produce; and, whilst the sea of Nova Zembla can scarce supply the waste, an accumulation of foreign ice takes place around Jan Mayen Island, and Cape Farewell, where it covers the sea as low as latitude 58°; whilst, towards Nova Zembla, all remains open as high as 73° or 74°.

4. *Action of Attrition.*—Attrition has been enumerated among the ice-destroying agents in the north; and, although Captain King, who continued Cook's narrative, esteems it as a principal one in Behring's Straits, it seems to be an inefficient one in Greenland. No doubt, during the gale, the heaving to and from may wedge each adjacent piece; and the collision of icebergs may overthrow their frozen battlements; but change of position alone is effected.

5. *Action of the Wind-lipper.*—The *lipper*, too, may act its part, and appears to destroy much ice in lower latitudes; but, far to the north, where the temperature of the water is low, its effects are trivial. Its little splashings undermine the margin of each piece, giving rise to many a fantastic form. In miniature we often see cities, towers, temples, trees, villages, and many lively representations of animated nature. This destroyer of the ice, insignificant as it may appear, is the source of annoyance to the mariner; for, as the superjacent portion alone is worked away, that which lies under retains its original extent; and, stretching horizontally, forms what whalers call *tongues*, which, from

their depth, extent, sharpness, and hardness, often injures the bottom of his passing bark.

The causes above enumerated are those which annually destroy the ice in the Frozen Ocean. The chief of them are widely diffused; and, if their effects are such as I have noticed, I think we are furnished with matter sufficient to enable us to form reasonable conjectures concerning the state of those seas yet unexplored, which are to become the scene of our adventurers' investigation during the approaching summer.

According to the above sketch, we have the ice broken up by expansion and the tempest, and carried away by the currents, &c.

If what has been said concerning the effects of expansion is correct,—if the dilating influence of the warmth of spring rends the ice in pieces, then the whole of it, independent of every other cause, will be traversed with fissures forming, by their circuitous routes, detached fields, which will be floated abroad by the currents and winds, and broken up by the waves, as soon as the sea to the leaward is open.

The opening of the sea is a progressive process. Early in spring the devastation commences on the great margin extending from Labrador eastward, and often, in April, reaches the north of Spitzbergen, and clears the western shores of Nova Zembla. At first the process proceeds with rapidity; for the young ice is easily broken up; and, during the first months, the storms are most frequent and protracted: then no fields are met with, but *sludge*, *floes*, *packs*, and *streams*, are scattered over the face of the sea. Whales, about this period, are generally met with in greatest abundance; for the interior ice, continuing close, forces them to remain where they can reach the surface for respiration. As the season advances, the atmosphere becomes more settled, and the stronger northern ice opposes more resistance to its effects; and now the current is the most active agent; hence *fields* become more numerous, which are seldom met with in groups, except considerably to the eastward, where they are largest.

As these large plains are drifted off from the main body, and followed by others, it is probable that, throughout the track of the current, the ice, being divided by fissures, may be more or less in motion; so that, by August and September, the greatest progress may be made in these seas, though such navigation must be extremely hazardous, as it can be conducted only through lanes and open spaces, where the mariner would be constantly exposed to be nipped among the closing fields.

To determine how far the Northern Ocean is navigable can be ascertained only by repeated investigation. The course of the currents, and the few facts we possess, seem to indicate that the farther we proceed the sea will be the more crowded, till, around the pole, all remains firm and fast. All the circumjacent ice is certainly yearly in motion, which, even in the opinion of Parry, may be sometimes navigable. In this he is supported not only by his own observations, but by the evidence of other adventurers. Whilst Heemskerke lay grounded on the ice-piled coast of Nova Zembla, when the season was far advanced, he was shagreened with the view of an open sea extending eastward as far as the eye could reach, whilst he was pushed on shore by the masses which skirted the land. The expedition fitted out by the merchants of Amsterdam, traversed an open sea 100 leagues east from Nova Zembla, in the 80th degree of northern latitude. Baron Wrangel, in a sledge, travelled on the northern ice for forty days, during which he reached a sea free from impediment; but ere he reached the coast of Siberia the ice had given way; and, after drifting for some time, he was fortunately driven on shore. Though the expedition conducted by Cook encountered an impassable barrier of ice, uniting Asia with America, preventing all access to the Northern Ocean, through Behring's Straits; yet the circumstances of this ill managed attempt render the result of less importance. The voyage of Deshnef shews that such is not always the case; for he sailed from the Kovyma; and, having doubled Skelatskoi Noss, late in October, amidst storms and tempests, was wrecked south of the Anadir in Kamtschatka; and the whole of the shores of the Arctic Ocean, bounding the north of Europe and Asia, has been explored, except that portion surrounding Cape Ceverovostochni.

If it were necessary, the evidence of other circumstances could be adduced, indicating that the ice is broken up, such as the history of the whale, the presence of drift-timber on islands of the Siberian Sea, &c., but what has been already noticed is sufficient for the present purpose.

From what has been said, it would appear that the breaking up of the ice commences in the Northern Atlantic in February or March, and that all lying to the eastward progressively follows. Much disappears every season, but the season is far advanced before the eastern ice joins the train; and long ere that has reached the Greenland seas, it is arrested by returning winter, so that leaving out the interception of land, and the impediment of adverse winds, the ice generated on the north-east of Asia may see many a summer before it is laved by the sea of Spitzbergen; indeed the disposition to move reaches the longitude of the Lena in August, and scarcely clears Skelatskoi Noss by October. Now, it is very probable that it may also extend to high northern latitudes, from the ancient fields that are sometimes met with. The farther from their source the more scattered will these masses be, and consequently the fréer the navigation; but remote regions become more and more hampered, till all becomes fixed as terra firma.

Much light may be thrown on the nature of this country by the projected expedition, which no doubt will be equipped with all due deliberation, on that plan which past experience suggests. It is to consist of two sledges, capable of containing twelve men each, built of light materials, and of such a construction, that if water comes in the tract, they may be used as boats. These are to be provisioned for three months, which, with short stages, will allow the party to travel from Spitzbergen to the Pole, and back. In dragging these vehicles along the ice, dogs or rein-deer are to be used, which may be fed, partly on fish caught by the way, and, in case of scarcity, may serve for provision.

This plan is a modification of that proposed some years ago in the *Wernerian Society*, by Mr William Scoresby *junior* *, who, during many voyages to the Spitzbergen sea, had ample opportunities for making observations on the peculiarities of the Greenland ice. He, like every judicious theorist who indulges his fancy on the probabilities of executing his project, first conceives the nature of the tract over which he has to pass,

* The very interesting details of Mr Scoresby's plan are given in the 2d volume of the Memoirs of the Wernerian Natural History Socety, p. 325. *et seq.*

and then accommodates his means to its imagined peculiarities, and provides for every anticipated exigency. But as we are entirely ignorant of the real constitution of those parts immediately surrounding the Pole, the plan chalked out by the most sagacious, may, in very many points, prove inapplicable. So the first adventurer must necessarily be exposed to much peril, from unforeseen difficulties, whilst he paves the way for his successors.

Though the means adopted by Captain Parry possess many recommendations, yet such might not be impaired by some little modifications. If it is probable that the Pole is perpetually surrounded with immoveable ice, the following method seems to possess all the advantages of that which Captain Parry is to put in practice, and may not be entirely worthless, if it is capable of more extensive application.

Instead of *two*, let the party be provided with *three sledges*, convertible into boats, capable of carrying only *five men* each, suitably provisioned; let these proceed northward from the place of rendezvous on the north of Spitzbergen. On the meridian of which it is probable the boundaries of the stationary ice may not be far distant, for the destructive action of the current, which, in more eastern seas, makes such ample breaches, is here, as in Behring's Straits, of little consequence, as it flows against the frozen barrier, by which the action of those agents, which would otherwise destroy the ice, is restrained.

Having reached the 84th or 85th degree of northern latitude, if the ice seems old, continuous and stationary, they could calculate on its being similar all the way northward. Then with safety *one sledge* might be left in charge of *three men*, with suitable orders for their future guidance. In establishing such a position, land would be of much importance, not only in so far as the comfort of these individuals was concerned, but the danger of any movement in the ice changing their longitude would be avoided,—a difference which, if the party were left on ice not stationary, would require to be rectified by daily observation, lest they being drifted out of the way, should be missed by their associates on their return. Provision should be left sufficient for these, and to serve the whole party during their return from that latitude to Spitzbergen. The expedition might then proceed till they reached the latitude at 87°, where, under similar circumstances, they might leave a *second sledge* in charge of *four men*, with as much provision as would serve these and the returning party, till they reached the first establishment. The *third sledge* could be left at the 89th degree, with *five men*, whilst the *three* remaining with their hand-sledges, blankets, and provisions, disburdened of every other incumbrance, might trudge on to the Pole.

In such a journey, the assistance of dogs or rein-deer would be a very sensible advantage. These might be taken even as far as the second establishment, and if land fortunately lies in such a quarter, they might be kept to assist the returning expedition, otherwise the want of provision would render it necessary to destroy them, for it is not very probable that many fish can be caught there for food to them.

The advantages of such arrangements, if they could be effected, would be very sensibly felt; for fresh assistance would be derived from the lengthened journey. The first sledge, with a load of provision, is left in charge of only three men, consequently not only is the burden of the other two lightened, but two additional hands are added to drag these along. A diminution of burden takes place also at the second establishment, when four men are left in charge. The remaining eight with the last sledge proceed to take up the position just sixty miles from the Pole: three of the company travel the rest, with scarce any cumbrance at all. Thus the burden diminishes whilst the ability to bear it increases; and, as the party returned, they would more sensibly feel the benefit of such management, as each detachment, refreshed and strengthened, would be in good condition to yield their much-needed help to their weary associates.

Further, if the unaccustomed toil should unfortunately disable any one, rest might be obtained till health was re-established, and the expedition relieved of any incumbrance which might frustrate all their endeavours.

But, perhaps, the idea of a firm continent of ice is chimerical. Mayhap there is not an island, not even a rock, above water, between Spitzbergen and the Pole: well, but most likely there are such things, and if there are none, having such provisions in store, the views of the expedition can be prosecuted as easily with them as without them. The only untoward circumstance is, that Parry would be confined to the same track in returning, by which means his sphere of observation would be more contracted; but then the chance of encountering difficulties unprepared for, on his road homeward, might involve him and his party in ruin.

If the Pole is surrounded by ancient ice, may it not, like the polar glaciers, be fissured all over, much to the inconvenience of the expedition?

Far to the north, among these icy realms, the still atmosphere may enjoy perpetual serenity, a matter of the first magnitude in promoting the interests of this undertaking; for though, in the latitude of Spitzbergen, during June, July, and August, the air is so often obscured by dense raw fogs, yet, in the interior ice it is always clear; if it were otherwise, our adventurers would be exposed to the most imminent peril; for though recent improvements in the compass exclude the influence of such a state of the air on its movements, yet continued obscurity would not only cover the sun from their view, but conceal all the circumjacent country, rendering their observations very unsatisfactory.

Hitherto the general opinion has been very inimical to undertakings of this nature, and all northern voyages have been condemned, on account of the impracticability of reaching the object of pursuit, and the inutility of such, even though it were attained. But the opinions of *cui bono* philosophers are unworthy of consideration. We feel convinced that all these expeditions have contributed much to our knowledge of the globe; and we hesitate not a moment in affirming, that every one having a right feeling of what constitutes the character of a great nation like ours, will agree with us, that the bold and daring enterprize in which Captain Parry is soon to embark, is worthy the marine of Great Britain, honourable to the science of the country, and a proof, if any were wanted, of the liberal and enlightened views of our Government. Though the enterprize of Parry may not enable us to solve the grand geographical problem which has for so long a period engaged the attention of mankind,—though the secrets of the Pole may ever remain unrevealed,—yet the interests of science, and the not less important one of the whale-fishery, now so impoverished, may be much promoted.

Many alterations have taken place in the physical distribution of whales, originating probably in the persecution with which they have been so vigorously followed during the last 200 years. Some think that the present scarcity is caused by the numbers captured having over-reached the breeding of that animal; but the perspicuous view we have in Mr Scoresby's chronological account of the whale-fishery, would rather suggest the idea that captures are now more rare, on account of the scattered haunts to which persecution has driven it. About 200 years ago they were taken in abundance on the shores and in the bays of Jan Mayen Island; now even a straggler is scarce ever seen in that situation. As soon as they were expelled from thence, they abounded in the bays of Spitzbergen, where they were slain in vast numbers, till, alarmed by their foes, they fled, and are now scattered abroad among the ice; and their former haunts, which have been relinquished for a hundred years, are now occupied only by the tremendous razor-back and ugly sea-horse.

The sea adjoining Spitzbergen is the usual resort of what are called the Greenland fishermen. Their fortune depends on their success during the two early months of the voyage, for whales all disappear by the middle of June. It is, I think, not improbable that this migration may happen as soon as the ice is open in more eastern seas, where a successful fishery might be prosecuted during the late months, if these remote regions can be safely navigated: a point of much importance, the practicability of which will be ascertained during the present voyage; for the Hecla being stationed at Cloven Cliff to wait the return of Captain Parry and his party, the rest of the crew are to be occupied with the boats in surveying the eastern shores of Spitzbergen, concerning which all our knowledge is derived from the Dutch, whose accounts of other parts in the Frozen Ocean have been found dangerously erroneous.

Boats, or very small vessels, appear best adapted for examining the sea east from Spitzbergen, being best qualified for navigating the narrows among ice-fields; and, from their portability, are not only less liable to besetment, but may escape the ruin in which they would otherwise be involved, from the approximation of large masses of ice. In the sea south from Spitzbergen, light boats would be useless; for it being strewed with the wreck of fields, which, from its various dispositions, acquires the name of *packs*, *streams*, or *floes*, the process of *boring* is requisite, which can be accomplished only with heavy vessels. But, in high eastern latitudes, such a process may be seldom required; and so far as these little vessels can proceed, they may traverse with tolerable freedom, rendering them the fittest means of seeking the highest northern latitude, or the greatest eastern longitude.

General Observations on the former and present Geological Condition of the Countries discovered by Captains Parry and Ross. By Professor JAMESON *.

THE observations made during the four Arctic Expeditions, viz. that under Captain Ross, and the three under Captain Parry, afford the following general facts and inferences:

1. That the regions explored abound in primitive and transition rocks; that, although the secondary rocks occupy considerable tracts, still their extent is more limited than that of the older formations; that the alluvial deposites are not extensive; that true or modern volcanic rocks were nowhere met with; and that the only traces of the tertiary strata were found in the sandstones and clays connected with the secondary traps of Baffin's Bay.

2. That the primitive and transition islands were, in all probability, at one time connected together, and formed a continuous mass with the continental parts of America; and that, in the plains and hollows of this land were deposited the secondary limestones, sandstones, gypsum, and coal, and upon these again the tertiary rocks.

3. That, after the deposition of these secondary and tertiary rocks, the land appears to have been broken up, and reduced either suddenly or by degrees, or partly by sudden and violent action, and partly by the long continued agency of the atmo-

* From Parry's Third Voyage.

sphere and the ocean, into its present insular and peninsular form; and that, consequently, the secondary and tertiary formations were formerly, in those regions, more extensively distributed than they are at present.

4. That, previous to the deposition of the coal-formation, as that of Melville Island, the transition and primitive hills and plains supported a rich and luxuriant vegetation, principally of cryptogamous plants, especially the ferns, the prototypes of which are now met with only in the tropical regions of the earth. The fossil corals of the secondary limestones also intimate, that before, during, and after, the deposition of the coal-formation, the waters of the ocean were so constituted as to support polyparia, closely resembling those of the present equatorial seas.

5. That, previous to, and during, the deposition of the tertiary strata, these now frozen regions supported forests of dicotyledonous plants, as is shewn by the fossil dicotyledonous woods met with in connection with these strata in Baffin's Bay, and by the fossil wood of Melville Island, Cape York, and Byam Martin Island.

6. That the boulders or rolled blocks met with in different quarters, and in tracts distant from their original localities, afford evidence of the passage of water across them, and at a period subsequent to the deposition of the newest solid strata, namely, those of the tertiary class.

7. That nowhere are there any discoverable traces of the agency of modern volcanoes; and we may add, that, in the Arctic Regions, the only appearances of this kind are those in Jan Mayen's Island, described by Scoresby.

8. That the only intimations of older volcanic action are those afforded by the presence of secondary trap-rocks, such as basalt, greenstone, trap-tuffa, and amygdaloid.

9. That the black bituminous coal, the coal of the oldest coal-formation, which some speculators maintain to be confined to the more temperate and warmer regions of the earth, is now proved, by its discovery in Melville Island, far to the west, and in Jameson's Land, far to the east, in Old Greenland, to form an interesting and important feature in the geognostical constitution of arctic countries.

10. That the red sandstone of Possession Bay, &c. renders it probable that rock-salt may occur in that quarter.

11. That, although no new metalliferous compounds have occurred to gratify the curiosity of the mineralogist, yet the regions explored by Captain Parry have afforded various interesting and highly useful ones, such as octahedral or magnetic iron-ore, rhomboidal or red iron-ore, prismatic or brown iron-ore, and prismatic chrome-ore, or chromate of iron; also the common ore of copper, or copper pyrites; molybdena glance, or sulphuret of molybdena; ore of titanium; and that interesting and valuable mineral, graphite or black lead.

12. That the gems, the most valued and most beautiful of mineral substances, are not wanting in the Arctic Regions visited by the Expeditions, is proved by the great abundance of the precious garnet, which we doubt not will be found, on more particular examination of the primitive rocks, to present all the beautiful colours and elegant forms for which it is so much admired. Rock-crystal, another of the gems, was met with, and also beryl and zircon.

13. That these newly-discovered lands exhibit the same general geognostical arrangements as occur in all other extensive tracts of country hitherto examined by the naturalist; a fact which strengthens that opinion which maintains that the grand features of nature, in the mineral kingdom, are every where similar, and, consequently, that the same general agencies must have prevailed generally during the formation of the solid mass of the earth.

14. Lastly, That the apparent irregularities which, at first sight, present themselves to our attention, in the grand arrangements in the mineral kingdom, are the offspring of our own feeble powers of observation, and disappear when the phenomena are examined in all their relations. It is then, indeed, that the mind obtains those enduring and sublime views of the Deity, which, in geology, reward the patient observer, raise one of the most beautiful and interesting departments of natural science to its true rank, and prove that its relations connect, as it were, in the scale of magnitude, the phenomena of the earth with those more extensive arrangements presented to our intelligence in the planetary system, and in the grand frame-work of the universe itself.

Remarks tending to explain the Geological History of the Earth. By Professor Esmark.*

If we carry back our investigations with regard to the structure of the earth to its original formation, we find all involved in thick darkness. There have not been wanting, however, ingenious men, who have formed theories on this subject; we find some of these even among the Greek philosophers. Among these, two opposite opinions especially prevailed; some considered fire as the chief agent in this process; others water. Anaxarchus from Lampascus averred, that in his country the mountains had stood under water. Aristotle, Eratosthenes, Strabo, and Plutarch, supported his opinion. In later times, nobody doubts this fact, as we find petrified animals on the highest mountains. In America, such have been found on the Andes, at the height of 12,000 Rhenish feet above the level of the sea †. At first it was believed that these petrifactions were remains of the general deluge; but a more accurate investigation discovered, that they could not all be derived from this source; for, as we find on the highest mountains, and inclosed in the bowels of the earth, petrifactions of animals in every stage of their growth, and arranged in classes such as we still find alive in the sea, it may be readily inferred, that the duration of the flood was not sufficient to produce that amazing multitude of organic forms, the remains of which are now to be found in the bosom of the earth, but that these places must have once been the bottom of the sea.

In considering these petrifactions with attention, we may observe the following peculiarities among them:—

1. That the greater part of these petrifactions consist of sea animals and sea plants.

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* It being our intention to lay before our readers, as occasion may offer, statements of the opinions on the formation of the Earth entertained by distinguished writers, we now communicate the ideas on this subject by Esmark, from the Christiania Journal.

† Colonel Gerard found many *ammonites* at a height of 16,200 feet above the sea, in the Himalya range of mountains.

2. That they are not all of the same sort.

3. That they have not all been deposited at the same time, but at periods far remote from one another.

4. That those which belong to the earliest periods have a less perfect organization, the farther back the less perfect; that those on the contrary which have been found in mountains of a later formation, have a more perfectly developed organization.

5. That we find a multitude of petrifactions of different animals which are now totally extinct, and that we find others which have some resemblance to animals now existing; but with differences which prove them to be of another species.

6. That we likewise find a great multitude of plants incorporated with the solid strata, of which some are different from those which now exist, while a great many seem to resemble them. The most remarkable circumstance connected with this fact is, that the climate of those places where these plants are found inclosed in the solid rocks, is not at all like the climate where they are now found growing. We find, for example, a multitude of plants in a state of petrifaction in the most northerly regions of Europe, which are now found growing in the torrid zone. As they are found with stalks and leaves, and sometimes even with fruit upon them, they must necessarily have grown in the places where they are now found, and could not have been wafted on the surface of the sea from regions lying far distant.

7. That of the human race, we find, with certainty, no remains inclosed in the earth, with the exception of a few which have been found partly in tuffaceous limestone, partly in clefts of older mountains which have since been filled up with sand, clay, and rubbish, and which must be considered as remains of the latest revolutionary changes in the earth.

We find a variety of theories formed in later times on this subject, by Burnet, Whiston, Woodward, Fontanelle, De Luc, Ray, Hutton, &c. They have each their own peculiar notions; and though it cannot be said that any one of them is right, this will be a matter of no surprise, when we consider how far behind they were in many of the sciences which have made such progress during the last century. Though from this progress in mineralogy, chemistry, physical, mathematical, and astronomical science, we stand on much higher ground than they did, there is still much remaining which we cannot explain, with regard to the original formation of the earth, and the successive revolutions it has undergone, especially as we find that all these took place prior to the existence of the human race. For this reason, we are not able to give a perfectly satisfactory account of the history of the creation by Moses, who, without determining the length of this period, merely says, that, "in the beginning, God created the heaven and the earth, and that the earth was without form and void." In all probability a very long period, perhaps several thousands of our present years, intervened between the creation of the world and the time when the earth had advanced so far in the arrangement of its parts as to be capable of exhibiting signs of organization. By a day and a night, we now understand the period of the earth's revolution round its axis; by a year, the revolution of the earth in its orbit round the sun. Moses says, that the light was first formed, and that that was the first day. On the third day after this, the sun and moon were formed. As we have now no light but what comes either immediately from the sun himself, or by reflection from the moon; and as there was light, and likewise day and night before the sun and moon were formed, we must infer that the day here mentioned has been of a different character from our day, and that this light had a different source from an immediate communication from the sun. We may therefore conclude, that during the period of the incipient formation of the earth, it had possessed a light peculiar to its own constitution, such as we shall afterwards find exhibited in the case of other heavenly bodies in a similar stage of their formation.

For this purpose, let us cast a glance over the solar system, stating such phenomena as may assist in explaining this formation of the earth. On viewing this system, besides the earth, which completes its circuit round the sun in a period which we can exactly calculate, there are several other globes, some of them larger than the earth, and some of them smaller, which revolve round the sun likewise in a determined period, some of them longer than that of the earth, and some of them shorter. Besides these bodies, the planets, with their satellites or moons, there belong also to the solar system a multitude of comets.

There are several phenomena by which these last are distinguished from the planets. They revolve like them round the sun, but in much more eccentric orbits. The period of the revolution of a comet is very different from one century to another.* Their greatest distance from the sun is so immense, that if men could exist upon them, they would not see the sun for thousands of years, and the degree of cold must be such, that if there were sea or water upon them, it must be in a state of ice.

When these bodies are advancing to their perihelium, and at different distances approach nearer the earth, we observe that they are not only surrounded by a luminous atmosphere, but that they have likewise a long luminous tail, both of which become the greater the nearer they come to the sun, decreasing in the same manner as they remove from him to a greater distance. With regard to this increase and decrease of light too, we observe a difference among them. In the case of some of them, almost the whole mass of the comet is changed into this luminous elastic atmosphere and tail; in others we perceive a distinct red nucleus, which, on its approach to the sun, has a less expanded atmosphere and tail. These atmospheres, and still more the tails, are so thin and elastic, that, without the least obstruction, we can see through them the lesser stars. Counsellor Huth has calculated, that the luminous matter in the tail of the great comet of 1811, was a million of times rarer than our atmosphere at the surface of the sea. The volume of its tail he computed to be 2000 times the bulk of the sun, and the diameter of its nucleus to be eighteen times that of the earth. Bessel calculates the period of its revolution to be 3383 years. Herschel has accurately observed this comet, and, among other things, he concludes, that its light was peculiar to itself. The colour of its nucleus was greenish, or a bluish green, and the nucleus or head was not in the centre of the atmosphere, which was most expanded on that side turned to the sun. The radius of the atmosphere he makes to be about 322,000 English miles, and the length of the tail more than 100 millions. By continued observations on this comet, he found that it underwent actual physical changes in its structure, and that it was globular. On

* Their number is considered as exceeding 4000.

its approach to the sun, his light and heat seemed to produce chemical effects upon it; he believed that it revolved on its axis. By comparing this comet with that of 1807, he concludes, that every time comets approach their perihelium, they come nearer and nearer to the sun; that, therefore, the comet of 1807 had several times been in its perihelium, it beng 25 million of times nearer the sun than the comet of 1811. Its tail was only 9 millions of miles long, whereas that of 1811 was 91 millions. The effect of the sun on the latter was much greater than on the other, and it had probably seldom or never before been in its perihelium; whereas, on the contrary, the comet of 1807, in consequence of having been several times in its perihelium, must be more advanced in its growth, and matured. By comparing likewise the constitution of the great comet, with a smaller one in the same year 1811, he found that the smaller one was much more complete, and approached nearer the nature of a planet than the great comet, as the influence of the sun upon its perihelium, was not much greater than his influence on a planet in the same situation *.

I have made these remarks on the nature of comets, and this comparison of some of them, for the sake of introducing certain considerations, drawn from facts, which I consider as a proof that our earth, in its rude and undigested state, has been a comet. Of this hypothesis, I shall state, in what follows, several strong proofs in phenomena which occur in our own country.

Whiston, in his Theory of the Earth, supposes that it has originally been a comet, or the atmosphere of a comet, which, in its course round the sun, has moved in a very eccentric ellipse; that, of course, in its perihelium, it has been subjected to a very high degree of heat, and in its aphelium, to an equally strong degree of cold; that, in the one of these situations, it was vitrified by the heat, in the other covered with ice; that, by degrees, its orbit has gradually changed from this long ellipse, to that almost circular path in which it now moves on the whole, at a much smaller distance from the sun. How far does this agree with the phenomena which we can observe on our

* See Phil. Transact. 1811, and Bœde's Astronomisches Jahrbuch für das Yahr 1816, p. 185.

globe? With regard first to the change in the form of its orbit, this must be a matter of very difficult proof; to accomplish such a change, requires a period of incalculable length, and if it has taken place to such a degree, we ought to find the change still going on, approaching nearer and nearer to a circular orbit. By the period of the earth's annual revolution round the sun, we cannot ascertain this point; for though this continues 365¼ days without change, every day, every hour, every second, may be shorter, without our being able to discover this. La Place computes, that, since the time of Hipparchus, who lived about 900 years ago, the year has become some few seconds shorter. However inconsiderable this quantity may be, it proves a real change. Probably the change was greater at first, diminishing as the orbit of the earth approaches a circular form. Does the present physical constitution of the earth, and the phenomena which occur on it, countenance the idea of the orbit of the earth having at first been a long ellipse? From our present knowledge of chemistry and mineralogy, we cannot adopt the idea of Whiston, that, in its perihelium, the earth underwent a process of vitrification, in the sense in which we now understand the word. The solid body of our globe consists of various minerals, composed of different kinds of earth, combined together in certain proportions. In former times, these were considered as simple bodies, or, as they were called, elements. But by the discoveries of the illustrious chemists Davy and Berzelius, it has been found, that not only potass and natron, but that all kinds of earths, which we formerly considered as simple, are compound bodies, each species consisting of a peculiar base, with a fixed proportion of oxygen.

The form of the earth, a spheroid compressed at the poles, proves, 1*st*, That, at its original formation, it was in a state of perfect fluidity. 2*d*, That to account for this figure, it must have revolved on its axis with more velocity than it does now, as it is higher at the equator, and more compressed at the poles, than it ought to be from the laws of gravity with its present velocity. From its original fluidity, all sorts of mineral bodies must have been dissolved in a fluid medium. When we assume that a body undergoes combustion in being combined with oxygen, by which it is by no means to be considered as destroyed or annihilated, and that a burnt body is a body combined with a certain quantity of oxygen; then, since all sorts of minerals are composed of particular kinds of earth, combined with a certain proportion of oxygen, our globe must, at certain times, have undergone a state of combustion. This agrees entirely with its present constitution; and as it appears that comets, during the time of their perihelium, undergo decompositions and combustions, we may conclude, that the earth, during one or several perihelia, has passed from its fluid to its present, as we may call it, burnt state. Its original fluidity can scarcely be denied; but the fluid substance of which it was composed, and in which all other things were dissolved, cannot have been of the same nature with our present water, which is incapable of holding such a multitude of mineral bodies in a state of solution. We are therefore entitled to conclude, that, at the time when the solid masses of the globe were decomposed, the fluid medium which held them in solution was also decomposed and converted into a different character. The peculiar fluids found in cavities, in rocks and minerals, may, when strictly examined, give us some information as to the original fluid in which the matter of the strata was dissolved. During this state of combustion, an immense quantity of light must have been disengaged, as we see takes place with other comets at the time of their perihelium. As we find thus, that both fire and water have acted a part during the period of the earth's first formation, we may, in this manner, without inconsistency, combine the two opinions which have been opposed to one another on this subject.

And now, with regard to the other part of Whiston's theory, he assumes, that, during the period of its aphelium, the earth was covered with ice and snow. At first view, it seems not likely that we should be able to exhibit any proof of this. But besides its extreme probability, we shall find actual proofs that the earth has been covered with ice and snow. In our own Norway, so rich in geognostic phenomena, there are to be found unquestionable proofs of this. In reading geognostic and other works, containing descriptions of particular countries, we rarely meet with observations, from which the authors were led to draw this conclusion. Sir James Hall, in his remarks on the changes on the surface of our planet, and on the huge masses of rock which are found about Geneva, and the coast of the Baltic, and the formations of the vast sand-plains which are found in Holland and in the north of Germany, infers that not only strong currents, but ice likewise, must have had a share in producing these effects*. There are not wanting many facts to confirm the conclusion that ice has worked prodigious changes on mountain masses, and conveyed from them large rocks into regions, where now no perennial ice is to be found, at a great distance from the mountains, from which they must have come. Men have often had recourse to extraordinary exertions of the powers of nature in explaining these phenomena. Thus has De Luc endeavoured to account for them by the eruption of gaseous fluids from the bowels of the earth, which have burst the mountains, and scattered the loosened fragments to a great distance around. The huge masses of granite which are to be found on the limestone mountains of the Jura range, and which have evidently come from the Alps of Switzerland, though there lie deep valleys between the Alps and the Jura mountains, have been a riddle to many, especially as they are found very high up on the slope of the hills, and not in the bottom of the valley. Some, as I have mentioned, wish to explain this by a projectile power. Dolomieu imagines that there has been formerly a continued slope from the top of the Alps to the Jura hills, on which these rocky masses have descended from the one to the other, and that the present intervening valleys have been hollowed out by more recent revolutions. A few suppose that these masses have been brought to their present situation by ice. According to Von Buch this is a very general opinion in Switzerland. It is not only in mountainous regions we find this phenomenon, but also in flat alluvial districts, where these rocky masses lie upon gravel and sand, a circumstance which cannot be explained in any other way, than by their having been brought thither in combination with masses of ice. It cannot be admitted that they could be brought to such situations by torrents of water, for the same torrents which could have been capable of bringing such masses of rock, must at the same time have carried off the gravel and sand

* *Vide* Sir James Hall's Memoirs, in the Transactions of the Royal Society of Edinburgh.

on which they rest. One needs only to travel through the plains of Denmark, to perceive how improbable the supposition is, that such masses could be placed where they are by water. In short, in every country, whether it be mountainous or flat, we shall find similar traces of the operation of masses of ice. The prominent conglomerations to be found in many districts, may be easily accounted for in the same manner. But it is particularly in Norway I have found many proofs of the operation of immense masses of ice which have now disappeared.

1. As in other countries we find large loose rocky masses lying spread over pretty level plains; for example, in travelling from Marstuen, on the Miosen, to Leuten in Hedemark. These must have been brought from a great distance, for there are in the neighbourhood no mountains of the same character as these masses.

2. In no other satisfactory way than by the operation of ice can we explain how those prodigiously large loose stones, sometimes with sharp corners, have been brought up to the ridges and tops of high mountains, which are found in such numbers in the province of Christiansand. The first time I met with such single loose blocks lying on the ridge of the high mountains in Numedal, I thought they must be the remains of strata, or of masses which had covered the mountain, and which had in after-times been decomposed and carried off by water, leaving those traces of their former existence. But, on examining them more closely, I found that this account of the matter would not do, for I found that, in their internal structure, many of these stones neither corresponded with one another, nor with the mountain mass on which they rested. By the assistance of immense masses of ice, on the other hand, it is easy to conceive how they could have been brought from a great distance, and pushed high up on the mountains.

3. In travelling over our mountainous districts, especially in Osterdal, it will be frequently found that the slope of the mountain towards the valley is covered with large loose stones, mixed with a great quantity of loose sand and gravel, and that this covering extends to a considerable height over the bottom of the valley. If we consider attentively this mixture of large loose stones and gravel, we shall find that these could not have been produced and brought hither by any current of water descend-

ing through the valley, and depositing these larger and smaller remains of the ruins of the mountains; for the current which brought down the large masses, and deposited them there, could not possibly, at the same time, have deposited the finer sand and gravel, but must have carried it down to places where the influence of the current was less powerful. We may indeed suppose that two different currents at different times might produce this mixture; that the first and largest current deposited the large stones, and that a later and less powerful current deposited the gravel and sand. At first view this supposition seems not improbable; but, on a closer examination of this mixture, we shall find that it is not consistent with fact, for if a mighty current had brought down and deposited the large stones in the first instance, they must in that case rest upon one another, without any thing interposed between them, and the gravel, brought down and deposited by the succeeding current, could only have filled up the surrounding cavities; whereas, on the contrary, we find the large stones lying separated from one another, surrounded by sand and gravel, a circumstance which cannot be explained in another way than by supposing that the whole has formerly been filled up with ice, which has pushed the whole mixed mass up the slope of the mountain. The water of the ice, afterwards thawing, carried off by its rapid streams a part of the stones and gravel, which were then heaped together, deeper down in the valley: these heaps resemble entirely those which glaciers carry before them.

4. We come now to the fourth and the strongest proof, that immense masses of ice have formerly existed in Norway, in places where now no perennial ice is to be found. When I last summer (1823) undertook a journey to Stavanger, to examine the Union Copper Works, which have been commenced and again given up, I made an excursion from the dwelling-house of Fossan, which Pontoppidan, in his map, calls Fossland, in Holle Annex, in the parish of Strand, to examine a branch of the works at Vasbotten, about a quarter of a mile (more than 1½ English miles) north-east from Fossan. The road went first over some cultivated ground, ascending a little, but after between four and five thousand paces it went over a large level sandy plain. This plain was overspread with a multitude of

tumuli, that had been all opened. Urburhill, which reaches out to the sea, lay upon the right hand, and, on advancing farther over the plain, you see the dwelling-house of Howkelie, at a little distance to the right, in a valley which stretches up into the hill. At the upper end this sandy plain was bounded by a glacier-dike or rampart, which extended across the whole valley. As this glacier dike is remarkable, and, so far as I know, the only one of its kind lying close to the level of the sea, in a district* where you find only a few heaps of perpetual snow in hollows of the mountains, where it slopes to the north-east, at the height of from two to three thousand Rhenish feet above the sea, I must be a little more particular in describing it. Its length across the valley, from mountain to mountain, is 2250 feet, its perpendicular height above the plain 100. At one of the ends where it approaches to the mountain, it is broken through, so that there the highest part of its brink is not above twelve feet higher than the plain. This opening or breach is not above 200 feet broad. The dike itself consists of coarse gravel and sand, mixed with a great number of immense blocks of gneiss, which is the prevailing kind of rock in the mountain. We find this gravel and sand not only heaped up across the valley, but pushed up in great quantity on the opposite side of the dike, to the length of 1400 feet towards the mountain.

The whole bottom of the valley is covered with a lake, which is called Howkelie Water, of the same breadth as the length of the dike, and extending about ten thousand feet up the valley. The people in the neighbourhood say that it is one hundred fathoms deep. As the surface of the lake is only ten feet higher than the plain on the other side of the dike, and as this, therefore, where it is lowest, is two feet higher than the surface of the lake, there can be no run from it on this quarter. The water has its outgate at the other end, by a fall of a few feet, into a similar lake, and from this again, by a little fall at Vasbotten, it passes into a larger lake, called Ejewater, from which it soon after runs into Lyseford. These three lakes lie in a semicircle.

From this description it will be easy to see that this dike

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* By observations I made, Stavanger Church lies in Lat. 58° 57′ 56″.

could have been formed only by masses of ice, which must have filled up the whole valley, and, by their spreading and pressure, have hollowed out its bottom. In all probability the water of the melted ice, at a late period, burst through the dike, and for a while had its issue through the opening, and its present outlet either did not then exist, or was filled up with ice and gravel. On the plain below we find not a trace of the gravel carried down from the dike, a thing of course not to be expected, when we think of a torrent 200 feet in breadth rushing out with violence. Not only the dike itself, but the whole horizontal surface, exhibits proofs that there has been a glacier here, for the plain exactly resembles those which I found adjoining to the glaciers presently existing between Londfiord and Lomb, in Guldbrandsdal, where I had likewise occasion to travel last summer. The resemblance is so striking, that every one who has an opportunity of making the comparison, must form the same opinion. As a proof of this I may mention, that Mr O. Tank, a skilful young mineralogist, who visited with me the dike of which I have given the description, and afterwards accompanied me to the glaciers, I have just mentioned, on seeing the latter, without having heard a hint on the subject from me, he immediately exclaimed that the dike we had seen at Stavanger must be a glacier dike.*

As I think that what I have stated will be sufficient to prove that the Norwegian mountains have been covered with ice down to the level of the sea, and therefore that the sea itself must have been frozen, we may from this find the reason why the Norwegian mountains in general are so steep, I may say perpendicular, on the sides which hang over the valleys, not only in the valleys which are high above the level of the sea, but in those from the bottom of which the waters run into the Norwegian Fiords (Firths).† Ice, or glaciers, by their immense expanding powers, must, beyond doubt, have produced this change in their original form, from this circumstance, that they were continually sliding

* The principal glacier in the valley of Boredhus descends from 3000 feet above the sea to 1400, with a moraine or dike, of earth and stones, in front, from 6 to 800 feet broad.—Edit.

† Our English geographers use Frith from *fretum*, instead of the correct word Firth, from the Danish *Fiòrd*.—Edit.

downwards from the higher mountains to the lower districts, and, by this progressive motion, carried with them the masses of stone which they had torn from the mountains. It is easy to explain why no trace of these masses thus separated is to be found immediately below the precipices thus formed.

As these mountain precipices are often from three, four, to five thousand feet high, and the valleys over which they hang are likewise several thousand feet in breadth, it must be a matter of astonishment to think of such valleys being filled with ice to the extent of several miles. This ice in lower districts must have stretched a long way out into the sea, and, on its thawing, large masses must have broke loose, and gone out to sea, as we find takes place now in the polar regions. I have no hesitation in affirming this, when I survey the effects of immense masses of ice, where there is no room to be mistaken.

I shall further mention the supposed effects of glacier ice in another part of Norway, at the level of the sea.

Last summer I went by sea from Bergen to Söndfiord and Nordfiord, on the outside of the Scars (the rocks which lie along the shore), to examine the petrifactions which Pontoppidan talks of in his Natural History of Norway, as to be found in Steensund, in the island of Gulé, at the beginning of the 61° of north latitude. I went on shore at different places; and although I carefully examined every place around, I found not a trace of petrifaction.* On the contrary, I found that the part of the continent separated from it by the Sound, and the island of Inner or Easter Lulé, consisted of a solid conglomerate, composed of boulders, from the size of a pea to that of a man's head. These boulders consisted chiefly of gneiss, quartz, and clay-slate, which were involved and bound together in a mass so solid, that it was difficult to find out what the binding medium was, as the interstices between the large stones were completely filled up with small boulders. On closer examination, at particular spots, I found that this binding medium was chlorite and hard clay.

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* Professor Rathke, who had formerly been at the same place, and found none, recommended to me to make this examination.

On this rock there seemed to me proofs of the powerful operation of ice. I found that the precipices on the side of the mountain next the Sound were several feet in height, and perfectly perpendicular; and though they were composed, as I have mentioned, of boulders cemented together, they were perfectly even and smooth. If these precipices had been the effect of rents, attended with successive masses tumbling down, then the boulders adjoining the rent must have been found adhering sometimes to the one and sometimes to the other of the separated masses, (those which have fallen into the sea are no more to be seen); and, in that case, the boulders left in one mass must have left a mark of itself in the corresponding one. This, however, was by no means the case, as the rock which remained was perfectly smooth, and had the appearance as if these boulders had been cut across by a sharp knife. I can explain this phenomenon in no other way than by supposing, that large masses of ice pressing through the Sound, have cut these precipices lying parallel to the direction of the Sound.

I could give other proofs of the conclusion I have sought here to establish, but, to persons capable of judging of the matter, I consider these as sufficient.

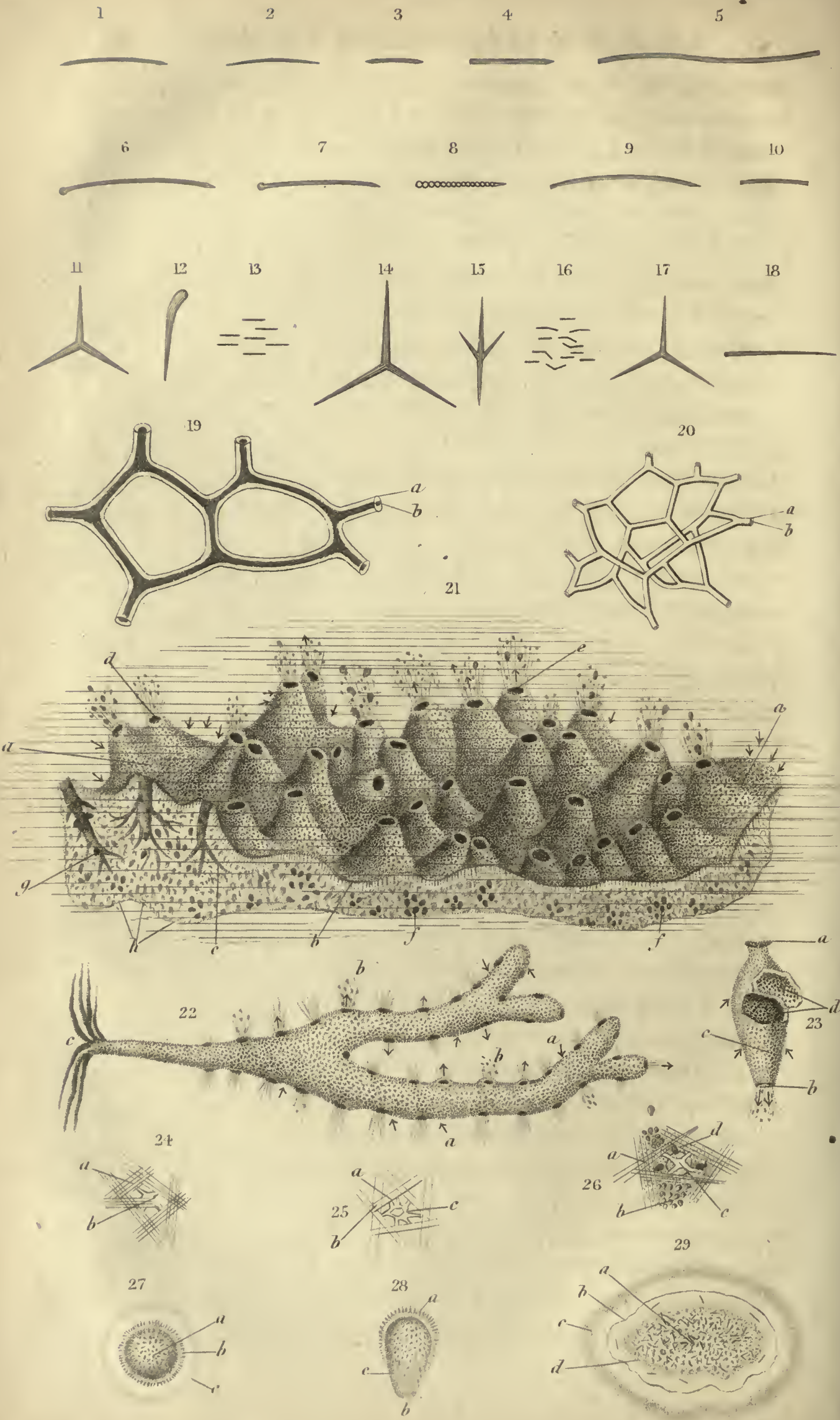
The result of what I have said I may state in the following particulars.

1. That, in the beginning, the earth existed in a fluid state.

2. That, during the long period it required to assume its proper composition and form, it has alternately been, at one time, at such a distance from the sun, that all the water upon it must have necessarily been converted into ice; at another so near it, that not only the solid earth and minerals underwent a change, but also the fluid substance which held them in solution was decompounded and changed. How deep these changes went into the body of the earth we have yet no means of ascertaining. By comparing the phenomena of burning volcanoes with the combustion of the metalloids, kalium, natrium, silicium, calcicum, we may conclude, that, deep in the bowels of the earth, there is to be found a multitude of specific metalloids, the combustion of which is the cause of the eruptions of volcanoes.

3. That organisation did not begin till this long period was

PLATE II.



W. H. Lizars sc.

completed, which the earth required to the full development of its own constitution; that, after it began, it proceeded by successive steps from the less to the more perfect formations, ending with man as the head of the whole.

Observations on the Structure and Functions of the Sponge. By R. E. Grant, M. D., F. R. S. E., F. L. S., M. W. S., Honorary Member of the Northern Institution, &c. Communicated by the Author. Concluded from the preceding Volume, p. 351. (With a Plate.)

The silicious and calcareous spicula above described are grouped into strong fasciculi, which are disposed around the internal canals of the sponge, in the order best calculated to defend these passages from compression, and from the entrance of extraneous bodies, and likewise to form between the canals certain interstitial spaces for the development and exit of the ova. Like the hard parts composing the skeleton in other animals, these earthy spicula are maintained in their relative situations by a tough ligamentous matter, distinct from the other soft parts of the sponge. In the horny species, however, where the axis is composed of cylindrical tubular horny fibres, ramified and continuous throughout the whole body, this connecting cartilaginous matter appears to be unnecessary, and, from the examination of dried specimens, it appears to be altogether wanting. The examination of the living properties of the axis in the horny species forms a subject of curious and interesting inquiry, which must be left to those who have opportunities of observing them alive in warmer latitudes, as they do not seem to inhabit the British shores. The dried filaments of the *S. fistularis*, Lam. when viewed through a powerful microscope, appear to consist of one continuous ramified tube, whose central cavity (Pl. II. Fig. 19. *b*) is entirely filled with a dark opaque granular matter, which does not consist of spicula, while the sides of the tube *(a)* are transparent and amber coloured like common cat gut. In the *S. officinalis*, where the filaments are much finer, the sides of the tube (Fig. 20. *a)* have the same colour and homogeneous appearance, but the central cavity *(b)* appears empty. Mr Ellis states, that, in the branched species, the central cavities of the horny filaments are filled with a soft white matter, and that they terminate by distinct apertures on the surface of the body; and he considered these cavities as undoubtedly the habitations of animals of a particular kind, (Hist. des Cor. p. 94). The confirmation of this opinion, by accurate experiments, would establish a very striking distinction between these elastic species and the more friable earthy sponges of our own shores, and would point out a remarkable approximation in these highly organised species to the polypiferous axis of tubulariæ, sertulariæ, and other keratophytes. In all the calcareous sponges which I have hitherto examined, we invariably find triradiate spicula, which are completely enveloped in the *connecting matter*, and are employed in forming the bounding fasciculi of the pores. Besides these complicated spicula, we frequently find a second and simpler form of spiculum, one extremity only of which is immersed in the connecting matter, while the other end, projecting free from the surface, defends the entrance of the pores and orifices. Thus, in the *S. compressa* (Fig. 23.), the bounding triradiate spicula (Fig. 11.), of various sizes, are found enveloped in the tough connecting matter around the pores, the defending clavate spicula (Fig. 12.) have their straight tapering portion immersed in the connecting matter, while their curved extremity hangs free over the entrance of the pores. In the *S. coronata* the connecting matter seems to cover entirely the bounding triradiate spicula (Fig. 17.); and only the thick obtuse extremity of the needle-shaped defending spiculum (Fig. 18.) is immersed in it, while the tapering pointed end hangs free over the pores and fecal orifice. I have never observed a combination of calcareous and silicious spicula in the same sponge, nor any kind of spiculum in the horny species. Two distinct forms of spicula are very seldom observed in silicious sponges, though they are frequent in the calcareous species. In the *Spongia ventilabrum*, Lin., besides the long waved silicious filament (Fig. 5.), we observe a distinct needle-shaped spiculum obtuse at one end, and tapered to a point at the other, (similar to Fig. 18). In the *S. pilosa*, Mont., besides the long straight fusiform spiculum, we observe a shorter curved spiculum, of equal thickness throughout, and rather obtusely pointed at both ends, like that of the

Spongilla friabilis (Fig. 1.), but larger. In general, however, the only difference observed among the silicious spicula of the same individual is a great variety in their size. Donati not only observed that the hard spicula of the *Tethya sphærica* differed remarkably in size, but likewise, that they were bound together by a peculiar fleshy or tendinous matter, (Mar. Adr., p. 62). In the *S. coalita*, besides the slender curved fusiform spiculum (Fig. 2.), we observe a long thick spiculum of the same form, which extends along the sides of two or three successive pores, and contributes much to their strength in a species peculiarly liable to have the diameter of these passages disturbed from the flexibility of its branches, and their erect position at the bottom of the sea.

At the approach of death, and during putrefaction, the soft gelatinous or cellular matter of the *S. panicea* escapes plentifully from every opening of the body, and drops down like the ropy transparent colourless matter of an egg, without loosening, in the slightest degree, the connecting matter of the spicula, or altering perceptibly the form of the skeleton. When we extract, by strong pressure, the cellular matter from the *S. coalita*, *S. tomentosa*, &c. we obtain a very tough leathery substance, composed of spicula firmly bound together by the cartilaginous matter, and retaining the original colour and form of the sponge. By repeatedly and strongly agitating a thin portion of the recent *S. papillaris* in fresh water, and then examining it under a powerful microscope, we find that the cellular matter has been entirely washed away, and the spicula are left imbedded in a transparent homogeneous tough matter, which retains its original colour and form unaltered. This *connecting matter* tears like a piece of cartilage, emits a fishy odour when burnt, dissolves without effervescence in nitric acid, contracts much, and acquires an amber colour by drying, and becomes very brittle in the dried state, probably alone from the earthy spicula it contains. There seems, therefore, to be a distinct matter in the earthy sponges for connecting, and probably secreting, the spicula of their skeleton. The dried preparations of this animal, preserved in museums, owe their form and stability to this tendinous connecting substance, and, from its close resemblance in the dried state to the amber coloured filaments of horny species, it is probable, that, by removing the spicula, we might obtain from the earthy sponges of our own coasts the advantages for economical use derived from the elastic species of tropical seas. The soft gelatinous matter mentioned above, as escaping abundantly from the broken *S. panicea*, is met with in greater or less quantity in all the other species which have been examined. Cavolini observed it to be very abundant and consistent in the *S. officinalis* and *S. carnosa*. Schweigger observed it to be most abundant in the sponges of the Mediterranean in autumn. Vio and Olivi considered it as a distinct matter from the other soft parts of the sponge; and Schweigger found it to consist almost entirely of minute granules, with a little transparent moisture. It has an unctuous feel, emits a fishy odour when burnt, leaves a thin film or membrane when evaporated, and appears to the naked eye transparent, colourless, and homogeneous, like the colourless part of an egg. But, when a drop of it is examined on a plate of glass under the microscope, it appears entirely composed of very minute, transparent, spherical or ovate granules, like monades, with some moisture. These monade-like bodies, nearly all of the same size and form, resemble the pellucid granules or vesicles, which Trembly has represented as composing the whole texture of the hydræ, or the soft granular matter we observe in the stems of living sertulariæ, and, indeed, most of the fleshy parts of organised bodies appear to be composed of similar pellucid granular or monade-like bodies in different states of aggregation. This soft substance, which might be termed the *parenchymatous matter* of the sponge, to distinguish it from the tough connecting matter of the spicula, is found in all parts of the body, but is chiefly contained in the intermediate spaces between the parietes of the internal canals, and it is more abundant at the time when the ova first make their appearance. The tough glistening substance which lines the internal canals, and passes over the surface, between the pores, is the most highly organized part of the animal. That of the canals resists repeated strong agitation in fresh water, and appears through the microscope a very consistent homogeneous jelly, with a rough granulated internal surface. The roughness sometimes assumes a lineal appearance, exhibiting the rudiments of fibres, and the transparent granules which project considerably from its surface, become more rare near the fecal orifices. There is an apparatus at the entrance of the pores, of a nature very different from any of the parts already described, and which throws much light on the functions of these openings. When we cut a thin layer from the surface of the *S. papillaris* (fig. 21.), and look down through one of its pores with the reflecting microscope, we perceive a very delicate net-work of gelatinous threads (fig. 25, *c*) thrown over the entrance of the pore. This piece of structure is so fine as to be perfectly invisible to the naked eye, and is always effaced in dried specimens. It is present in every pore of the living animal, and consists of several broad filaments of a soft transparent, colourless, and perfectly homogeneous substance, which pass directly inwards from the bounding fasciculi, (fig. 25, *a b*) or gelatinous margins of the pores, to be connected with one or more central meshes, formed of the same threads, and lying in the same plane. This gelatinous net-work, consisting generally of six or seven meshes, lies always beneath the defending fasciculi (fig. 24. *b*) in the species where these occur. And, while it is admirably protected by the depending spicula of the pores, as in the *S. panicea*, where these spicula spread over it like the rays of a fan, it serves to guard still more completely the interior of these passages from particles of sand or small floating animalcules. By making deeper sections, we sometimes observe one or more net-works of a simpler structure (fig. 26. *c*), but of the same nature, lying beneath the first. None of the projecting granules, which line the whole internal surface of the canals, and compose the parenchymatous matter, are seen on any part of these net-works, and their position, regularity, and constant appearance, sufficiently point out their function, and show, independently of the surrounding frame-work, and the currents passing constantly in, that the pores are not the open cells of polypi, nor accidental perforations, made by worms or animalcules in a pulpy substance. When we examine carefully the base of sessile species of sponge, we observe, that the part which forms the connecting medium between their body and the rock on which they spread, is a tough consistent gelatinous substance (fig. 21. *h*), similar to that which lines the canals, and passes over the surface between the pores; it insinuates itself into all the inequalities of the surface to which it is attached, and is the part we observe to advance first during the spreading of the ovum, (fig. 29. *b*). It is a very remarkable circumstance, that Aristotle is almost the only writer who has described this part of the anatomy of the sponge. He observes, that they do not adhere by a continuous surface; that they have some intermediate empty canals; that they are fixed only at particular parts to the rocks, and have a kind of membrane spread out under their base (Lib. v. cap. 16.) He has accurately distinguished and described the pores and fecal orifices, and was as well acquainted with their functions as Ellis or Lamarck. He says, we observe on the upper surface of the sponge minute pores (ποροι) placed close to each other, and almost imperceptible, and a few, about four or five, wide orifices (φανεροι), through which the animal is supposed to take in nourishment."—*Ibid.*

The organs which we know to cause the currents in other zoophytes, and in infusoria, are very small, short, almost imperceptible processes, termed ciliæ, disposed around the mouth, or on the tentacula. They are kept in a state of very rapid vibration during the expanded state of the animals, for the purposes of nourishment, respiration, or progressive motion. The highest orders of aquatic animals produce currents in the water, by the contraction and relaxation of various muscular parts of their bodies; and the most perfect inhabitants of the dry land produce similar currents in the air to oxidate their blood. We are not yet acquainted with any zoophyte capable of producing these currents, by contracting and dilating its axis; and I have already shewn, that the currents of the sponge are not produced by any contraction or dilatation of the mass of its body, or of the pores, canals, or orifices. No naturalist has ever discovered polypi in the sponge; and, as I have used every effort in vain to detect them with a microscope, magnifying nearly a hundred times, it is very probable that no such organs exist. If they be present and indistinguishable by such aid, they must be at least a hundred times finer than a filament of silk, and the ciliæ of the tentacula of such polypi would bear no proportion to the velocity and volume of the currents already described. I have stated above, that the currents can be distinguished by the naked eye passing into the open pores of the *S. panicea*, and they are readily seen through the microscope passing into the pores in most of the other species. I was therefore led to suspect that the currents are not caused by polypi on the surface, but by ciliæ, or some similar apparatus, placed around the entrance of the pores, or on the margins of the gelatinous networks, or on the whole surface of the internal canals. I first placed a thin layer from the surface of the *S. papillaris*, in a watch-glass with sea water under the microscope, and, on looking through its pores, I perceived the floating particles driven with impetuosity through these openings, they floated with a gentle motion to the margin of the pores, rushed through with a greatly increased velocity, often striking on the gelatinous networks, and again relented their course when they had passed through the openings. The motions were exactly such as we would expect to be produced by ciliæ, disposed round the inside of the pores; but the most intense observation, with high magnifying powers, did not render ciliæ visible on this or any other species which I examined. I now took deeper sections from the substance of a great variety of living sponges, after removing their surface, and on examining them in the same manner, under a powerful microscope, I found that, wherever a portion of an internal canal presented itself, there was a distinct and rapid current through it, but the moving organs were as little distinguishable on these, as on the margins or net-works of the pores. On looking with the microscope through the pores of a detached portion of the *S. compressa*, (fig. 23. *d*,) I have sometimes observed a confused motion among the granular bodies lining their sides, and have even seen these monade-like bodies in groups staggering to and fro, when they had fallen separate to the bottom of the watch glass. But, although every known analogy would lead us to believe that these motions and the currents are produced by ciliæ, I have never been able, by any artifice, or by the highest magnifying powers, to bring them distinctly into view in any species of sponge.

What relates to the formation, expulsion, and development of the ova, I shall exemplify chiefly by what I have observed during three successive winters in the *S. panicea*, adding at the same time such peculiarities as I have remarked in other species. By dividing this memoir into parts, and thus protracting its publication, I have been enabled to vary and repeat my experiments; to observe the animal at all seasons of the year; and to confirm my observations, by various continental authorities which were unknown to me when my experiments were first read before the Wernerian Society. During the months of October and November, we observe a remarkable change taking place in the internal texture of the *S. panicea*, the parts which in summer were transparent, and nearly colourless, have now become every where studded with opaque yellow spots visible to the naked eye, and without any definite form, size, or distribution, excepting that they are most abundant in the deeper parts of the sponge, and are seldom observable at the surface. The parenchymatous matter seems likewise to be more abundant throughout the whole body. By examining thin sections with the microscope at this period, we find that the bright yellow spots consist of groups of very minute irregular-shaped gelatinous granules, which lie imbedded in the parenchymatous matter, and are contained in certain recesses formed between the parietes of the internal canals, (fig. 26, *b*.) These yellow granules are the rudiments of the ova, and when they are first perceptible by the aid of the microscope, they consist only of a small round compact group of the same monade-like bodies which compose the parenchymatous matter; they have no cell or capsule, and appear to enlarge by the mere juxtaposition of the monade-like bodies around them. As they enlarge in size they become oval shaped, and at length in their mature state they acquire a regular ovate form. In about two months after their first appearance, the ova are nearly a fifth of a line in length, and half as much in breadth, and the greater number of them have acquired the same ovate form and bright yellow colour. Their form is now quite distinguishable by the naked eye, both when floating detached in water, (above fig. 26,), and when lying in groups in the substance of the animal, (fig. 21. *f*, *f*.). Before they have attained this perfect ovate form, they are not washed out from broken sponge, by violently shaking it in water, but now they readily fall out from broken portions, without any agitation, and we generally find a great number of them floating in the water in which specimens of this sponge have been placed in the months of December, January, February, and March. If we watch the fecal orifices with some attention during any of these months we observe many of the ova pass out spontaneously along with the currents and feculent matter, (fig. 21. *e*.), and when they have been discharged by the fecal orifices, or have fallen out from broken portions of the sponge, they do not sink to the bottom of the water by their own gravity, like every other substance composing the body of the animal, but continue floating and drifted about by the currents. The most remarkable appearance exhibited by these ova, is their continuing to swim about by their own spontaneous motions, for two or three days after their detachment from the parent, when they are placed separately in vessels of sea water, at perfect rest. During their progressive motions, they always carry their rounded broad extremity forward, and when we examine them under a powerful microscope, we perceive that these motions are produced by the rapid vibration of ciliæ, which completely cover the anterior two-thirds of their surface, (fig. 28. *a*. to *c*.). I have not perceived any ciliæ on the tapering posterior third of their body (fig. 28. *c*. to *b*), which has a whiter and more pellucid appearance even to the naked eye, than the ciliated anterior part. By examining the sponge carefully with the microscope, we are surprised to find that many of the mature ova are now hanging by their tapering extremity from the parietes of the internal canals, (fig. 26. *d*, and fig. 21. *g*.), either by having advanced themselves into the canals, or by opening new passages for themselves, by the motions of their ciliæ. While in this fixed situation their ciliæ are always in a state of very rapid vibration, which has a tendency to tear them from the sides of the canals, and when their connection is once destroyed, they are driven headlong by the currents through the fecal orifices (fig. 21.) The singular motions and structure of the detached ova, are best observed by placing a few of them together in a small drop of sea water, on a plate of glass under a powerful microscope. They have all the same size, the same regular ovate form (fig. 28), and the same bright yellow colour by reflected light; but by transmitted light they have an amber colour, appear much less translucent in the central parts than towards the sides, and have a rough granulated surface. Their ciliæ are longest, and exhibit the most distinct motions, on the anterior part (fig. 28. *a*.), and become gradually shorter and more imperceptible as we approach the tapering extremity, (fig. 28. *c*, *b*.), which has a granulated translucent appearance, but exhibits no ciliæ. The part of the surface on which the ciliæ immediately rest is more transparent than the other parts, and appears like a thin gelatinous covering spread over the other darker parts within. The ciliæ are very minute transparent filaments, broadest at their base, and tapering to invisible points at their free extremities; they have no perceptible order of succession in their motions, nor are they synchronous, but they strike the water by constantly and rapidly extending and inflecting themselves; and the result of these motions is, that the ova either impel the water backwards from their anterior towards their tapering end, or they advance through the fluid, carrying their broad ciliated extremity forward. We sometimes observe them standing erect on their tapering extremity, and revolving quickly round their long axis. This is particularly remarked, after they have been swimming about for a day or two, and are about to fix themselves on the surface of the glass. When viewed from above in this erect position, they appear perfectly circular, (fig. 27.) with a translucent margin, and a complete circular zone of moving ciliæ, (fig. 27. *b*.); and when they have continued to move their ciliæ for some time in this erect position in a watch-glass, they clear away all loose particles of matter from beneath their base, and accumulate a perceptible zone of loose sediment (fig. 27. *c*.) at a little distance from their circumference (fig. 27. *b*.). The incessant slow gliding motions of these ova to and fro through the water, are not like those of animalcules. They appear to have no definite object, and are not performed by starts, like the zig-zag motions of animalcules in search of prey; yet the ova appear to have a consciousness of impressions made on them. When they strike against each other, or against any object in their course, they retard a little the motions of their ciliæ, glide for a few seconds round the spot, and then renew the action of their ciliæ, and proceed in their smooth gliding course. They frequently collect in large quantities at the surface of the water round the margin of the vessel, in which the broken sponge is laid; and I have observed them particularly accumulate on that part of the glass jars which was shaded most from the light, by the body of the parent. About a thousand ova are contained in every cubic inch of the *S. panicea,* and a specimen of moderate size may be computed to discharge at least ten thousand ova every season. The smaller species are much more prolific. On cutting an ovum transversely through the middle, the ciliæ on its anterior half continued in motion for twenty-four hours. On tearing an ovum to pieces with two needles on a plate of glass, we perceive, by the aid of the microscope, about twenty rudimentary spicula occupying its central opaque part, and having the same form with those of the parent. The ovum does not show any power of changing its form, during its most active state, which the ova of some higher zoophytes distinctly exhibit. During the months above mentioned, every specimen of the *panicea* is found crowded with ova; some presenting them in a more advanced state than others, and the same specimen presents them in every stage of maturity.

In about two or three days after the ova of the *S. panicea* have separated from the body of the parent, we observe them beginning to fix themselves on the sides and bottom of the vessel, and some of them are found spread out like a thin circular membrane on the surface of the water. Those which have fixed on the sides of the vessel, have a more regular circular outline than those on the surface of the water, which have often a torn appearance, with holes of different sizes through them; but in all those which have thus fixed and spread out like a thin transparent film, we can very distinctly perceive, with a single lens, numerous spicula, disposed without any apparent order throughout their central parts. On immersing several watch-glasses in a basin of sea-water, containing many specimens of the *S. panicea* in the act of discharging their ova, I found, after a few days, that most of the ova had fixed on the outside of the watch-glasses, so as to have their pores and orifices, when fully grown, vertically downwards, and almost none were in the concavities of the watch-glasses, where I wished to collect them. It is easy, however, to cause them to fix and grow in the concavities of watch-glasses, by placing them there near the natural time of their fixing, when the ova exhibit much less inclination to swim about; and the progress of their development is most conveniently watched when they are caused to grow in that situation. When we examine the ova through the microscope, while in the act of fixing on the surface of the glass, we find that they are always so placed, that some part of their white translucent base (fig. 28. *c*, *b*.), is in contact with the glass; and this part has not only the power of adhering firmly to the surface, but that of spreading itself outwards, so as to extend the whole ovum into a thin transparent convex circular film. During the expanding of the base, the ciliæ are still observed in rapid motion on the upper part, and propelling particles of matter to a distance. They soon, however, become languid, and, in the course of a few hours, they cease to move, first at a particular part, and then gradually round the whole circumference. When first completely expanded, the whole ovum appears to consist of granular monade-like bodies, with a few spicula interspersed through the central parts, (fig. 29. part within *d*.). But within the space of twenty-four hours, a beautiful transparent, colourless, and perfectly homogeneous margin, has spread out round the whole ovum (fig. 29. *b*.), which continues to surround it during its future growth. And although all visible ciliæ have ceased to move, we still perceive a cleared space around the ovum, and a halo of accumulated sediment, (fig. 29. *c*.), at a little distance from the margin. The spicula, which at first were small, confined to the central part, and not exceeding twenty in number, now become much more numerous and larger, and some of them even make their appearance in the thin homogeneous margin (fig. 29. *b*.). The spicula make their appearance completely formed, and do not seem afterwards to increase their dimensions. I have never observed a spiculum in the act of making its appearance, but have thought that I perceived a lineal arrangement of the monade-like bodies in the interior of the ovum, where the spiculum afterwards started into being. When two ova, in the course of their spreading on the surface of a watch-glass, come into contact with each other, their clear homogeneous margins unite without the least interruption, they thicken and produce spicula: in a few days we can detect no line of distinction between them, and they continue to grow as one ovum. Cavolini long since observed, that, when two adult specimens of the *S. rubens*, Pall. growing on the side of an earthen vessel, came into contact with each other, they grew together and formed an inseparable union, (Abhand. p. 126.) In a few weeks after an ovum has fixed, the spicula assume the appearance of fasciculi; at particular places towards the centre they present circular arrangements, and distinct openings are at length perceptible, by the aid of a microscope at these inclosed places. The ova spread and enlarge in every direction, they become more compact in texture, more opaque and convex; and, before they exceed a line in diameter, they present through the microscope a marked resemblance to the parent sponge.

The ova make their appearance at very different seasons, in different species of sponge, and the same species very probably, varies its time of generating, according to its latitude. Olivi, Vio, and Schweigger, observed these yellow ovate bodies only in autumn in the sponges which they examined in the Mediterranean, (Schweigger's Beob. auf R. R. p. 90). From the season of their appearance, Olivi considered these bodies as grains, while Vio and Schweigger considered them as ova, from their believing the sponge to be an animal. The latter authors observed, that they were distributed, without any apparent order, through the gelatinous matter, and that they were of a somewhat different colour from that matter, and more consistent. Schweigger considered them as beings formed out of that matter, and capable of independent existence,—an opinion which happily accords with the experiments above detailed. In the *S. papillaris*, *S. cristata*, and *S. tomentosa*, on Leith rocks, the ova do not make their appearance till spring. They are present in April, May, and June; and they exhibit the same mode of distribution through the deeper parts of the animal, (fig. 21. *f*, *f*.), the same ovate form, granular or vesicular texture, ciliated anterior surface, mode of expulsion, and spontaneous motions, as in the *S. panicea*. They have a darker yellow colour, and a more lengthened posterior extremity, than those of the *S. panicea*, and we can scarcely detect the rudiments of spicula in them, at the time of their expulsion. It is somewhat remarkable, that, in the portions of these species, which we frequently find of a deep sea-green colour, the ova have exactly the same yellow colour, as in specimens which present their more common yellow hue. I have repeatedly performed, during two successive summers, the same experiments on these ova as those above detailed, and with the same results. From the manner in which these ovate bodies are formed in the parenchymatous substance of the sponge, and their changes after expulsion, this animal appears to present a new and singular mode of internal gemmiparous generation. Since these germs, or so-named ova, are evolved within the body of the parent, and are detached without injuring or affecting its general form, this may be considered as a more complicated, or more perfect, kind of generation, than that by spontaneous division, exhibited by animalcules, where the form of the parent's body suffers materially during the process, and half of its substance is removed. As the ova of the sponge, however, are not fully formed individuals at the time of their separation, but require to undergo a further change to bring them to the fixed and perfect state of the parent, this mode of generation is less perfect than the true external gemmiparous generation of the hydra, where the new individual falls off from the body of the parent in a state of perfect maturity. Many other zoophytes exhibit the same kind of internal gemmiparous generation by the detachment of imperfectly formed portions of their soft substance; their ova require to undergo the same metamorphosis to bring them to the perfect state, and they exhibit the same singular spontaneous motions during the intermediate state between the time of their forming a part of the parent's body, and that of their existence as new individuals. Mr Ellis observed similar spontaneous motions in the ova of the *Campanularia dichotoma*, Cavolini in those of the *Gorgonia verrucosa* and *Caryophyllia calycularis*, and I have observed them in those of the *Plumularia falcata* (See Ed. New Phil. Journn. vol. i. p. 155). The power of spontaneous motion is not given in vain to these minute portions of gelatinous matter on which the propagation of the species depends. As the fecal orifices open into the general cavity in such cup-like sponges as the *S. ventilabrum* and *S. patera*, which sometimes appear to grow erect in the still recesses of the deep, the spontaneous motions of the ova in these, and, in all erect tubular species, will aid their escape, and prevent them from destroying the parent, by a parasitic growth in the interior. The power of spontaneous motion will prevent the ova of such species as the *S. oculata*, *S. panicea*, *S. palmata*, and *S. compressa*, which hang vertically from the roofs of caves, from sinking by their gravity to the bottom, where they could not fail to be crushed or buried among the moving sand, and will enable them to seek and to take that vertical position which seems necessary to their future development; and, by this locomotive power, produced by the vibrations of the ciliæ, the ova are suspended for a longer period at the mercy of the waves, the tides, and the streams of the ocean, by which the species are gradually spread over the globe. Thus the *S. communis*, *S. lacinulosa*, *S. usitatissima*, and other horny species, which seem to be confined to warm climates, and abound in the Red Sea and the Indian ocean, appear to have been gradually wafted by the Gulf Stream from the shores of the east to corresponding latitudes of the new world. The *S. fulva*, *S. fistularis* and fine varieties of the *S. officinalis*, Pall. are among the horny species which abound on the tropical shores of America, and their elastic filaments form a beautiful transition to the cartilaginous threads which wind round the cells of Alcyonia. All the known calcareous sponges are inhabitants of the British coasts; the delicate and minute *S. compressa* has been seen on the shores of Greenland, Shetland, Scotland and England, and I have found it along with the *S. nivea* abundant and extensively distributed over the Western Islands. The *S. botryoides*, *S. nivea*, and *S. compressa*, are calcarious species, inhabiting the Frith of Forth. An immense number of silicious species inhabit our northern latitudes; and from their peculiar habits, their simple structure, and their tenacity of life, they are probably the animals which exist nearest to the poles. The *S. coalita*, *S. oculata*, *S. dichotoma*, *S. prolifera*, *S. palmata*, *S. suberica*, *S. papillaris*, *S. panicea*, *S. cristata*, *S. tomentosa*, and *S. cinerea*, Gr., (fig. 3.) are found in the Frith of Forth. The *S. papillaris* and *S. tomentosa* I have found common on the coasts of Britain, Ireland, and the Western Islands; and I have observed the *S. panicea* roofing the excavated basaltic cliffs of the island of Staffa. The *S. sanguinea*, Gr., (fig. 9.) a remarkable blood-red sessile species, I have found growing, like the *S. panicea*, on the under surface of the sea-beaten rocks of Islay, Staffa, Iona, and, along with the *S. nivea*, at the entrance of the spar caves on the shores of Skye. The *S. tomentosa* is said to occur on the shores of Europe, North America, Africa and India (Lamouroux, Hist. des Polyp. p. 30.); but I believe it has not been authentically shewn that the same silicious species occur in the corresponding latitudes of the two hemispheres; indeed the geographical distribution of the species cannot be satisfactorily ascertained till their characters are better described and defined. This animal, however, seems eminently calculated for an extensive distribution, from the remarkable simplicity of its structure, and the few elements required for its subsistence. Its inertness, its soft gelatinous structure, its want of organs for seizing prey, the incessant currents through its body, and the growth of its ova, when nourished only with sea-water, shew that it subsists either on the elements of that fluid, or on the minute particles of organic matter suspended in it. Its canals present the first rudiments of an internal stomach; by these simple organs it extracts a mass of gelatinous matter from the waters of the ocean, and organises it for the digestive organs of animals higher in the scale. Its interior affords a domicil and a magazine of food for myriads of minute marine animals. It extracts silicious matter from the ocean, and precipitates it in regular and beautiful crystalline forms. It precipitates, in the form of an insoluble carbonate, the calcareous matter continually poured by rivers into the bed of the ocean in a soluble state; it thus assists in purifying the vast abyss of a corrosive ingredient, and prepares it for the maintenance of the various tribes of vertebral inhabitants that people its boundless expanse. And it has probably aided in the formation of silicious and calcareous rocks.

I have now given a brief outline of the natural history of the Sponge as a genus, and stated the laws which regulate its external form, in so far as I have been able to observe the living characters and habits of the species in the Frith of Forth. I have endeavoured to trace to their sources the discoveries which have been successively made in its structure and economy, and have shewn, that the true nature of this singular being, and the uses of all its parts, were as well known to the ancient Greeks as to the naturalists of modern Europe,—that the description of it given by Aristotle is more correct and complete than that of Lamarck. I have detailed a series of experiments to determine the uses of the pores, canals and orifices; and have shewn, that the incessant currents through these passages, which are subservient to the nourishment, respiration, and reproduction of the animal, are not produced by the alleged irritability of its axis, nor by the supposed systole and diastole of its apertures, but by certain minute organs disposed over the whole surface of the internal canals. I have described the most striking differences which I have observed in the chemical constitution and microscopical forms of the minute parts composing the skeleton of this animal, in the three great tribes of horny, calcareous, and silicious species, and their beautiful arrangements to maintain the general form of the zoophyte, and to support and defend its soft parts. I have stated the characteristic properties and appearances of the connecting matter of the spicula, the parenchymatous, or general cellular substance of the body, the gelatinous net-works of the pores, and the granular bodies of the internal canals. I have examined the successive changes which the ova undergo from the time of their first appearance in the parenchymatous substance of the parent till their full development, and their expulsion from the fecal orifices, the causes of the singular spontaneous motions they exhibit, from the time of their expulsion till their metamorphosis into fixed inert zoophytes, and the progress of their growth in this fixed state, till they attain the perfect form of the parent. And, lastly, I have stated a few observations on their geographical distribution, and their purposes in the economy of nature. The uses of the central cavities in the horny fibres, and in the earthy spicula, and the different forms of these elementary parts, in all the known species; —the mode in which the animal imbibes nourishment through the parietes of the internal canals, and the chemical changes produced on the fluid by its transmission through these passages;—the particular tribes of infusoria and more perfect animals that infest the different species, and depend on them for subsistence, and the applications of the earthy species of this animal to useful purposes in the arts, are still unknown. No one has yet excited to action any part of the adult animal, and the moving organs of the currents have never been seen. The mode of generation of this animal, and the structure of its soft parts, have yet been examined only in a very few species. The characters and the geological distribution of its organic remains have yet to be investigated, and probably not a tenth part of the existing species have yet been brought to light from their recesses in the depths of the ocean. This animal still affords many curious and interesting subjects of inquiry to those who have leisure and opportunities of examining the more perfect species of tropical seas; and, though probably the simplest of animal organisations, the investigation of its living habits, its structure and vital phenomena, and the distinguishing characters of its innumerable polymorphous species, is peculiarly calculated to illuminate the most obscure part of zoology, to exercise and invigorate our intellectual and physical powers, and to gratify the mind with the discovery of new scenes of infinite wisdom in the economy of Nature.

PLATE II.

Fig. 1. Silicious, double-pointed, curved spiculum of the *Spongilla friabilis*. (See Edin. Phil. Jour. vol. xiv. p. 279.) This and the following 19 figures are magnified 50 times.

Fig. 2. Silicious, fusiform, curved spiculum of the *Spongia papillaris*. (See Edin. New Phil. Jour. vol. i. p. 346). This spiculum occurs in *Spongia tomentosa*, or *urens*, *S. cristata*, and large in *S. coalita*.

Fig. 3. Silicious, double-pointed, curved, short spiculum of the *Spongia cinerea*, Gr. (See zoological notices at the end of the present Number.) This spiculum occurs half as large in *S. oculata*, *S. palmata*, *S. dichotoma*, *S. prolifera*, and *S. cancellata*, Sowerby.

Fig. 4. Silicious, single-pointed, straight spiculum of the *Spongia panicea*. (See Edin. New Phil. Jour. vol. i. p. 347.) This spiculum occurs slightly curved in the *S. parasitica*, Mont.

Fig. 5. Silicious, long, waved filament, obtuse at both ends, of the *Spongia ventilabrum* (see Edin. New Phil. Jour. vol. i. p. 349.), occurs along with another silicious spiculum, similar to fig. 18.

Fig. 6. Silicious, single-pointed, curved, thick spiculum, with a round head on its obtuse end, of the *Spongia patera*. (See Edin. New Phil. Jour. vol. i. p. 348.)

Fig. 7. Silicious, single-pointed, curved, slender spiculum, with a round head on its obtuse end, of the *Cliona celata*. (See Edin. New Phil. Jour. vol. i. p. 80.)

Fig. 8. Silicious, single-pointed, straight, moniliform spiculum of the *Spongia monile*, Gr. (See Edin. New Phil. Jour. vol. i. p. 348.)

Fig. 9. Silicious, single-pointed, curved, long spiculum of the *Spongia sanguinea*, Gr. (See zoological notices at the end of the present Number.)

Fig. 10. Silicious, curved, short spiculum, obtuse at both ends, of the *Spongia fruticosa*. (See Edin. New Phil. Jour. vol. i. p. 350.) For the *S. hispida* the same form occurs, but more than double this length.

Fig. 11. Calcareous triradiate spiculum of the *Spongia compressa*. (See Edin. New Phil. Jour. vol. i. p. 166.)

Fig. 12. Calcareous, clavate, curved spiculum of the *S. compressa*. (Ibid.)

Fig. 13. Calcareous, straight, very minute spicula of the *S. compressa*. (Ibid.)

Fig. 14. Calcareous, triradiate, large spiculum of the *Spongia nivea*. (Ibid. p. 168.)

Fig. 15. Calcareous, quadriradiate, minute spiculum of the *S. nivea*. (Ibid.)

Fig. 16. Calcareous minute fragments of triradiate spicula of the *S. nivea*. (Ibid.)

Fig. 17. Calcareous triradiate slender spiculum of the *Spongia coronata*. (Ibid. p. 170.)

Fig. 18. Calcareous, single-pointed, slightly curved long spiculum of the *S, coronata*. (Ibid.)

Fig. 19. Horny tubular thick fibres of the *Spongia fistularis*. (See Edin. Phil. Jour. vol. xiv. p. 339.) *a*. Amber-coloured horny translucent parietes. *b*. Dark opaque granular matter filling the central cavity.

Fig. 20. Horny tubular thin fibres of the *Spongia communis*. (Ibid.) *a*. Amber-coloured transparent parietes. *b*. Empty central cavity.

Fig. 21. Living *Spongia papillaris* under water, shewing its mode of generation, &c. (See Edin. New Phil. Jour. vol. ii. p. 133.) *a, a,* Minute pores through which the currents enter. *b,* Commencement of the internal canals. *c,* Uniting of the internal canals to form a fecal orifice. *d,* A fecal orifice discharging a current of water with feculent matter. *e,* A fecal orifice discharging two ova and feculent matter with the current. *f, f,* Groups of mature ova. *g,* Ovum passing into a canal. *h,* Gelatinous base connecting this animal to the rocks.

Fig. 22. Living *Spongia oculata,* shewing its currents, mode of generation, &c. *a, a,* Minute pores transmitting water obliquely into the canals. *b, b,* Fecal orifices discharging currents, feculent matter, and ova. *c,* Strong fibrous part of the animal by which it hangs from rocks.

Fig. 23. Living *Spongia compressa,* with a part of its side laid open, to shew the terminations of its canals in the interior of its general cavity. *a,* Expanded base by which it hangs from rocks, fuci, &c. *b,* Compressed terminal opening of its general cavity, by which the currents, ova, and feculent matter, finally escape. *c,* Minute pores by which the water passes obliquely through its parietes. *d,* A part laid open, to shew the fecal orifices terminating in the general cavity of the animal.

Fig. 24. A pore of the *Spongia panicea* highly magnified, to shew (*a*) its bounding fasciculi, and (*b*) a defending fasciculus spread over a gelatinous network.

Fig. 25. A pore of the *Spongia papillaris* highly magnified, to shew (*a*) its bounding fasciculi, (*b*) the part where the bounding fasciculi cross each other to form recesses for the ova, and to which the connecting matter of the spicula was supposed to be confined, and (*c*) the most usual appearance of the gelatinous network of the pores in this species.

Fig. 26. A transverse section of an internal canal of the *Spongia papillaris. a,* Its bounding fasciculi, covered with the very minute monade-like bodies composing the parenchymatous matter. *b,* Groups of imperfectly formed ova lying in recesses of the parenchymatous matter. *c,* Simplest form of the gelatinous network found within the canals. *d,* Ova hanging by their tapering extremity to the side of the internal canal, and producing currents by the motions of the ciliæ covering their free surface.

Fig. 27. Highly magnified ovum of the *Spongia panicea,* viewed from above, when about to fix. *a,* Central opaque part occupied by spicula, and covered with ciliæ. *b,* Zone of vibrating ciliæ distinctly seen round the margin. *c,* Zone of accumulated sediment, produced by the ciliæ constantly clearing the space next the ovum.

Fig. 28. Highly magnified ovum of the *Spongia panicea,* viewed laterally, to shew its entire ovate form. *a,* Ciliæ, longest on the vertex of the ovum, and resting on a more translucent part of the ovum. *b,* White pellucid base by which the ovum fixes

and expands. *c,* The part where the white base commences, and where the ciliæ seem to terminate.

Fig. 29. Appearance of the young *Spongia panicea,* after the ovum has fixed and spread for fourteen days on a watch-glass. *a,* Central opaque part to which the spicula were at first confined. *b,* Transparent homogeneous margin by which the young sponge spreads, and which likewise produces spicula. *c,* Halo of accumulated sediment frequently seen round the margin, at a little distance from the young sponge, and inclosing a cleared space, as in Fig. 27. *d,* The part where the monade-like parenchymatous matter terminates, and where the colourless homogeneous matter commences.

Enumeration of the Instruments requisite for Meteorological Observations ; with Remarks on the mode of conducting such Observations. By Professor Leslie.

EVERY meteorological observatory, if it shall register with accuracy, and in a complete and satisfactory manner, the various atmospheric phenomena, ought to be provided with the following instruments.

1. The *barometer,* which measures the pressure of the atmosphere ; 2. The *thermometer,* which indicates its degree of heat ; 3. The *hygrometer,* which marks its relative dryness ; 4. The *atmometer,* which measures the quantity that evaporates in a given time from the surface of the earth * ; 5. The *photometer,* which indicates the intensity of the light transmitted from the sun, or reflected from the sky ; 6. The *æthrioscope,* which detects the cold showered down from the chill regions of the higher atmosphere ; 7. The *cyanometer,* which designates the gradation of blue tints in the sky ; 8. The *anemometer,* which measures the force and velocity of the wind ; 9. The *ombrometer* or *rain-gauge,* which marks the daily fall of rain, or haill, or snow ; 10. The *electrometer,* which indicates the electrical state of the air ;

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* In a close room or sheltered in external air, the atmometer might supply the place of an hygrometer ; and compared with another one freely exposed, it might serve as a substitute for the anemometer.

and, 11. The *drosometer*, which measures the quantity of dew. These various instruments are not, however, all of equal importance. The barometer, the thermometer, and the hygrometer, may be considered as quite indispensable. Next to them, deserves to be ranked the photometer and æthrioscope, which disclose the more recondite condition of the atmosphere. The atmometer, the ombrometer, and the anemometer, are of great consequence, from the practical results which they furnish. I would strongly recommend, as a most useful auxiliary in meteorological observations, Rutherford's maximum and minimum thermometer. In many cases, likewise, it would be convenient for the scientific traveller to be provided with a thermometer bearing large divisions, and lodged at the bottom of a walking-stick, protected by a coating of down inclosed within a brass tube. This instrument is peculiarly adapted for exploring the temperature of the ground and of springs*.

But the value of any meteorological register must depend on the accuracy with which it is kept. The observations should be made in a place rather elevated, sheltered from the direct action of the sun, but exposed freely on all sides to the aspect of the sky; and they should be repeated either at equal intervals, during day and night, or at least at those hours which represent most nearly the mean state of the atmosphere. These requisites are seldom attained, and very few registers of the weather, accordingly, are entitled to much confidence.

It cannot be expected, that registers of the weather will possess much value, so long as they are kept merely as objects of curiosity. Like astronomical observations, as now conducted, they should no longer be left to the chance of individual pur-

* It would be particularly desirable, if travellers over land were provided with light barometers and staff-thermometers. A very portable barometer, sufficiently accurate for general purposes, might be constructed with a conical tube, or two portions of unequal diameters conjoined. But the staff-thermometer might often supply the want of a barometer, by discovering the mean temperature at moderate depths under the surface. Hence the relative altitudes of different places above the level of the sea could be estimated with tolerable precision. Had the various travellers who have visited the Interior of Africa made observations of that kind, the question respecting the course of the Niger would have been decided long before now; at least we should have known, whether the great lakes were, like the Caspian, below the surface of the ocean.

suit. They would require to be unremittingly prosecuted, in all variety of situations, and at the public expence. Proper sets of meteorological instruments should be placed, not only in the regular observatories, but sent to the different forts and light-houses, both at home and at our principal foreign stations. They might also be distributed among the ships employed in discovery, or engaged on distant voyages. The cost of providing those instruments would be comparatively trifling; and the charge incurred, by conducting registers on a regular and digested plan, might shrink almost to nothing in the scale of national expenditure *.

The state of the barometer alone is now kept with tolerable accuracy, because that instrument, being little influenced by adventitious circumstances, marks nearly the same impressions over a wide extent of surface. The thermometer, again, is seldom observed at the proper hours, or in situations sufficiently detached from buildings and solid walls.

It is customary, for the sake of convenience, to note the thermometer in the morning, at the height of the day, and again in the evening. But these three observations must evidently give results below the medium temperature of the whole

* Government provided our discovery ships, sent to the Arctic seas, with meteorological instruments; but these, owing either to the ignorance or carelessness of the makers, were, in some instances, discovered to be very inefficient. Thus the thermometers were found to differ from one another ten degrees, and the Six's thermometers used for ascertaining the temperature of the sea at different depths, were not trustworthy. In future experiments with Six's thermometer, we would recommend correction to be made for the effect of the compression of the water against the bulb, as had been carefully done in Lord Mulgrave's voyage to those regions. Captain Parry carried out, in his second expedition, two sets of hygrometers, photometers, and æthrioscopes; but these instruments, it seems, were entrusted to the charge of the astronomer, who either broke or neglected them. Yet a connected series of observations, performed with such instruments in the Polar Regions, would have furnished most important data for extending meteorological science.

In a late philosophical voyage, directed to the Equator, some loose attempts have been made to estimate the radiation from the sky. But whatever may be said of the theory of the æthrioscope, its great delicacy is beyond dispute; and for an observer to overlook or disregard such an instrument, seems about as reasonable as if a navigator should prefer the old cross-staff to the sextant or the repeating circle.

twenty-four hours, since the accumulated warmth is counted only once, while the freshness, partaking of the night, is repeated twice. It would come nearer the truth to assume the middle point between the maximum and minimum, though even this cannot be deemed absolutely correct, because the heat neither mounts nor declines in an uniform progression. The hottest time of the day is generally about two o'clock in the afternoon, and the coldest just before sunrise. The hour of extreme descent is consequently, in most latitudes, very variable; and it would be difficult to fix the times suited for observing, unless they were more multiplied. But even fewer observations could sometimes be made to serve the purpose. In this climate, the daily average heat may be reckoned from that of eight o'clock of the morning; and the month of October is found to have nearly the mean temperature of the whole year.

The observations usually made with the hygroscopes of Deluc or Saussure, cannot be regarded as affording any definite indication of the dryness of the atmosphere. It would essentially contribute to the advancement of meteorological science, if the hygrometer, which I have described, were introduced into general practice. This adoption cannot be very distant *.

Some of the monks, in the religious houses dispersed over the Continent, might find agreeable and useful occupation in recording the state of the atmosphere. Many of these establishments are seated in lofty and romantic situations; and several of them, destined by their founders for the charitable accommodation of travellers, occupy the summits of the most elevated and inaccessible mountains. Accurate registers kept in such towering spots would be peculiarly interesting.

Meteorological registers might be regularly kept by the junior surgeons in all our medical depots which are scattered over various points of the globe. Lighthouses, too, would, from their usual position, be well fitted for observing the force and direction of the wind, and the swell and relapse of the tide. The elevation of the water could be most accurately noted by extending a leaden-pipe from the shore into the sea, and bending the nearer

* We purpose soon to give the results of some interesting observations made with this instrument in the West Indies, and in New South Wales.

end of it into a low cellar where a vertical glass syphon is attached to it.

Our navigators who traverse the ocean in every latitude, besides keeping meteorological journals and taking soundings, might record the variation of the needle, and examine the intensity of magnetic attraction.

To promote the science of meteorology, it would be most expedient that the various learned associations, planted in different parts of the globe, should institute inquiries into the state and internal motions of the higher strata of the atmosphere. As the ultimate results would prove advantageous to the public, the several governments, both in Europe and in America, might be expected to defray the moderate expence of carrying this plan into effect. Light small balloons could at times be launched towards the most elevated regions, to detect, by their flight, the existence and direction of currents which now escape our observation. Barometers, thermometers, hygrometers, and perhaps æthrioscopes, in compact forms, and which should register themselves, might be sent up in the car. Observers, furnished with accurate and complete instruments, could likewise be dispatched occasionally to the intermediate heights in large balloons. By classing the various meteorological journals, and combining those ulterior facts, some new lights could not fail to be struck out, which would gradually reveal that simple harmony, which assuredly pervades all the apparent complication of this Universal Frame.

The chief instruments here mentioned, and of the best and most accurate construction, may be purchased of Mr John Cary, optician, London, and of Mr Adie in Edinburgh.

Prices according to the style of mounting,

Hygrometer (branched),	£2	10	0	to	£3	0	0
Do. (portable),	3	0	0	to	3	6	0
Atmometer, -	1	10	0	to	2	0	0
Photometer, (portable),	3	3	0	to	3	10	0
Do. (branched),	3	5	0	to	3	15	0
Æthrioscope, -	4	0	0	to	5	0	0

N. B.—Mr Cary manufactures the staff-thermometers, and Mr Adie, Rutherford's thermometers.

Description of the Eruption of Long Lake and Mud Lake, in Vermont, and of the desolation effected by the rush of the waters through Barton River, and the lower country, towards Lake Memphremagog, in the summer of 1810, *in a Letter to Prof. Silliman* *. By the Rev. S. Edwards Dwight. With a Plan of the Lakes. (Plate III.)

My Dear Sir, *Boston, April* 4. 1826.

I left Burlington on Monday, August 18. 1823, and proceeded on horseback, in company with Mr ———, an alumnus of Burlington College, to Craftsbury, sixty miles; where we arrived at 2 p. m. on Tuesday. Through the kindness of my fellow traveller, an inhabitant of Craftsbury, I was able to engage a select and very agreeable party of five gentlemen to accompany me, on the succeeding day, to the bed of Long Lake, in the town of Glover,—the lake which was emptied of its waters in the summer of 1810. In the course of the afternoon, I had leisure to examine the local situation of Craftsbury. This village is built on a table-land, rising abruptly in the centre of a deep valley, which surrounds it on all sides, and separates it, at a moderate distance, from hills generally of the same height with itself, but occasionally aspiring to a greater elevation. This table-land is about three miles in length, and one and a half in breadth. The valley surrounding it was once probably a lake, and the table-land a large island in its centre. At present it is almost an island; one river winding more than half round it, in its progress through the valley, and a second nearly completing that part of the circuit which the first had left. Its situation is more than commonly beautiful and picturesque; and, in connection with other more solid advantages, bids fair to render it one of the most pleasant and flourishing villages in the state. The population planted here is of a superior character; and it gratified me to learn that the village reading-room, or *athenæum*, was regularly furnished with the most important reviews and magazines of England and the United States, as well as with

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* From Silliman's American Journal of Science and Arts, June 1826.

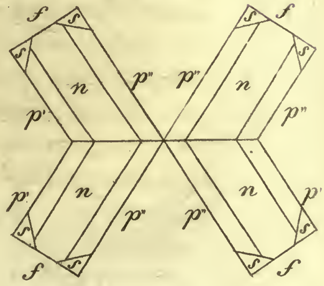
Plan illustrative of the Eruption of Long Lake and Mud Lake.

A surface of Long Lake.—B surface of Mud Lake.—C Wilson's Mill.
D Keene corner.—E Blodgets Mill.—F Enos's Mill.

Fossil Libellula.

Fig. 4.

Fig. 5.



Published by A. Black Edinr. 1827. E. Mitchell sculpt.

the gazettes of the latter. The village is well built, and every thing indicated good order and general prosperity.

Precisely at 4 A. M. of Wednesday, I sat down with one of my companions, to an excellent breakfast, which was rendered more hearty from the reflection that we might fare worse before the day was over; and at five we were all on our horses. We rode eastward, through a country chiefly forested, twelve or fifteen miles, to a scattered hamlet in the north part of Glover, called *Keene-Corner*, and settled by emigrants from Keene, in New Hampshire. As we began to descend from the high grounds towards the hamlet, we first saw the valley of Barton river; originally resembling the valleys of other streamlets of a similar size, but, at the time of the efflux of the lake, excavated into a broad, deep channel, with perpendicular banks; in the bottom of which the stream had worked out for itself a somewhat deeper bed. This river, which is here too small for a mill-stream, issues from Mud Lake, four miles south from Keene-Corner; and, after running northward from this hamlet about seven miles to the village of Barton, turns somewhat to the north-west, flows about fifteen miles, and is discharged into Lake Memphremagog. I was most agreeably surprized, as I descended the hills which overlook the valley of the river, to find the ravages made by the flood so distinctly visible, after the lapse of thirteen years. Our first view of the desolation presented a *gulley*, or excavation in the earth, extending up and down the river as far as its course was visible, and varying in breadth from twenty to forty rods, and in depth from twenty to forty feet. This immense channel, except what had been previously worn away by the gradual attrition of the streamlet, had all been hollowed out at once by the violence of the torrent. Its sides were precipices of earth or sand, every where indicating the avulsion of the mass which had been adjacent, and exhibiting in frequent succession, large rocks laid bare, and often jutting out into the gulley; and, near the top, the uncovered roots of trees, which, having been partially undermined by the water, still nodded over the precipice. The bottom of this channel, as far as we could see, was covered with larger and smaller rocks and stones, and in some places with extensive deposits of sand. The sight of this vast excavation only heightened our conceptions of the effects of the flood, and satisfied us that, in our visit to the bed of the lake whose waters had occasioned it, we should not be disappointed.

Having engaged a dinner at a sorry substitute for an inn, we turned to the south, and ascended Barton River, about four miles. In order to see the ravages of the flood more perfectly, we left the usual path on the left bank of the gulley, and rode all the way in its bed, over ground regularly ascending, until we came upon the northern shore of Mud Lake. This lake was originally the source of Barton River, and lay directly in the path along which the waters of Long Lake flowed, at the time of its evacuation. Here, of necessity, we left the gulley, and rode along the eastern shore of Mud Lake, until we had passed it; when, resuming our route in the bed of the gulley, we found the ground ascending very rapidly, until we entered the bed of the discharged lake. Having rode about half its length, we tied our horses, and pursued our way on foot, through the middle of its bed to the southern end. Here, ascending the bank to the original water-level, we could survey the whole bed of the lake, with its shores and surrounding scenery.

From my own personal observation, and from minute inquiries made of several individuals who were concerned in letting off the water, and of several gentlemen who were present at the legal investigation which it occasioned, I possessed myself of the following facts.

Long Lake, before it was drained, was a beautiful sheet of water, about a mile and a half in length from north to south, and, where largest, three-fourths of a mile in breadth. For about five hundred yards from the southern extremity, the lake was very narrow; and, to this distance, its water was shoal, having been nowhere more than ten or twelve feet deep. Here there is a sudden and steep descent in its bed, to the depth of 100 feet. Here also the lake opened rapidly to the breadth of half a mile, and then more gradually to three-fourths of a mile. The depth also increased, in the broadest part, to 150 feet, and did not diminish until within a small distance of the northern extremity, where the lake was about half a mile wide.

The eastern and western shores were bold, and rose immediately from the surface into hills of moderate height. These hills gradually subsided into plains, as they converged near the two ends of the lake, to form the northern and southern shores.

The lake was supplied with water by a small rivulet, which still continues to flow in on its western side. At the southern extremity, over ground scarcely descending, and through a channel of probably not more than a yard in width, the water of the lake flowed out in a dull streamlet toward the south-west, and between trees, shrubs, and rocks, worked out for itself a sluggish passage. This was the original outlet of the lake, and the remotest head-water of the river La Moelle, a tributary of Lake Champlain. The northern shore was generally low, rising not more than five or six feet above the surface of the lake, and consisted of a narrow belt of sand, succeeded by a bank of light sandy earth. The country all around the lake, as well as along its outlet at the southern extremity, was one unbroken forest.

The distance from the northern end of Long Lake to the southern end of Mud Lake, was about 200 rods. There was no original communication between them; the waters of the former, as we have already seen, having been discharged towards the south, and those of the latter towards the north. The ground between the two was covered with a thick forest, and formed a very rapid declivity from Long Lake towards Mud Lake. The low bank of sandy earth which formed the northern boundary of Long Lake, continued of an uniform height for about five rods from the shore, where, becoming more firm and solid, it descended so rapidly towards Mud Lake, that the perpendicular descent between the two, in the distance of 200 rods, was at least 200 feet.

The bottom of Long Lake, near the western shore, was rocky; at the southern extremity, beneath the shoal water, it was a mound of sandy earth, and throughout the great body of the lake was either sand or mud. The mud was black, light and loose; when wet, flowing like water, and when dry, of a blue colour, and light as a cork. The descent, at the northern shore, was bold and rapid; and on the bottom, near the shore, was spread out a calcareous petrifaction, or deposit, called by one of the workmen a *hard-pan*, of the thickness generally of two or three inches, though occasionally of six or eight. I saw numerous fragments of it; and one, which I brought home, was an inch and a half thick, and had the solidity and hardness of limestone. Its upper surface was of a light yellowish-brown colour, and had the smoothness of a stalactite; while the lower was rough and uneven, embodying pebbles, sand, weeds, and other coarse substances, on which the calcareous deposit, at its first commencement, had settled. The fracture, to use the sprightly language of my principal informant, one of the individuals concerned in letting off the water, resembled *frozen gravel.*

This hard-pan reached out from the shore into the lake, for a breadth of five or six rods, resting on the bottom; and was found along the whole northern extremity. Being rather feebly and doubtfully sustained by the mass of sand underneath, on which it lay as on an inclined plane, it supported the superincumbent water, and formed the only solid barrier which prohibited the contents of Long Lake from descending into Mud Lake.

Mud Lake was originally three-fourths of a mile in length from north to south, and half a mile in breadth. Its shores, both on the western and eastern sides, soon rose into high grounds; between which, and over the bed of Mud Lake, the waters of Long Lake, if let out northward, must necessarily pass. The bottom of Mud Lake was a mass of thick deep mud, tough and gritty, of a rusty dark blue, many feet in thickness; and, when dry, becoming of a pale blue, and of a hard solid texture. This lake was originally deep, though less so than the other. Barton River, its outlet, descended very rapidly through a rough uneven country, over a bed of sand and pebbles, for about five miles, and then more gradually, and with a margin of meadow on each hand, for six miles, to the village in Barton. All this distance, with the exception of a few cleared spots at Keene-Corner, and in Barton, the country was, in 1810, a thick forest, on both sides of the stream, to its very banks. At Keene-Corner, four miles from Mud Lake, stood a grist-mill and a saw-mill, both owned by a Mr Wilson; but the stream was so small that, in the dry season, the supply of water was insufficient for the mills. About seven miles lower down, it unites with a still larger stream from the right, the outlet of Belle Pond, a beautiful lake in Barton. Two miles further down was another grist-mill, owned by a Mr Blodget; and three miles lower, were the mills of a Mr Enos.

The insufficient supply of water at Wilson's mills, was a serious inconvenience to the inhabitants of Keene-Corner, as well as to the proprietor himself. The comparative elevation of the water in the two lakes, and the nature of the ground between them, had long been known at the hamlet, and had frequently provoked discussions of the question, *Whether it was not practicable to let out a part of the water of Long Lake into Mud Lake, and thus furnish an additional supply to the mills on Barton River?* These discussions always ended in an affirmative decision; and the disposition to test its correctness regularly gaining strength, as the practicability and importance of the measure were more and more developed, it was at length resolved, in *out-of-door* convocation, that the thing should be done; and the 6th of June 1810, the day of the general election of New Hampshire, which, out of respect to their parent state, they had usually observed as a holiday, was selected for the purpose.

On the morning of that day, about 100 individuals from Glover, Barton, and several of the adjacent towns, assembled at Keene-Corner, with their shovels and spades, their hoes and axes, their crowbars and pick-axes, and their *canteens*, and voted that they would march to Long Lake, and there have "a regular Election *Scrape*."* They arrived at the scene of action about ten o'clock; and, having selected the spot which seemed most feasible, began to cut down the trees, and to dig a channel for the water across the belt of sandy earth which constituted the northern boundary of the lake. At three o'clock, a trench five feet wide, five or six rods in length, and seven or eight feet deep, was completed. It began within a yard of the water, and reached to the brow of the declivity, towards Mud Lake; yet gradually descended in its line of direction; so that, when the small remaining mass of sand in the trench should be removed, they might see the waters of the lake flow out without interruption, to increase the mill-stream of the village.

At length, the command being given that all hands should leave the trench, the mass of sand left in it, with a portion of that under the hard-pan, were removed; and as large a piece of the hard-pan as their pick-axes would reach, was broken off. The water issued at first through the chasm thus made, with a moderate degree of force; but, to the great surprize of the work-

* *Scrape*, in this sense, is a colloquial Americanism, and denotes *a frolic.*

men, it did not run off into the trench. One fact, having an important bearing on the ultimate success of their enterprize, had escaped their observation. The sand under the hard-pan was a species of *quicksand;* and the issuing stream, instead of flowing obliquely towards the declivity, began to sink perpendicularly beneath the hard-pan, and to work down a portion of the quicksand, so that it disappeared with the water. In a few moments a large amount of the sand under the hard-pan was washed from beneath it; and the portion of the hard-pan, thus undermined, being unable to sustain the immense pressure, gave way. This occasioned a violent rushing of water to the deeper outlet thus formed; which, in its turn, sinking under the hard-pan, and washing down a still larger portion of the sand on which it rested, occasioned a still broader and deeper fracture of the hard-pan, and prepared the way for a still more violent gushing of the water, and a still wider and deeper gulf in the sands beneath, until all traces of the original trench had vanished. This process was repeated a considerable number of times, every fracture of the hard-pan being more extensive than the preceding; until, by the undermining force of the water, a deep gulf was worn where the trench had been, several rods in width, and descending immediately and rapidly towards Mud Lake.

Just as the efflux of the water commenced, four or five of the workmen pushed out into the lake upon a raft; intending to cross its northern end, and on their way to sound an *hurrah* becoming the occasion; but, the alarm having been given, they put to shore, and had barely left the ground on which they landed, when it disappeared. One of the others, having remained too long at work in the trench, was struck by the torrent; and the ground being washed from beneath him, he would have been carried away, had he not been caught by the hair of his head. Another, waiting too long to witness the violence of the water, was forced partly under the earth; and it was owing probably to the momentary resistance presented by the roots of a large tree, against which he was driven, that he, and those who came to his assistance, were saved. These accidents induced the workmen to retreat with rapidity from the sides of the widening gulf. In the language of one of them, they felt the ground beneath "quiver, quiver, quiver," as they ran away with all possible speed to save their lives. Having all at length got out of danger, they stood on firm ground near the lake, and on both sides of the widening chasm, and observed the progress of the desolation.

As the water rushed from the southern towards the northern extremity, it forced up upon the shore a large mass of soft, oozy mud, several rods above the existing water-level, on either side of the outlet. This mud remained stationary for some time, and on its surface a large number of the fish of the lake lay snapping and flouncing. Just as one of the workmen was venturing into the mud to secure some of the fish, the water having chiefly run out; the two masses of mud, being no longer pressed upward by the force of water, slid down at once into the gulf, and were immediately swept away.

This process of undermining and fracturing successive portions of the hard-pan having been continued about twenty minutes, a passage was forced through it, down to its lower extremity; and the superincumbent water of the lake, being thus left wholly without support, flowed with such impetuosity towards the northern shore, that it all gave way to the width of more than a quarter of a mile, and the depth of 150 feet. The whole barrier being thus removed, the entire mass of waters rushed out with inconceivable force and violence; and, the northern end being the deepest, it was but a few moments before a volume of water, a mile and a half in length, about three-fourths of a mile in width, and from 100 to 150 feet in depth, had wholly disappeared.

The liberated mass of water made its way down the declivity, to the valley of Mud Lake, tearing up and bearing before it, trees, earth and rocks, *and excavating a channel of a quarter of a mile in width, and from* 50 *to* 80 *feet in depth.* With the immense momentum which it had gained, it flowed into this valley, forcing forward, with irresistible impetuosity, the spoils which it had already accumulated; tore away masses of earth from the high grounds on each side of the lake; excavated the whole bottom of the valley, including the shores of the lake, to the depth of perhaps 30 feet; and, with the additional mass of water thus acquired, made its way down the channel of Barton River.

Mud Lake had originally a narrow outlet, and rising grounds of moderate height bounded it at the northern end. The accumulated torrent, bearing along the gathered spoils of its own desolations, broke away this mound in a moment; and following the course of the river, rushed down the long and rapid descent of five miles towards the flats in Barton. Through all this distance it tore up and carried away the forest trees, and hollowed out to itself a path in the earth, varying from 20 to 40 rods in width, and from 20 feet to 60 in depth, so that every trace of the original bed of Barton River disappeared, and the river was left to choose for itself a new bed, many feet below the old one in the bottom of the gulley. In some instances the excavation was narrower, in consequence of huge rocks on both sides, which the torrent could not move; but, in such cases, amends were made in its greater depth. Where an immoveable rock was found on one side only, it usually altered the course of the torrent, without materially diminishing its breadth. Wherever any such obstruction made an eddy, by stopping momentarily the torrent's progress, the effect was still observable in deposits of sand, immediately above the obstructions, varying in depth and extent with the time during which the water paused, and the surface which it covered at the moment. Some of these are an acre or more in extent, and 20 feet in depth. In these cases there was usually a deposit of the floating forest trees. At Keene-Corner, it not only swept away the grist-mill and saw-mill of Mr Wilson, with the mill-dams, but the mill-sites, with the ground beneath them for many feet, as well as the bed of the river by which they had been imperfectly supplied. A man in one of the mills, hearing the noise of the approaching flood, ran to save himself; and had but just escaped from its path as it went by. His horse, tied at a post near the mill, was swept away, and was afterwards found a great distance below, literally torn to pieces.

About a mile below the mills the torrent entered a more level country; where the river had been wont to glide through a broader valley, and was generally bordered with flats or intervals of some rods in width, covered with forest trees. Here this moving mass of trees, earth and water, expanded itself as the country opened, and with the velocity acquired in its long descent, marched onwards in its work of desolation. Not satisfied with tearing up the trees, it removed the earth beneath them to a considerable depth, and bore away masses of earth from the sides of the high grounds, by which the original valley of the river was bounded. These it left precipitous; exhibiting on the perpendicular face denuded rocks and roots of trees, and in every place pointing out the exact breadth of the torrent's march. The trees on the brink, which were not destroyed, showed strong proofs of the violence; proofs which were often discoverable at the end of thirteen years. Wherever the original valley narrowed, or suddenly changed its course, and its boundaries were too firm to be pushed away, the torrent, receiving a momentary check, became narrower and higher, and left deposits of sand and of trees in the valley, and frequently on the high grounds. The forests were thus levelled, and the excavation continued some distance below the mill of Mr Blodget, 14 miles from the lake. There, owing to the widening of the hills, and the more cleared state of the country, it gradually spent its force, though many marks of its violence are witnessed all the way to Lake Memphremagog. Through the more level country, the excavation which it left to indicate its path, varied from 30 to 60 rods in width, while its average depth was probably from 10 to 15 feet.

An inhabitant of Barton, who was standing at the time on a high ground, told me, that, hearing the noise, he looked up the stream, and saw the flood marching rapidly forward, opening itself a path through the valley, and bearing a moving forest on its very top; so that those who were with him gave the alarm that the forest from Glover was coming down upon Barton. The house of a Mr Gould, in Barton, standing 15 feet above high-water mark, was within the track of the torrent, and himself and his wife were at home. Alarmed by the noise, he caught his wife in his arms, and carried her up the bank; yet it was with the utmost difficulty that they escaped. The water rose to the eaves of the house, and removed it from its foundation: but bearing it against some stumps of trees, which were very firmly braced in the earth, it remained there when the flood had subsided. The saw-mill of Mr Blodget, with the mill-dam, was entirely swept away, as was every bridge on Barton river, between Mud Lake and Lake Memphremagog. At Enos's Mills, 5 miles below the village of Barton, and 17 below Long Lake, the torrent retained so much of its impetuosity, that it moved a rock, supposed to be of 100 tons in weight, a number of rods from its bed.

Some of the deposits of sand were very extensive; and the changes effected by the deposition were different in different species of soil. Extensive tracts of the flats on Barton river were fine meadow land; while other tracts were sunken swamps. The former, so far as they received the deposits, were left mere fields of barren sand; while the latter were converted by them in a short time into the richest meadows. One swamp, to the amount of two hundred acres, and several others to the amount of three hundred more, were thus recovered; while various tracts of meadow, in all about one hundred acres, were permanently ruined.

Masses of wood were deposited, in greater or less frequency, along the banks of the gulley, as well as in much larger heaps in those places where the progress of the torrent was momentarily suspended. Some of the men who witnessed it, told me that tens of thousands of cords, a quantity which could not be calculated, were thus left in Barton, besides a vast number floated further down. Near the church in Barton, a field of twenty acres was covered with deposited timber to the height of twenty feet. In several places, where the torrent was powerfully obstructed and suddenly narrowed, (as I was informed by two of the inhabitants), the timber was piled up by the force of the stream, to the height of 60 or 80 feet. Vast quantities of it were sunk under the sand. That which lay upon the surface was burned as fast as it dried, and they had been burning it continually to clear the land; yet many acres of meadow still remained covered with timber; and I also saw numerous large heaps of it skirting the edge of either bank. The kinds of timber were spruce, cedar, hemlock and hackmontak. The trees were much bruised, the branches generally broken, and the bark peeled off; while the trees left standing near the two edges of the torrent, were principally killed.

I was informed that deposits both of wood and sand were made in this manner, on both sides of the torrent's path, all the way from Barton to Lake Memphremagog; and that large quantities of forest trees were strewed over the surface of the lake. The hard tough mud in the bottom of Mud Lake, was all forced out and carried away, and was seen scattered in smaller and larger masses—some, of the size of haycocks—for a great distance along the progress of the torrent, and over the adjoining fields.

Several of the workmen informed me that when the northern barrier of Long Lake gave way, and while the waters rushed down the declivity into Mud Lake, the convulsion shook the earth like a mighty earthquake; and that the noise was louder than the loudest thunder, and was heard for many miles around. One of them, whose house was more than five miles from the spot, told me that the noise there was so loud that the cattle came running home, with the most obvious marks of terror and alarm; and that his family supposed, until his return, that there had been a tremendous earthquake, accompanied with loud thunder. The noise and agitation were also very great, while the torrent made its way downward, from Mud Lake to Keene Corner, and, even during its progress in the more level region, greatly alarmed all the surrounding country.

The waters of Long Lake were undoubtedly *calcareous.* I saw on the bottom many siliceous rocks; but the fissures of these rocks were frequently filled with deposits of limestone. There were numerous masses or rocks of limestone, of a bluish black colour, occasionally imbedding pebbles of a different colour and genus. Some of these masses were exceedingly hard and firm, others were only brittle, while others were friable, and others still were heaps of bluish black limestone dust,—the embryos of rocks which had not yet received the cohesion necessary to bind them into solid masses, when the matrix in which they were forming was dissolved. Probably the black sponge mud of Long Lake was chiefly of this character; as this very substance, when wet, has a similar appearance. In various places on the bottom of the lake, are deposits of a friable white substance, which is almost pure carbonate of lime. This substance, as we shall have reason to see, was much more abundant before the emptying of the lake. Had a skilful mineralogist been with me, he might doubtless have made important discoveries.

The bottom of the lake was in some places boggy, but generally so dry that we could walk over it without difficulty. It was extensively grown over with sedge and other weeds, and in many places with shrubs and young trees. The original water-level of the lake was generally discoverable along the shores. The same rivulet still flows in on the west side, which originally supplied its waters; but it now flows out at the northern end into Mud Lake. It is about a yard over; and, as no reason can be given why it should have diminished, I conclude that this was the size of the outlet of Long Lake. The flood left obvious traces of its violence within the bed of the lake. At the southern end, the water on the shoal, not more than 10 or 12 feet deep, rushing down the pitch into the deeper part of the lake, swept down a considerable mass of earth and rocks, and near the middle of the pitch, from east to west, formed an excavation, or trench, about one hundred yards in length, narrower and shallow at its commencement, but widening and deepening all the way to the bottom, where it is several rods in width. On both shores of the lake, the force of the water tore away large masses of earth, forced rocks out of their original bed, and, in various instances, laid bare the surface of extensive ledges of rock, which had been previously imbedded in earth; leaving them projecting a considerable distance beyond the line of the shore. These effects were most marked towards the northern end. About twenty rods from that end, an excavation, or trench, commences in the bottom of the lake, and continues to widen and deepen, until it coincides with the deep gulley at the outlet.

The surface of Mud Lake is at least 30 feet lower, in the opinion of the workmen, than before, and has not more than half of its original extent. The soft mud from the bottom of Long Lake, flowed into Mud Lake *, and took the place of the hard, tough mud, which originally formed its bed. So large was the supply, that Mud Lake is now shallow—having been

* This lake was without a name, until this event procured for it this less poetical than appropriate designation.

filled up at the bottom, as well as cut off at the top by the abrasion of the torrent. I saw perhaps twenty of the trees, which had been left in it thirteen years before, standing up from its bottom, in various directions; and the length of their stems above the water, indicated that the depth was moderate. Before the draining of Long Lake, Mud Lake had no lime; but large quantities of the white friable carbonate of lime were brought down and deposited within and around it, so as to render the manufacture of quick-lime a regular employment for several of the inhabitants.

Mr Blodget, the proprietor of the mill destroyed in Barton, instituted a suit against some of the individuals employed in letting out the waters of Long Lake. In the course of the trial, the whole history of the event was brought to light. He laid his damages at 1000 dollars; but, *pendente lite*, compromised the matter for 100, on condition that each party should pay his own costs.

It was doubtless a favourable circumstance, that Long Lake was drained while the country on Barton River was a wilderness. From the singular configuration of the adjacent ground, it is certain that its contents would sooner or later have been emptied into Mud Lake; and had the discharge been deferred until the country had been well settled, the injury would have been incalculable. At the time when the event occurred no material injury was done, and an essential service rendered the community; as the bed of the lake furnishes an advantageous site for a road leading to the country eastward of Glover, which the hills had previously rendered impracticable. Such a road had been seriously proposed when I was there; and my only objection to the measure lay in the fact, that, by effacing the vestiges of desolation, it would violate the rights of philosophical enquiry.

This event appears to confirm an opinion, extensively entertained in this country, respecting the changes which various parts of its surface have in former periods undergone. Valleys are here and there found, with streams of water passing through them, surrounded on all sides by high grounds, except a very narrow passage for the stream to enter, and another for it to escape; and in both, the whole appearance of the ground indicates that the high ground actually met, in some former period; that the valley was originally a lake; and that its water was discharged by a waterfall. There is so much resemblance between the bed of Long Lake and some of these places which I have examined, that I cannot doubt the correctness of this opinion. Had the waters of that lake been discharged two centuries earlier, its bed, and the gulley which it formed, would have been filled with a thrifty forest; and the evidence that it had ever been a lake would have been no more satisfactory than we now possess, that the places to which I have alluded were once filled with water. We now *know the fact*, however, that lakes may be suddenly and finally emptied, and their beds changed to fertile valleys, so as to lose, in no great length of time, all traces of the immediate action of water.

Several individuals, well acquainted with the country, informed me that the ground at one extremity of Lake Willoughby, which lies a few miles east of Barton, is formed like that at the northern extremity of Long Lake; and that its waters could be discharged with even less labour, than were those of the latter. Lake Willoughby is about seven miles long, about three miles wide in the broadest part, and very deep; and its waters, if thus discharged, must flow south-eastward, through the valley of the Presumpsick, into the Connecticut. Could the discharge be achieved without too much hazard, it would be an incalculable advantage to a large extent of country; as a long range of towns in the neighbourhood of this lake, are separated from the Connecticut by a chain of pathless mountains, through which no road can be formed, except over the emptied bed of Lake Willoughby, and are thus compelled to find their market down the valley of the Presumpsick; a fact which has almost entirely prevented their settlement.

After we had examined the bed of Long Lake, and the ravages which its waters had occasioned, as long and as minutely as our time would permit, we returned down the gulley, and arrived at our inn at 3 o'clock, where we sat down to a meal rendered welcome by laborious exercise and the fasting of ten hours. Immediately after, bidding four of my companions adieu, I rode down the river in company with the fifth, to the village of Barton. Our course was on the eastern bank of the gulley, and every step of the way I could witness the desolation of the torrent. Taking the whole excavation for the twelve miles in which I followed it, it is the highest exhibition of the effects of physical force, instantaneously exerted, which I have yet seen.

See Plate III. for a Plan of the Lakes, illustrative of the details above given.

Overland Arctic Expedition.

As any notice, however short, of the scientific doings of this enterprise, cannot fail to prove acceptable, we now add the following details to those already communicated.

"Fort Franklin, Great Bear Lake,
"*February* 6. 1826.

"Nothing of any importance has occurred since I wrote you last, except that we have received a friendly message from the Esquimaux, through the Sharp Eyes, a neighbouring tribe, who frequent Fort Good Hope, the most northerly of the Company's posts. On the 29th of November last, the S. W. quarter of the sky was cloudless, but of a pure *emerald-green colour* (compared at the moment with Syme's book), soon fading away into mountain-green. The rays of the sun setting to the S.S.E. at the same time tinged some clouds gold-yellow, &c. The aurora has not been so frequent, and our observations of course upon it are not so interesting, as at Fort Enterprise As far as they go, they confirm the few general remarks then hazarded, although I think not favourable, in general, to Hansteen's theory. With regard to facts, Captain Franklin's observations and Hansteen's seem to agree. The *Edinburgh Philosophical Journal* for March 1825 reached us last month, and has proved a great treat to us. I am glad to see it go on so vigorously.

"We expect, if every thing prospers with us, and at present we have no reason to fear any misadventure, that we shall reach England early in November 1827. This is rather too quick a movement for the purposes of science. Even a cursory view of the geology of the Rocky Mountains skirting Mackenzie's River might occupy some months very pleasantly; but the delay of a few days here is the loss of a season, and we cannot reckon on more than two months in the year for such purposes."

"FORT FRANKLIN, GREAT BEAR LAKE,
"*March* 23. 1826.

"MY DEAR SIR,

"IN consequence of an imperfect, but very interesting, Indian report of Captain Parry's wintering on the coast, and which Captain Franklin is desirous of investigating, I have another opportunity of writing to you this season. The particulars of the report, when ascertained, will be transmitted to Mr Barrow, from whom you may get them.

"I mentioned, in a former letter, that a formation of *lignite* occurs in this quarter. The lignite has a slaty structure, thinnish, or only moderately thick; and, when exposed to the atmosphere, cracks into forms generally nearly rectangular. Some portions, which are rather thick slaty, with a flat conchoidal fracture in the small, bear a very near resemblance to the slaggy mineral pitch or bitumen so common in the limestone formation of Slave River (zechstein?). It is distinguished from it when put in the fire.

"In the more common form of the lignite, the surface of the slates is more dull and earthy, of a brownish-black colour, but yielding a shining streak. These slates are entirely composed of fragments, having all the appearance of charred wood united together by a paste of more comminuted woody matter, mixed perhaps with a minute portion of clay. In the paste, there are some minute perfectly transparent crystals, having the form of compressed four sided prisms, and sometimes of tables. The fibrous structure of the woody fragments is fine, and the lustre resembles that of fresh well-made charcoal of brick. The structure is evidently *exogenous*. The fragments are generally small, but, when several inches in diameter, their layers of structure are waved and curved, as if they had been knots, which of course would not so easily break down as the other portions. One of my specimens shews a small grain, either of resin or of amber; and I have picked out of another a membranous substance, which has all the appearance of a portion of *Ulva montana* (Bot. App. Franklin's Journey) common here at the present time. I inclose this minute specimen, which has already suffered some diminution in the course of my examination of it. Muriatic acid produced no change in it; but I was afraid to try the nitric acid, lest it should destroy it.

"When put into the fire the lignite burns without flame, and emits a very disagreeable stench, unlike that of either peat or of sulphur. The combustion does not cease when the coal is removed from the fire, but goes on slowly, until there is only a brownish-red ash remaining, not one-tenth of the original bulk of the specimen.

"The beds of lignite lie on the east side of Bear Lake River, where it joins the Mackenzie, are in the aggregate six or seven yards thick, and are covered by a thick bed of loose sand. They were on fire when Sir A. Mackenzie discovered the river (in 1789), and have continued burning ever since. At the distance of a few hundred yards up the Bear Lake River, there are some thick beds of a coarse, bluish-grey, earthy looking sandstone (very like that on the north side of the Calton Hill), dipping at a small angle under the lignite. They were not seen in actual contact. On the opposite side of Bear Lake River, which is 200 yards wide, a craggy hill of (carboniferous?) limestone rises abruptly to the elevation of 400 feet. About 30 miles farther up Bear Lake River, and nearly east from its mouth, the stream cuts the base of another limestone hill, of similar form and height, belonging to a chain of (partly transition?) hills, which runs N.W. and S.E. through a flat country. At the foot of the nearly vertical limestone, but separated from it by a small rivulet, there are thick horizontal beds of sandstone, resembling that at the mouth of Bear Lake River. Upon this sandstone lie a number of thin beds of bituminous shale and sandstone, which weather easily. In the shale there are impressions of ferns (polypodiaceæ), and in the slaty sandstone lepidodendra? I have had no opportunity of examining these rocks, excepting very cursorily, as we passed them in the boat, and occasionally snatched a specimen; but I purpose, if the snow disappears long enough before the opening of the navigation, to visit them carefully this spring. The finest sections on the banks of the river will be hid by accumulations of ice till the autumn."

On the Luminousness observed in the Eyes of Human Beings, and also in those of Cats, Dogs, Horses, and Sheep. By Dr CHARLES LUDWIG ESSER *.

APPEARANCES of light, as is well known, are not uncommon in inferior animals, and the number of luminous animals in the sea is so great, that large tracts of the water's surface have been seen to be illuminated by them.

This phenomenon, however, is comparatively seldom observed in fishes, and the more rarely the higher we ascend in the scale of the animal kingdom, if under the denomination of luminousness, we understand the real evolution of light, and do not consider it as the reflection of the incident rays of light; for in this latter case the luminous appearance does not inhere in the animal body itself, but is in reality merely a reflection, which is totally different from the evolution of light in the inferior animals. A real phosphorescence is sometimes observed in the higher animals, and even in human beings, particularly in their excrementitious fluids. The light of the eggs of the lizard, the luminousness of the perspired matter in man and horses, the irradiation of light in cats and other animals, from the stroking of their hair, and finally the phosphorescent quality of human urine, have been frequently observed.

On most of these various kinds of light, I have neither performed experiments myself, nor have I collected the facts of others; the present memoir being chiefly devoted to an examination of the light or luminousness of the eyes in human beings and inferior animals.

The more perfectly to accomplish this object, I some years ago performed a series of experiments, that led to an important result.

Having brought a cat into a room half darkened, I observed that the eyes of the animal when opposite the window, and in a certain direction to myself, sparkled very brilliantly, which phenomenon suddenly vanished, when I, either by the motion of my head, changed the direction of my eyes to those of the cat, or the

* Karsten's Archiv, b. viii. heft iv.

animal, by moving its eyes to and fro, brought them into a different position. In a situation wherein I could best observe the eyes of my cat, I caused the room to be slowly darkened, by gradually closing the window-shutters. The light of its eyes became weaker, and vanished entirely as soon as the room, on the place where the cat was situated, became absolutely dark. Incident rays of light were always necessary to produce the luminousness of the eyes.

I wrapped another cat in a cloth, but left the head uncovered, whereby I was able to handle the animal as I had a mind, and place it in any situation I chose. In this cat what I have just stated was confirmed. I placed it in such a position that its head, at the distance of a few steps, was directed towards the window, by which means I could lighten or darken the room at pleasure. I now permitted a few rays of light to fall through the window into the room, in such a manner, that the place where the cat was present was illuminated; and I placed myself in such a direction towards the window, that my eyes were in a straight line with those of the animal, so that I saw the light of its eyes very distinctly, which light, as in the former experiment, suddenly vanished when I turned my head, or the cat turned its eyes. At the moment when my eyes were directed in the manner just mentioned, I observed a most beautiful green light; but when they were out of this direction, the cat's eyes had their usual appearance. By the turning of my head, or by any other arrangement I chose, by which I intercepted the incident rays, I could at pleasure cause sometimes the one eye of the cat, sometimes the other, and sometimes both together, to shine. If I intercepted the incident rays of light from the left half of the head, the right eye became luminous, and conversely. In these experiments, I observed quite distinctly that the light of my cat's eye emanated from the pupil, the eye itself being lightened only in proportion to the dilatation of that part of it. By suddenly admitting a strong glare of light into the room, I produced a contraction of the pupil; and when I suddenly rendered the room somewhat dark, a small round luminous point first appeared in the eye, and that point enlarged according as the pupil was dilated. The pupil of the eye of these animals being thus dilated in imperfect darkness, so that the iris seems to encircle the pupil as a small ring, and the sclerotic in cats being scarcely visible, may be the reason why it is believed that the whole eye of the cat is luminous, although its light is, nevertheless, only in proportion to the dilatation of the pupil.

The dilatation of the pupil in twilight is, however, not the only cause of the light of the eyes; but the light surrounding the animal being fainter, also assists us in perceiving with greater distinctness the light as it is more vividly reflected from their eyes; for, if we suddenly illuminate the chamber in which there is a cat, there remains nothing but a luminous brightness where there was formerly a beautiful yellowish green light.

The light of my cat's eyes seemed to be more vivid when she opened them wide from apprehension, or looked around her attentively; whence Treviranus observed, that the eyes of cats sparkled most when the animals were in a lurking position, or in a state of irritation. That author says,

"The light of the cat's eyes appears most conspicuous when she is in a lurking position,—when she is attracted by any unusual appearance,—or when irritated. In the first two instances, the light is faint and dull: in the last instances, it darts forth in intermittent scintillations, and at those moments when the light is most vivid, there are accompanying movements of the eyes." That the light of the eyes of animals appears brighter in a state of irritation than in a state of quiescence, seems to originate in this, that the eyes of all animals, as well as those of man, appear brighter in violent rage, and sparkle more, than in a quiescent state. This, in man, seems to arise from an increased secretion of the lachrymal fluid on the surface of the eye, by which fluid the light of the eye is undoubtedly rendered more brilliant. Treviranus farther observes, "The eyes of the cat shine also where no rays of light penetrate, and the light must in many, if not in all, cases proceed from the eye itself." Before performing the above experiments, I entertained the same opinion with Treviranus, and made many fruitless experiments with cats in the dark, before I abandoned the position. The light must be brighter in proportion to the darkness of the place where the cat is. I soon renounced this opinion, when, in all the experiments I made on cats, in places absolutely dark, I did not discover the slightest trace of light in the eyes of these animals, let me irritate them as I could.

Many of my friends, to whom I mentioned my experiments, and the result of them, objected to me, that I could not possibly be correct, for they themselves had observed cats' eyes shining in the very darkest places, as, for example, in a cellar. I have had frequent opportunities since of making observations to the same effect; but every time has, nevertheless, convinced me, that, even in such places, the rays of light having passed through a window or some other aperture, fell upon the eyes of the animals as they turned towards the opening, and were placed in a proper position in regard to the observer. Gruithuisen likewise mentions a case in which he could produce light from the eyes of a cat at pleasure; in places absolutely dark, however, he never observed any light.

To ascertain what appearance the eyes of a cat exhibit after death, I cut off the head of one, placed it opposite to the window, at the distance of some yards, so that the rays of light passing through the window might fall on the eyes. I now observed, that the eyes of the dead cat shone far more vividly than those of a living one. By illuminating the apartment, the light was not, as in living cats, weaker but stronger, and was so powerful when I completely illuminated the room, and allowed the sun's rays to fall immediately on the eyes of the cat, that it resembled the most beautiful green fire, which lost its intensity however, and exhibited only a clear greenish brightness, when the rays of the sun, as in the open air, fell on all sides. In places perfectly dark, the light of the eyes, as in all my former experiments, completely vanished. All my subsequent experiments, in which many a cat lost its life, were uniformly followed by the same result.

The light of the cat's eyes being brighter after death than when in life, may probably be owing to this,—that after death the pupil is so much dilated as almost entirely to hide the iris; and that the pupil, being now insensible to the rays of light falling on it, is never closed again, and does not obstruct the passage of the penetrating rays of light, as is well known to be the case during life.

Farther, the light of the eyes of those animals, that after death were subjected to experiment, became gradually weaker as the cornea grew duller. When that part of the eye was moistened, the intensity of the light was increased to a certain extent, but faded away with the decomposition of the eye itself, and eternal darkness reigned in the stead of glorious light. I believe I observed a difference in the degree of light, according to the colour of the cat; and it is certain, that black and fox-coloured cats evolve a brighter and more conspicuous light from their eyes, than grey and white ones, though there may undoubtedly be exceptions to this distinction *.

Besides cats, many domestic as well as other animals, are furnished with luminous eyes.

Under similar circumstances as above, I observed that the light of a dog's eye, as was the case in my experiments on cats, vanished suddenly as soon as I had completely darkened the room where the dog was. I observed the eyes of another dog sparkle when he was irritated, and in the corner of a room that was faintly lighted. The eyes of the animal protruded very much, glittered brilliantly, and the pupils were dilated to an unusual degree. The colour of the light, which was commonly yellow, changed more or less as the rays of light fell on the eyes of the animal, and exhibited the following appearances. When a small body of rays of light fell on the eye, the light was of a fiery redness, and sometimes so strong, that after I looked a long time attentively at it, my own eyes experienced a disagreeable sensation. When there was a great body of rays, the light was green or yellow, sometimes bluish. In respect to this change in the colour of the light, I was inclined to think, that it might be owing as much to the motions of the animal's eyes as to the body of light that fell upon them. This change was different in different dogs, and in some it was not at all observable. Further, the eyes of every dog placed in the same situation, shone, but the intensity of the light varied with the individuals.

I have observed luminousness in the eyes of horses, sheep and hares, which was different, however, in colour and strength.

Many appearances of light have been observed in the eyes of human beings. Treviranus mentions, that G. T. L. Sachs, and his sister, both belonging to albinoes, had phosphorescent

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* Bened. Prevost's Memoir on the Luminousness of the Eyes of animals, will be given in our next number.

eyes. Late in the evening there appeared in them a lively yellowish brightness, which darted forth in fiery *coruscations* or globules, from the interior of the eyes. The balls rolled *hither and thither*, and frequently ejected rays, at least an inch in length. In these two relatives the light was liveliest and strongest after their birth, and during infancy: in their more advanced years the light was strongest when they were in deep meditation; at this time, also, the oscillation, which they had in common with other albinoes, was liveliest.

A rather remarkable observation, and similar to the case of the Sachs, is that of Michaelis, who, many years before his death, during the interval between day and night, and during the night itself, observed irradiations of light issuing from his eyes; sometimes so strong that he could read the smallest print. (Schlichtegroll's Necrolog, des 19. Jahrhunderts, B. 3. s. 337).

In a boy, who belonged to the Albino variety, I observed a similar case, though not accompanied with irradiation. In this boy, who suffered so much from the dread of light that he never ventured abroad except in twilight, I frequently observed the same fiery eyes, yet were they very different, both in the strength and colour of their light, from the luminous eyes of animals which I had observed, partly from design and partly from accident; for this boy's eyes might be called glassy rather than luminous. Some years ago I was assured by (Hr^{n} Geheimenrath W), that his sister had often observed the eyes of her children, who were also albinoes, to be luminous. These last two cases could be traced to rays of light falling on the eyes.

It now remained for me to search out the cause, which, by means of the incident rays of light, gave rise to the shining appearance in the eyes of human beings and inferior animals. The explanation seemed to me no easy matter, yet, from the beginning, I expected to be able to search out the cause of this phenomenon, in a reflection of rays of light penetrating into the eye. The colour of the light, however, and particularly its changes in dogs, appeared to me very difficult to explain, and to be rather at variance with my own opinion.

To discover the cause of the shining in the eyes of human beings and inferior animals, I came to the resolution of undertaking the extraction of the lens on a cat, from which I anticipated the best result, in so far as I might, by that means, best determine to what extent the remoter parts of the eye contributed to its luminousness.

I attempted to perform the above operation on a cat, but the utter restlessness of the animal rendered it extremely difficult, indeed almost impossible. Having ascertained that eyes of cats shine after death, I resolved to kill the cat, that I might have it in my power to dissect any part of the eye I thought proper.

First, by means of a pair of scissors I cut away the whole of the cornea, and completely destroyed the anterior chamber of the eye. I now observed, that the light of the eye was not in the least diminished, but somewhat weakened in regard to colour, which was changed from a yellow to a pale green. I then took away the iris, that lay exposed before me, without injuring the conformity of the hinder part of the eye, to discover whether the iris, as Treviranus maintained, really contributed to the light. This, however, was not the case; for the light still continued. The taking away of the lens was followed by a different result, which considerably weakened the intensity of the light, and the greenness of its colour. It now struck me that the tapetum in the hinder part of the eye must form a *spot*, which caused the reflection of the incident rays of light, and thus produced the shining. This was the more probable, as the light of the eye now seemed to emanate from a single spot. After taking away the *vitreous humour*, I observed, that, in reality, the entire want of the pigment in the hinder part of the choroid coat, where the optic nerve enters, formed a greenish silver coloured changeable oblong spot, which was not symmetrical, but surrounded the optic nerve in such a manner, that the greater part was above, and only a small part below it; and, therefore, the greater part lay beyond the axis of vision. It is this spot, therefore, that produces the reflection of the incident rays of light, and, beyond all doubt, according to its tint, contributes to the different colouring of the light, to which, nevertheless, the remaining parts of the eye, when conjoined, seem to be no less necessary.

The situation of this spot corresponds exactly with the position in which the shining of the eyes is seen to the greatest advantage. I have before remarked, that the shining is perceptible only in a certain position, and, in fact, when the eyes of the observer are almost opposite to the eyes of the animal on which he is performing the experiment. This is easily explained. Only those rays of light are reflected which fall on that part of the choroid where the pigmentum is wanting; but as this spot occupies rather the upper wall of the concavity of the choroid, the reflection caused by it will not be perceived, if the eye of the observer is not in a nearly straight direction to the eye of the animal, and at some distance; and hence it is why, in living cats, we observe the light only when their eyes are directed towards our own; in which case, the upper wall of the eye-ball becomes more the hinder and under, and the point of reflection stands in almost a straight line with our own eyes.

From these experiments, it is abundantly evident that there is no light or shining in the eyes in places absolutely dark, and that the opinion of many authors is, in this respect, completely erroneous. These experiments, at the same time, prove what has been doubted by some physiologists, *the transparency of the retina;* for it must naturally be transparent, if reflection takes place from behind it. The transparency of the retina may also be proved from our seeing the image upon the choroid, or rather upon its pigment, while the retina has not the least share in producing the effect; since it appears when the retina on being taken away, brings the vitreous humour, or the lens, to the coats of the eye.

I remarked above, that the light of the eyes of animals was stronger when they were irritated than when they were in a quiescent state; and I attributed this phenomenon to the greater projection of the eyes, but particularly to the increased secretion of the lachrymal fluids. This was rendered still more probable by my last experiment, when I destroyed the convexity of the eye, by taking away the cornea and the lens. By this it appears, that a shining substance is better fitted for reflection than a dull one, which is proved by the gradual fading away of the light after death, from the cornea becoming duller, and by the gradual increase of light, when the cornea is moistened. I further remarked, that the different colours of animals, particularly of the cat, probably tend to strengthen or weaken the light; which may be thus explained, that, in beasts, as well as human beings, the greater or smaller size of the pigment may usually be in conformity with the colour of the hair, which is the common covering.

From this examination, it will now be more probable that the luminousness of the eyes of human beings, as well as of beasts, depends on the want of the pigment, and so much the more from being observed only in the albino. With this view of the matter, the two cases already quoted of Sachs and Michaelis are indeed at variance. I must confess that I have read and considered these cases with some degree of interest. Are they really fictions? When we read of the shape of fiery coruscations, or balls in the eyes, of their rolling round, of their frequently darting forth rays an inch long, our suspicions are surely pardonable.

As to the different colours of the light in the eyes of dogs, it is owing to the different colouring of the place where the pigment is awanting in the choroid,—a fact of which anatomical experiments on the eye of these animals has convinced me; and hence the varied colour of the light of one and the same eye may be owing more to the motion of that part where the rays of light are reflected upon different coloured portions of the choroid, than to the quantity of the incident rays of light.

Finally, there is no question but the light observed in the eyes of some beasts of prey, as well as in those of birds, has the origin above ascribed to it; and its nature is neither phosphoric nor electrical, nor has it any psychological relation.

Account of the Habits of the Turkey Buzzard (Vultur aura), particularly with the view of exploding the opinion generally entertained of its extraordinary power of Smelling. In a letter to Professor Jameson, by John J. Audubon, a Citizen of the United States *.

As soon as, like me, you shall have seen the Turkey Buzzard follow, with arduous closeness of investigation, the skirts of the forests, the meanders of creeks and rivers, sweeping over the whole of extensive plains, glancing his quick eye in all directions, with as much intentness as ever did the noblest of falcons, to discover where below him lies the suitable prey;—when, like

* This communication was originally intended to be sent to a friend unacquainted with the habits of birds.—J. J. A.

me, you have repeatedly seen that bird pass over objects calculated to glut his voracious appetite unnoticed, because unseen; and when you have also observed the greedy vulture propelled by hunger, if not famine, moving like the wind suddenly round his course as the carrion attracts his eye,—then will you abandon the deeply-rooted notion that this bird possesses the faculty of discovering, by his sense of smell, his prey at an immense distance.

This power of smelling so acutely I adopted as a fact from my youth. I had read of this when a child; and many of the theorists to whom I subsequently spoke of it, repeated the same with enthusiasm, the more particularly as they considered it an extraordinary gift of nature. But I had already observed, that Nature, although wonderfully bountiful, had not granted more to any one individual than was necessary, and that no one was possessed of any two of the senses in a very high state of perfection; that if it had a good scent, it needed not so much acuteness of sight, and *vice versa.* When I visited the Southern States, and had lived, as it were, amongst these vultures for several years, and discovered thousands of times that they did not smell me when I approached them covered by a tree, until within a few feet, and that when so near, or at a greater distance, I shewed myself to them, they instantly flew away much frightened, the idea evaporated, and I assiduously engaged in a series of experiments to prove, to *myself* at least, how far this acuteness of smell existed, or if it existed at all.

I sit down to communicate to you the results of those experiments, and leave for *you* to conclude how far, and how long, the world has been imposed on by the mere assertions of men who had never seen more than the skins of our vultures, or heard the accounts from men caring little about observing nature closely.

My first experiment was as follows:

I procured a skin of our common deer, entire to the hoofs, and stuffed it carefully with dried grass until filled rather above the natural size,—suffered the whole to become perfectly dry, and as hard as leather,—took it to the middle of a large open field,—laid it down on its back with the legs up and apart, as if the animal was dead and putrid. I then retired about a few hundred yards, and, in the lapse of some minutes, a vulture, coursing round the field, tolerably high, espied the skin, sailed directly towards it, and alighted within a few yards of it. I ran immediately, covered by a large tree, until within about forty yards, and from that place could spy the bird with ease. He approached the skin,—looked at it without apparent suspicion,—jumped on it,—raised his tail, and voided itself freely (as, you well know, all birds of prey in a wild state generally do before feeding),—then approaching the eyes, that were here solid globes of hard dried and painted clay, attacked first one and then the other, with, however, no further advantage than that of disarranging them. This part was abandoned; the bird walked to the other extremity of the pretended animal, and there, with much exertion, tore the stitches apart, until much fodder and hay was pulled out, but no flesh could the bird find, or smell; he was intent on discovering some where none existed, and, after reiterated efforts, all useless, he took flight, coursed about the field, when, suddenly rounding and falling, I saw him kill a small *garter snake*, and swallow it in an instant. The vulture rose again, sailed about, and passed several times quite low over my stuffed deer skin, as if loath to abandon so good-looking a prey.

Judge of my feelings when I plainly saw that the vulture which could not discover, through its *extraordinary sense of smell*, that no flesh, either fresh or putrid, existed about that skin, could, at a glance, see a snake scarcely as large as a man's finger, alive and destitute of odour, hundreds of yards distant. I concluded that, at all events, his ocular powers were much better than his sense of smell.

Second Experiment.—I had a large dead hog hauled some distance from the house, and put into a ravine, about twenty feet deeper than the surface of the earth around it, narrow and winding, much filled with briars and high cane. In this I made the negroes conceal the hog, by binding cane over it, until I thought it would puzzle either buzzards, carrion crows, or any other birds, to see it, and left it for two days. This was early in the month of July, when in this latitude a dead body becomes putrid and extremely fetid in a short time. I saw, from time to time, many vultures in search of food sail over the field and ravine in all directions, but none discovered the carcass, although, during this time, several dogs had visited it, and fed plentifully on it. I tried to go near it, but the smell was so insufferable when within thirty yards, that I abandoned it, and the remnants were entirely destroyed at last through natural decay.

I then took a young pig, put a knife through its neck, and made it bleed on the earth and grass about the same place, and having covered it closely with leaves, also watched the result. The vultures saw the fresh blood, alighted about it, followed it down into the ravine, discovered by the blood the pig, and devoured it, when yet quite fresh, within my sight.

Not contented with these experiments, which I already thought fully conclusive, having found two young vultures, about the size of pullets, covered yet with down, and looking more like quadrupeds than birds, I had them brought home and put into a large coop in the yard, in the view of every body, and attended to their feeding myself. I gave them a great number of red-headed woodpeckers and parokeets, birds then easy to procure, as they were feeding daily on the mulberry trees in the immediate neighbourhood of my orphans.

These the young vultures could tear to pieces by putting both feet on the body, and applying the bill with great force. So accustomed to my going towards them were they in a few days, that, when I approached the cage with hands filled with game for them, they immediately began hissing and gesticulating very much like young pigeons, and putting their bills towards each other, as if expecting to be fed mutually, as their parent had done. Two weeks elapsed; black feathers made their appearance, and the down diminished. I remarked an extraordinary increase of their legs and bill; and thinking them fit for trial, I closed three sides of the cage with plank, leaving the front only with bars for them to see through;—had the cage cleaned, washed, and sanded, to remove any filth attached to it from the putrid flesh that had been in it, and turned its front immediately from the course I usually took towards it with food for them.

I approached it often bare-footed, and soon perceived that if I did not accidentally make a noise, the young birds remained in their silent upright attitudes, until I shewed myself to them by turning to the front of their prison. I frequently fastened a dead squirrel or rabbit, cut open, with all the entrails hanging loosely to a long pole, and in this situation would put it to the back part of the cage; but no hissing, no movement was made: when, on the contrary, I presented the end of the pole, thus covered, over the cage, no sooner would it appear beyond the edge, than my hungry birds would jump against the bars, hiss furiously, and attempt all in their power to reach the food. This was repeatedly done with fresh and putrid substances, all very congenial to their taste.

Satisfied within myself, I dropped these trials, but fed them until full grown, and then turned them out into the yard of the kitchen, for the purpose of picking up whatever substances might be thrown to them. Their voracity, however, soon caused their death: young pigs were not safe if within their reach; and young ducks, turkeys or chickens, were such a constant temptation, that the cook, unable to watch them, killed them both, to put an end to their depredations.

Whilst I had these two young vultures in confinement, an extraordinary occurrence took place respecting an old bird of the same kind, which I cannot help relating to you. This bird sailing over the yard, whilst I was experimenting with the pole and squirrels, saw the food, and alighted on the roof of one of the outhouses; then alighted on the ground, walked directly to the cage, and attempted to reach the food within. I approached it carefully, and it hopped off a short distance; as I retired, it returned, when always the appearances of the strongest congratulations would take place from the young towards this new comer. I directed several young negroes to drive it gently towards the stable, and to try to make it go in there. This would not do; but, after a short time, I helped to drive it into that part of the gin-house where the cotton-seeds are deposited, and there caught it. I easily discovered that the bird was so emaciated, that to this state of poverty only I owed my success. I put it in with the young, who both at once jumped about him, making most extraordinary gestures of welcome; whilst the old bird, quite discomfited at his confinement, lashed both with great violence with his bill. Fearing the death of the young, I took them out, and fed plentifully the old bird; his appetite had become so great through fasting, that he ate too much, and died of suffocation.

I could enumerate many more instances, indicating that the power of smelling in these birds has been grossly exaggerated, and that, if they can smell objects at any distance, they can see the same objects much farther. I would ask any observer of the habits of birds, Why, if vultures could smell at a great distance their prey, they should spend the greater portion of their lives hunting for it, when they are naturally so lazy, that, if fed in one place, they never will leave it, and merely make such a change as is absolutely necessary to enable them to reach it? But I will now enter on their habits, and you will easily discover how this far-famed power has originated.

Vultures are gregarious, and often associate in flocks of twenty, forty, or more;—hunting thus together, they fly in sight of each other, and thus cover an immense extent of country. A flock of twenty may easily survey an area of two miles, as they go turning in large circles, often intersecting each other in their lines, as if forming a vast chain of rounded links;—some are high, whilst others are low;—not a spot is passed unseen, and, consequently, the moment that a prey is discovered, the favoured bird rounds to, and by the impetuosity of its movements, gives notice to its nearest companion, who immediately follows him, and is successively attended by all the rest. Thus, the farthest from the discoverer being at a considerable distance, sails in a direct line toward the spot indicated to him by the flight of the others, who all have gone in a straight course before him, with the appearance of being impelled by this extraordinary power of smelling, so erroneously granted them. If the object discovered is large, lately dead, and covered with a skin too tough to be ate and torn asunder, and afford free scope to their appetite, they remain about it, and in the neighbourhood. Perched on high, dead limbs, in such conspicuous positions, are easily seen by other vultures, who, through habit, know the meaning of such stoppages, and join the first flock, going also directly, and affording further evidence to those persons who are satisfied with appearances only. In this manner I have seen several hundreds of vultures and carrion-crows assembled near a dead ox, at the dusk of evening, that had only two or three in the morning; when some of the latter comers had probably travelled hundreds of miles searching diligently themselves for food, and probably would have had to go much farther, had they not espied this association.

Around the spot both species remain; some of them from time to time examining the dead body, giving it a tug in those parts most accessible, until putridity ensues. The accumulated number then fall to work, exhibiting a most disgusting picture of famished cannibals; the strongest driving the weakest, and this latter harassing the former with all the power that a disappointed hungry stomach can produce. They are seen jumping off the carcase, reattacking it, entering it, and wrestling for portions partly swallowed by two or more of them, hissing at a furious rate, and clearing every moment their nostrils from the filth that enters there, and stops their breathing. No doubt remains on my mind, that the great outward dimensions of these nostrils were allotted them for that especial and necessary purpose.

The animal is soon reduced to a mere skeleton, no portion of it being now too hard not to be torn apart and swallowed, leaving merely the bare bones. Soon all these bloody feeders are seen standing gorged, and scarcely able to take wing. At such times the observer may approach very near the group, whilst engaged in feeding, and see the vultures in contact with the dogs, who really by smelling have found the prey. Whenever this happens, it is with the greatest reluctance that the birds suffer themselves to be driven off, although frequently the sudden scowl or growl of the dogs will cause nearly all the vultures to rise a few yards in the air. I have several times seen the buzzards feeding at one extremity of the carcase, whilst the dogs were tearing the other; but if a single wolf approached, or a pair of white-headed eagles, driven by extreme hunger, then the place is abandoned to them until their wants are supplied.

The repast finished, each bird gradually rises to the highest branches of the nearest trees, and remains there until the full digestion of all the food they have swallowed is completed; from time to time opening their wings to the breeze or to the sun, either to cool or warm themselves. The traveller may then pass under them unnoticed, or, if noticed, a mere sham of flying off is made. The bird slowly recloses its wings, looks at the person as he passes, and remains there until hunger again urges him onwards. This takes oftentimes more than a day, when gradually, and very often singly, each vulture is seen to depart.

They now rise to an immense height, cutting, with great elegance and ease many circles through the air; now and then gently closing their wings, they launch themselves obliquely with great swiftness for several hundred yards, check and resume their portly movements, ascending until, like mites in the distance, they are seen all together to leave that neighbourhood, to seek further the needed means of subsistence.

Having heard it said, no doubt with the desire to prove that buzzards smell their prey, that these birds usually fly against the breeze, I may state that, in my opinion, this action is simply used, because it is easier for birds to maintain themselves on the wing encountering a moderate portion of wind, than when flying before it; but I have so often witnessed these birds bearing away under the influence of a strong breeze, as if enjoying it, that I consider either case as a mere incident connected with their pleasures or their wants.

Here, my dear Sir, let me relate one of those facts, curious in itself, and attributed to mere *instinct*, but which I cannot admit under that appellation, and which, in my opinion, so borders on *reason*, that, were I to call it by that name, I hope you will not look on my judgment as erroneous, without your further investigating the subjects in a more general point of view.

During one of those heavy gusts that so often take place in Louisiana in the early part of summer, I saw a flock of these birds, which had undoubtedly discovered that the current of air that was tearing all over them was a mere sheet, raise themselves obliquely against it with great force, slide through its impetuous current, and reassume *above it* their elegant movements.

The power given to them by nature of discerning the approaching death of a wounded animal, is truly remarkable. They will watch each movement of any individual thus assailed by misfortune, and follow it with keen perseverance, until the loss of life has rendered it their prey. A poor old emaciated horse or ox, the deer mired on the margin of the lake, where the timid animal has resorted to escape flies and musquitoes so fatiguing in summer, is seen in distress with exultation by the buzzard. He immediately alights, and if the animal does not extricate itself, waits and gorges in peace on as much of the flesh as the nature of the spot will allow. They do more, they often watch the young kid, the lamb, and the pig issuing from the mother's womb, and attack it with direful success; yet, notwithstanding this, they frequently pass over a healthy horse, hog, or other animal, lying, as if dead, basking in the sunshine, without even altering their course in the least. Judge then, my dear Sir, how well they must see.

Opportunities of devouring young living animals are so very frequent around large plantations in this country, that to deny them would be ridiculous, although I have heard it attempted by European writers.

During the terrifying inundations of the Mississippi, I have very frequently seen many of those birds alight on the dead floating bodies of animals, drowned by the water in the low lands, and washed by the current, gorging themselves at the expence of the Squatter, who often loses the greater portion of his wandering flocks on such occasions.

Dastardly with all, and such cowards are they, that our smaller hawks can drive them off any place; the little king bird proves, indeed, a tyrant whenever he espies the large marauder sailing about the spot where his dearest mate is all intent on incubation; and the eagle, if hungry, will chace him, force him to disgorge his food in a moment, and to leave it at his disposal.

Many of those birds accustomed, by the privileges granted them by law, of remaining about the cities and villages in our southern states, seldom leave them, and might almost be called a second set, differing widely in habits from those that reside constantly at a distance from these places. Accustomed to be fed, they are still more lazy; their appearance exhibits all the nonchalance belonging to the garrisoned half paid soldier. To move is for them a hardship, and nothing but extreme hunger will make them fly down from the roof of the kitchen into the yard, or follow the vehicles employed in clearing the streets from disagreeable substances, except where (at Natchez for instance) the number of these expecting parasites is so great, that all the refuse of the town, within their reach, is insufficient; then they are seen following the scavengers' carts, hopping, flying and alighting all about it, amongst grunting hogs and snarling dogs, until the contents, having reached a place of destination outside the suburbs, are emptied and swallowed by them.

Whilst taking a view of that city from her lower ancient fort, I have for several days seen exhibitions of this kind.

I do not think that the vultures thus attached to the cities are so much inclined to multiply as those more constantly resident in the forests, perceiving no diminution of number during the breeding season, and having remarked that many individuals, known to me by particular marks made on them, and a *special cast of countenance*, were positively constantly residents of the town. The Vultur aura is by no means so numerous as the attratus. I have seldom seen more than twenty-five or thirty together; where, on the contrary, the latter are frequently associated to the number of an hundred.

The Vultur aura is a more retired bird in habits, and more inclined to feed on dead game, snakes, lizards, frogs, and the dead fish that frequently are found about the sand-flats of rivers and borders of the sea-shore; is more cleanly in its appearance, and, as you will see by the difference in the drawings of both species, a neater and better formed bird. Its flight is also vastly superior in swiftness and elegance, needing but a few flaps of its large wings to raise itself from the ground; after which it will sail for miles, by merely turning either on one side or the other, and using his tail so slowly, to alter his course, that a person looking at him, whilst elevated and sailing, would be inclined to compare it to a machine fit to perform just a certain description of evolutions. The noise made by the vultures through the air as they glide obliquely towards the earth, is often as great as that of our largest hawks when falling on their prey; but they never reach the ground in this manner, always checking when about 100 yards high, and *going several rounds, to examine well the spot they are about to alight on.* The Vultur aura cannot bear cold weather well; the few who, during the heat of the summer, extend their excursions to the middle or northern States, generally all return at the approach of winter; and I believe also, that very few of these birds breed eastward of the Pine Swamps of West Jersey. They are much attached to particular roosting trees, and I know will come to them every night from a great distance: on alighting on these, each of them, anxious for a choice of place, creates always a general disturbance, and often, when quite dark, their hissing noise is heard in token of this inclination for supremacy. These roosting trees of the buzzards are generally in deep swamps, and mostly high dead cypresses; frequently, however, they roost with the carrion-crows (Vultur atratus), and then it is on the largest dead timber of our fields, not unfrequently close to the houses. Sometimes also this bird will roost close to the body of a thick-leaved tree; in such position I have killed several, when hunting wild turkeys by moonlight nights, and mistaking them for these latter birds.

In Mississippi, Louisiania, Georgia and Carolina, they prepare to breed early in the month of February, in common with almost all the genus Falco. The most remarkable habit attached to their life is now to be seen; they assemble in parties of eight or ten, sometimes more, on large fallen logs, males and females exhibiting the strongest desire to please mutually, and forming attachments by the choice of a mate by each male, that, after many caresses, leads her off on the wing from the group, neither to mix or associate with any more, until their offspring are well able to follow them in the air; after that, and until incubation takes place (about two weeks), they are seen sailing side by side the whole day.

These birds form no nest, yet are very choice respecting the place of deposit for their *two* eggs. Deep in the swamps, but always above the line of overflowing water mark, a large hollowed tree is sought, either standing or fallen, and the eggs are dropped on the mouldy particles inside. Sometimes immediately near the entrance: at other times as much as twenty feet in. Both birds incubate alternately; and both feed each other whilst sitting, by disgorging the contents of the stomach, or part of them, immediately close before the bird that is sitting. Thirty-two days are needed to bring forth the young from the shell,—a thick down covers them completely,—the parents at that early period, and indeed for nearly two weeks, feed them, by gorging food considerably digested in their bill, in the manner of the common pigeons;—the down acquires length; becomes thinner, and of a deeper tint as the bird grows older. The young vultures at three weeks are large for their age, weighing then upwards of a pound, but extremely clumsy and inactive; unable to keep up their wings, then partly covered by large pen feathers, drag them almost to the ground, bearing their whole weight on the full length of their legs and feet.

If approached at that time by a stranger or enemy, they hiss with a noise resembling that made by a strangling cat or fox, swell themselves, and hop side-ways as fast as in their power.

The parents whilst sitting, and equally disturbed, act in the same manner—fly only a very short distance, waiting there the departure of the offender to reassume their duty. As the young grows larger, the parents throw their food merely before them, and, with all their exertions, seldom bring their offspring fat to the field. Their nests become so fetid before the final departure of the young birds, that a person forced to remain there half an hour must almost be suffocated.

I have been frequently told that the same pair will not abandon their first nests or place of deposit, unless broken up during incubation. This would attach to the vulture a constancy of affection that I cannot believe exists, as I do not believe that pairing in the manner described is of any longer duration than the necessitous call of nature for the one season; and, again, were they so inclined, they would never congregate in the manner they do, but would go in single pairs all their lives like eagles.

Vultures do not possess in any degree the power of bearing off their prey as falcons do, unless it be slender portions of entrails hanging by the bill. When chased by others from a carcase, it even renders them very awkward in their flight, and forces them to the earth again almost immediately.

Many persons in *Europe* believe that buzzards prefer putrid flesh to any other. This is a mistake. Any flesh that they can at once tear with their very powerful bill in pieces, is swallowed, no matter how fresh. What I have said of their killing and devouring young animals, are sufficient proofs of this; but it frequently happens that these birds are *forced* to wait until the hide of their prey will give way to the bill. I have seen a large dead alligator, surrounded by vultures and carrion crows, of which nearly the whole of the flesh was so completely decomposed before these birds could perforate the tough skin of the monster, that, when at last it took place, their disappointment was apparent, and the matter, in an almost fluid state, abandoned by the vultures.

It was my intention to give you further details respecting this bird in the present letter, particularly of the anatomical structure of its head and stomach, wherein I have had the pleasure of meeting corroborating evidence, through the observations made on the same by a learned anatomist of this city, Dr Knox. My time, however, is at present quite limited; but I will very soon resume the subject with great pleasure.

EDINBURGH, *Dec.* 7. 1826.

List of Rare Plants which have Flowered in the Royal Botanic Garden, Edinburgh, during the last three months; with Descriptions of several New Plants. Communicated by Dr GRAHAM.

10*th December* 1826.

Aralia spinosa.

This plant has stood on the open wall three winters, protected partially with broom twigs, but never flowered till the beginning of November last, having nearly reached the top of a wall fourteen feet high.

Asplenium flabellifolium.

Aster pulcherrimus.

Banksia integrifolia.

Begonia undulata.

B. undulata; fruticosa; foliis inæqualiter cordatis, undulatis, integerrimis, glabris, nitidis; capsulæ alis rotundatis æqualibus.

DESCRIPTION.—*Stem* erect, turgid below, tapering upwards, annular; when young slightly hispid, green, and having numerous small, oblong white spots; when older smooth, and of a reddish-grey colour; branched, branches axillary and alternate. *Leaves* petioled, alternate, distichous, unequally cordate, smooth and shining, undulate, acuminate, full green on the upper surface, paler and minutely dotted below, 3 inches long; edges occasionally reddish, especially when young, callous, quite entire, but having a dot, like an obsolete tooth, at the termination of each vein;

petioles hispid, especially on the older branches, one-fourth of an inch long. *Stipulæ* varying in size and shape, pointed, transparent, reddish, and spotted like the stem, caducous. *Panicle* supported on footstalks about half the length of the leaves, dichotomous, smooth and shining. *Bracteæ* unequal, shorter than the pedicel, pellucid, colourless. *Flowers* white; *corolla* of the male of four petals, of which the two outer are large and cordate, that of the female of five petals, the largest about one-third of the length of the wings of the capsule. *Capsule*, wings rounded, tapering towards the pedicel. *Stigmata* convolute, pubescent, with two prominent angles on each, yellow. *Stamens* numerous, yellow. *Seeds* very numerous, covering the projecting wings of their green receptacle.

We received this plant in 1825 from M. Otto at Berlin, under the specific name here adopted, and were informed that the native country was Brazil. It has been kept in the stove.

Bignonia candicans.

This plant has never perfectly evolved its flowers, but these have repeatedly decayed, both this year and last, when they were just about to burst. The shrub thrives well in the stove, and is trained to a considerable length along the glass.

Brexia madagascariensis.

Buddleia brasiliensis.

B. brasiliensis; foliis deltoideis, per petiolos decurrentibus, connatis, irregulariter dentato-crenatis, floribus verticillatis, bracteatis, ramis tetragonis, lanatis.

Description.—*Shrub* erect. *Stem* nearly round. *Branches* opposite, decussating, young shoots four-sided, covered with a white wool, which subsequently peels off, exposing the brown and cracked bark. *Leaves* opposite, decussating, when young oblong, afterwards becoming wider at the base, and more pointed, so as to be nearly deltoid, unequally tooth-crenated, broadly decurrent along the petiole, where quite entire, connate, soft, tomentous, especially below where white, green above, reticulated. *Flowers* verticillated, the lower whorl on two short axillary footstalks; *verticillus* leafy; *bracteæ* small, pointed, green, placed on the outside of the whorls. *Calyx* persisting, green, covered with white tomentum, 4-cleft. *Corolla* orange-yellow, hairy within and without, least so on the upper surface of the limb; *tube* more than twice the length of the calyx; *limb* spreading, 4-cleft, segments rounded. *Anthers* reddish, sessile in the throat of the corolla, pollen pale yellow. *Germen* hairy, lodged in the calyx; *style* filiform, at length exserted; *stigma* rounded, lobular, deep green.

Seeds communicated to the Botanic Garden by Mr Hunneman in 1824, and received by him from Russia under the name here adopted. Sprengel quotes under *Buddleia brasiliensis, B. perfoliata* of Humboldt; but this is quite distinct from our plant.

Convolvulus candicans.

Flowered on the wall outside one of the stoves.

Cratægus glabra.

This fine plant was covered with flowers on the open wall in November, and will continue so during this month also, unless the weather prove very severe. It seems probable that it came into flower, and pushed much new wood, at this season, in consequence of the warm rains which succeeded the unusually long continued hot and dry weather of summer and autumn. If it shall prove sufficiently hardy for the open ground, there have been few more desirable additions made to the shrubbery; and it has already borne, without injury even to its flowers, a cold of 25° Fahr.

Crinum anomale.

Crotalaria dichotoma.

C. dichotoma; Fruticosa, diffusa; foliis ternatis, foliolis cuneato-ellipticis, pilosiusculis, mucronatis; stipulis subulatis, reflexis, persistentibus; racemis subcapitatis, oppositifoliis.

Description.—*Stem* weak, round. *Branches* long, straggling, pubescent, and slightly furrowed towards the top, subdichotomous, one of the limbs being generally a little thicker than the other. *Leaves* ternate, leaflets elliptical, mucronate, wedge-shaped at the base, rather longer than the petiole, and supported on very short, equal, partial footstalks, soft, covered with minute pubescence, very indistinct on the upper surface, bright green, and becoming mottled in fading, middle rib strong, petioles half an inch long, furrowed, spreading at right angles to the branch. *Racemes* opposite to the leaves, subtriquetrous, occasionally one flower in the middle, the rest crowded near the top. *Bracteæ* like the stipulæ, but less frequently reflected. *Calyx* bilabiate, hairy, segments pointed, green; upper lip 2-parted, segments diverging; lower lip 3-parted, segments parallel, closely applied to the carina. *Corolla* yellow; *vexillum* rounded, reflexed, streaked with brown on the back, claw furrowed and hairy on its lower side; *alæ* involute, shorter than the vexillum; *carina* pointed, equal in length to the alæ, split at its base, its lower edge forming nearly a right angle. *Stamens* monadelphous; *filaments* very slender, five nearly as long as the style, supporting small round (abortive ?) *anthers*, five shorter having oblong anthers of deeper yellow colour. *Germen* pubescent, flattened; *style* turgid at the base, above which it is bent nearly to a right angle, filiform, hairy, persisting; *stigma* small and pointed. *Legumen* covered with small adpressed hairs, inflated, nearly cylindrical, slightly furrowed above. *Seeds* numerous (about 14), kidney-shaped, and arranged in two rows, at least when young.

The seeds of this plant were brought to the Botanic Garden from Mexico in 1824 by Dr Mair, and the plants have flowered in our stove during the last two years.

Cypripedium insigne.

Dianthus fruticosus.

Flowered freely in the open border.

Eucalyptus cordata, and E. perfoliata.

These two plants have been covered with buds on the open wall during several weeks, but have not expanded any flowers. They have not, however, been in the least injured by the late severe frosts; and the last has been out of doors for three years.

Lantana hirta.

L. hirta; inerma; foliis ovato-lanceolatis, acuminatis, rugosis, supra hirtis, subtus nitidis, serrato-crenatis, basi cuneatis integerrimis; pedunculis axillaribus, foliis brevioribus; bracteis ovatis, acuminatis.

Description.—Shrub erect; *branches* 4-sided, brown, slightly hairy, angles blunt; *hairs* most conspicuous and harsh, and suberect on the young shoots. *Leaves* petioled, opposite and decussating, wrinkled, hispid above, shining, and destitute of all hairs below, excepting on the veins, where there are a few, acuminate, wedge-shaped, and quite entire at the base, the rest serrato-crenate, veins prominent behind; petioles short. *Flowers* capitate. *Bracteæ* ovate, acuminate, smaller inwards, hairy. *Calyx* sessile in the axil of the bractea, campanulate, bilabiate, the lips placed laterally, hairy, small, greenish-white. *Corolla* white; *tube* equal in length to the bractea, slightly curved upwards, dilated in the centre, about twice the length of the limb, hairy especially on the outside and in the throat, quite smooth within the calyx, hairs suberect; *limb* 4-parted, lateral segments blunt and smallest, lower segment subrotund, upper retuse, smooth above, hairy below. *Stamens* inserted into the tube of the corolla, at the mouth of the calyx; *filaments* short *anthers* brown, sagittate. *Germen* ovate, green; *style* short, reaching to the mouth of the calyx; *stigma* large, rounded, greenish, placed on the anterior part of the style, which projects a little way beyond it. *Drupe* round, deep purple, juicy; *nut* bilocular.

The leaves, when bruised, emit a smell considerably resembling the dry root of *Valeriana officinalis.*

This species is a native of Mexico, from whence the seeds were brought by Lord Napier in 1825, and obligingly communicated to the Botanic Garden. They, and the seeds of many other species, some of them entirely new, were picked by his Lordship from plants in the wild state, among the mountains of Arizaba, or Real del Monte. It is much to be desired that others of our countrymen would equally profit by the opportunities afforded them, of contributing to our knowledge of exotic botany.

Metrosideros lanceolata.

This plant has stood on the open wall for three winters, partially protected with broom twigs.

Monarda punctata.

Passiflora capsularis.

Patersonia glauca.

Pilea mucosa.

This curious little plant, so well illustrated in the Collectanea Botanica of Lindley, has for several years flourished in our stove; but I have not observed it frequently in collections.

Ruellia anisophylla.

Silene regia.

This fine plant was sent, while in flower, from Mr Ferguson's of Raith, whose gardener raised it from seed sent from Montreal.

Vanda rostrata.

It would be interesting to know, whether any remarkable deviation from the usual progress of vegetation has been observed, in consequence of the very uncommon degree of heat, and uninterrupted drought, of this season. Nothing easily accounted for by reference to these, has been noticed in the Botanic Garden, except the period of flowering in the *Cratægus glabra.* I have often observed, that, in different seasons, certain plants flower much before, or not till long after, their usual period, when the state of the weather would have led us to expect the very reverse. This season, the hairy-leaved *Laurus Tinus* will not be in flower till towards the end of January: two years ago, after a very inferior season, it was in full flower during December. The *Arbutus Andrachne,* and laurel-leaved variety of *Arbutus Unedo,* nailed to a wall with a south exposure, are considerably later than plants propagated from the same stock, and growing as standards, though the soil where they are placed is equally loose and dry. The tender plants in our borders seem to have suffered less from the frost which we have had lately, than they usually do, probably owing to the dryness of the soil; for the rains have yet penetrated but a little way below the surface.

Celestial Phenomena from January 1. *to April* 1. 1827, *calculated for the Meridian of Edinburgh, Mean Time.* By

Mr George Innes, Aberdeen.

The times are inserted according to the Civil reckoning, the day beginning at midnight. —The Conjunctions of the Moon with the Stars are given in *Right Ascension.*

JANUARY.

D.	H.	′	″		D.	H.	′	″	
1.	20	42	23	☌ ☽ ♂	20.	2	2	15	☌ ☽ α ♍
2.	5	25	51	☿ very near ρ Oph.	20.	3	27	8	☌ ☽ i ♍
4.				☿ greatest elong.	20.	5	57	52	Im. III. sat. ♃
5.	0	35	–	☽ First Quarter.	20.	16	46	27	☾ Last Quarter.
6.	0	51	30	Em. III. sat. ♃	20.	18	8	5	☉ enters ♒
8.	1	59	44	Im. I. sat. ♃	21.	14	47	35	☌ ☽ 2 α ♎
9.	3	8	34	Im. II. sat. ♃	22.	5	46	31	Im. I. sat. ♃
9.	19	6	43	♂ near λ ♒	22.	12	1	10	☌ ☽ κ ♎
10.	2	26	51	☌ ☽ ι ♉	22.	16	32	30	☌ ☽ λ ♏
10.	18	38	47	☌ ☽ ζ ♉	22.	21	9	45	☌ ☽ 1 β ♏
11.	12	25	4	☌ ☽ ♃	22.	21	11	3	☌ ☽ 2 β ♏
11.	18	39	46	☌ ☽ ν ♊	22.	23	40	35	☌ ☽ ν ♏
13.	1	59	40	Im. III. sat. ♃	24.	0	14	49	Im. I. sat. ♃
13.	4	48	18	Em. III. sat. ♃	24.	2	27	–	☌ ☽ ρ Oph.
13.	5	57	53	○ Full Moon.	24.	15	50	6	☌ ☽ ♀
14.	5	58	10	♄ very near η ♊	24.	22	36	3	☌ ☽ 1 μ ♐
14.	17	11	58	☌ ☽ 1 α ♋	24.	23	12	9	☌ ☽ 2 μ ♐
14.	18	10	19	☌ ☽ 2 α ♋	25.	23	23	–	☌ ☽ d ♐
15.	0	1	–	☌ ☉ ♅	26.	3	31	18	☌ ☽ ☿
15.	3	53	8	Im. I. sat. ♃	26.	14	34	30	☌ ☽ ♅
15.	23	37	56	☌ ☽ π ♌	27.	9	46	29	● New Moon.
16.	5	41	37	Im. II. sat. ♃	30.	22	24	–	☌ ☽ ♂
18.	23	58	–	☽ near 96 ♒	31.	2	8	13	Im. I. sat. ♃
19.	13	29	–	☌ ☽ ♃					

FEBRUARY.

D.	H.	′	″		D.	H.	′	″	
3.	0	4	46	Im. II. sat. ♃	12.	6	32	11	☌ ☽ π ♌
3.	21	8	11	☽ First Quarter.	14.	5	55	7	Im. I. sat. ♃
5.	17	25	–	☌ ☽ ε ♉	14.	6	54	51	☌ ☽ υ ♌
6.	9	59	55	☌ ☽ γ ♉	15.	18	41	38	☌ ☽ ♃
7.	2	14	56	☌ ☽ ζ ♉	16.	0	23	31	Im. I. sat. ♃
7.	4	1	39	Im. I. sat. ♃	16.	7	23	56	☌ ☽ α ♍
7.	16	50	40	☌ ☽ ♄	16.	8	49	6	☌ ☽ i ♍
8.	2	20	–	☌ ☽ ν ♊	17.	5	12	6	Im. II. sat. ♃
8.	22	30	3	Im. I. sat. ♃	17.	20	12	5	☌ ☽ 2 α ♎
10.	2	38	20	Im. II. sat. ♃	18.	0	32	16	Em. III. sat. ♃
11.	0	31	5	☌ ☽ 1 α ♋	18.	17	41	43	☌ ☽ κ ♎
11.	1	30	54	☌ ☽ 2 α ♋	18.	22	19	10	☌ ☽ λ ♎
11.	22	25	5	○ Full Moon.	19.	1	11	7	☾ Last Quarter.

FEBRUARY.

D.	H.	′	″		D.	H.	′	″	
19.	3	1	49	☌ ☽ 1 β ♏	22.	9	3	39	☽ very near ♀
19.	3	3	10	☌ ☽ 2 β ♏	22.	14	43	35	☌ ☽ ♅
19.	5	36	–	☌ ☽ ν ♏	23.	2	17	3	Im. I. sat. ♃
19.	8	53	19	⊙ enters ♓	23.	10	1	35	☌ ☽ β ♑
20.	9	4	5	☌ ☽ ρ Oph.	25.	1	45	45	Im. III. sat. ♃
21.	5	50	41	☌ ☽ 1 μ ♐	25.	4	29	29	Em. III. sat. ♃
21.	6	27	58	☌ ☽ 2 μ ♐	25.	22	15	6	● New Moon.
21.	7	42	0	☌ ♀ d ♐	26.	6	23	40	☌ ☽ ☿
21.	9	–	–	Sup. ☌ ⊙ ☿	28.	2	23	32	Im. IV. sat. ♃
22.	7	25	9	☌ ☽ d ♐	28.	3	6	7	Em. IV. sat. ♃

MARCH.

D.	H.	′	″		D.	H.	′	″	
1.	0	5	20	☌ ☽ ♂	18.	3	50	47	☌ ☽ λ ♎
1.	15	16	12	♂ near ζ ♓	18.	4	52	30	☿ near ε ♓
2.	4	10	39	Im. I. sat. ♃	18.				☿ greatest elong.
3.	17	28	–	☌ ♀ ♅	18.	8	30	10	☌ ☽ 1 β ♏
3.	22	39	2	Im. I. sat. ♃	18.	8	31	30	☌ ☽ 2 β ♏
4.	8	26	39	Em. III. sat. ♃	18.	11	2	40	☌ ☽ ν ♏
5.	1	27	56	☌ ☽ ε ♉	18.	16	21	34	Em. III. sat. ♃
5.	18	25	53	☽ First Quarter.	19.	14	22	29	☌ ☽ ρ Oph.
5.				♀ greatest elong.	19.	20	55	–	Im. I. sat. ♃
6.	10	22	50	☌ ☽ ζ ♉	20.	8	17	27	☾ Last Quarter.
6.	23	37	21	Im. II. sat. ♃	20.	11	52	55	☌ ☽ 2 μ ♐
7.	0	15	8	☌ ☽ ♄	21.	4	46	46	Im. II. sat. ♃
7.	10	37	21	☌ ☽ ν ♊	21.	8	58	10	⊙ enters ♓
10.	0	16	22	☌ ☽ 1 α ♋	21.	13	10	45	☌ ☽ d ♐
10.	10	16	29	☌ ☽ 2 α ♋	21.	21	12	–	☌ ☽ ♅
11.	0	32	43	Im. I. sat. ♃	22.	16	20	17	☌ ☽ β ♑
11.	12	24	21	Em. III. sat. ♃	23.	18	39	54	☌ ☽ ♀
11.	15	13	55	☌ ☽ π ♌	25.	4	20	22	Im. I. sat. ♃
13.	12	6	43	○ Full Moon.	25.	20	18	44	Em. III. sat. ♃
13.	12	59	7	☌ ☽ υ ♌	26.	22	48	53	Im. I. sat. ♃
14.	2	11	56	Im. II. sat. ♃	27.	11	55	8	● New Moon.
14.	21	13	11	☌ ☽ ♃	28.	14	2	35	☌ ☽ ☿
15.	14	15	39	☌ ☽ α ♍	31.	0	7	–	☍ ⊙ ♃
17.	2	10	40	☌ ☽ α ♎	31.	1	33	50	☌ ☽ ♂
17.	23	17	15	☌ ☽ κ ♎	31.	23	10	10	Em. II. sat. ♃
18.	2	26	30	Im. I. sat. ♃					

Eclipse of the Sun of 29th November 1826.

As the Beginning of the Eclipse could not be seen at Aberdeen, owing to clouds, the following is the observed time of the End, as made at the Observatory there:

End of the Eclipse, at - $11^h\ 49'\ 45'',0$ A. M.

Mean Time, after applying the error of the clock, which was obtained by the sun's transit on that day. The time of end is certain to *one* second.

At Edinburgh, neither the beginning nor end of the Eclipse was observed.

Times of the Planets passing the Meridian.

JANUARY.						
	Mercury.	Venus.	Mars.	Jupiter.	Saturn.	Georgian.
D.	H. ′	H. ′	H. ′	H. ′	H. ′	H. ′
1	10 27	11 7	15 39	6 10	23 25	13 0
5	10 25	10 44	15 33	5 55	23 6	12 44
10	10 30	10 22	15 30	5 38	22 47	12 27
15	10 38	9 58	15 24	5 19	22 26	12 7
20	10 48	9 44	15 17	4 59	22 6	11 46
25	11 1	9 33	15 13	4 41	21 44	11 25

FEBRUARY.						
	Mercury.	Venus.	Mars.	Jupiter.	Saturn.	Georgian.
D.	H. ′	H. ′	H. ′	H. ′	H. ′	H. ′
1	11 19	9 19	15 4	4 13	21 14	11 5
5	11 30	9 14	14 59	3 57	20 57	10 51
10	11 45	9 9	14 53	3 38	20 37	10 32
15	11 59	9 7	14 47	3 16	20 17	10 14
20	12 16	9 5	14 41	2 56	19 57	9 55
25	12 29	9 5	14 35	2 34	19 37	9 36

MARCH.						
D.	Mercury.	Venus.	Mars.	Jupiter.	Saturn.	Georgian.
	H. ′	H. ′	H. ′	H. ′	H. ′	H. ′
1	12 38	9 6	14 30	2 18	19 21	9 21
5	12 53	9 6	14 25	2 0	19 6	9 7
10	13 5	9 8	14 19	1 39	18 47	8 48
15	13 12	9 10	14 13	1 17	18 27	8 29
20	13 11	9 12	14 7	0 55	18 8	8 9
25	12 59	9 14	14 1	0 33	17 49	7 51

Proceedings of the Royal Society of Edinburgh.

Nov. 27. 1826.—AT a General Meeting held at the Society's new apartments on the Mound, the following Office-bearers were elected for the ensuing year:—

Sir WALTER SCOTT, *President.*

Right Hon. Lord Chief Baron. Lord Glenlee.
Dr T. C. Hope. Professor Russel. } *Vice-Presidents.*

Dr Brewster, *Secretary.*

Thomas Allan, Esq. *Treasurer.* James Skene, Esq. *Curator of the Museum.*

PHYSICAL CLASS.

Lord Newton, *President.* John Robinson, Esq. *Secretary.*

Sir William Forbes, Bart. Dr Turner.
Dr Home. Sir T. M. Brisbane, K. C. B.
Professor Wallace. Dr Graham. } *Counsellors for the Physical Class.*

LITERARY CLASS.

Henry Mackenzie, Esq. *President.* P. F. Tytler, Esq. *Secretary.*

Right Hon. Lord Advocate. Dr Hibbert.
Sir Henry Jardine. Lord Meadowbank.
Sir John Hay. Thomas Kinnear, Esq. } *Counsellors for the Literary Class.*

Proceedings of the Wernerian Natural History Society.

1826, *Dec.* 2.—AT this meeting Professor Jameson read Dr Thomas Latta's Observations regarding the Arctic Sea and Ice, and the intended Expedition of Captain Parry to the North Pole.

Several sheets of the Great Map of the county of Mayo in Ireland, the work of our ingenious and active countryman Mr William Bald, civil engineer, now engraving in Paris, were laid before the meeting; and the excellent execution of the work (done at one half of the London charges) met with universal approbation.

Specimens of the rare Macartney Pheasant,—a White Sparrow lately shot in Fifeshire,—a specimen of the beautiful Mexican bird called the Quezal,—and of the Lama of Peru, were exhibited; and various interesting articles from the Burmese country were shewn and described by Professor Jameson.

At the same meeting, the following gentlemen were elected Office-bearers of the Society for 1827.

ROBERT JAMESON, Esq. *President.*

VICE-PRESIDENTS.

Professor Graham.	David Falconar, Esq.
Rev. Dr Alex. Brunton.	Major-General Straton.
Pat. Neill, Esq. *Secretary.*	James Wilson, Esq. *Librarian.*
A. G. Ellis, Esq. *Treasurer.*	P. Syme, Esq. *Painter.*

COUNCIL.

Dr Robert Knox.	Dr R. E. Grant.
G. A. W. Arnot, Esq.	Dr John Boggie.
Dr Andrew Coventry.	Henry Witham, Esq.
John Stark, Esq.	Dr John Aitken.

SCIENTIFIC INTELLIGENCE.

METEOROLOGY.

1. *Meteors seen in India.*—Colonel Blacker has given the Asiatic Society an account of a singular meteor, having the appearance of an elongated ball of fire, which he observed at Calcutta, a little after sunset, when on the road between the Court-House and the Town-Hall. Its colour was pale, for the day-

light was still strong, and its larger diameter appeared greater, and its smaller less, than the semidiameter of the moon. Its direction was from east to west, its track nearly horizontal, and the altitude about thirty degrees. Colonel Blacker regrets not having heard of any other observation of this phenomenon at a greater distance, whereby he might have estimated its absolute height. As, however, it did not apparently move with the velocity of ordinary meteors, it was probably at a great distance, and consequently of great size. So long as Colonel Blacker beheld it, which was for five or six seconds, its motion was steady, its light equable, and its size and figure permanent. It latterly, however, left a train of sparks, soon after which it disappeared suddenly, without the attendant circumstance of any report audible in Colonel Blacker's situation. Colonel Blacker concludes his paper with some interesting observations on luminous meteors: and considers them of perpetual recurrence, although day-light, clouds, and misty weather, so often exclude them from our view. Of their number no conception can be formed by the unassisted eye; but some conjecture may be formed of their extent from the fact mentioned by our author, that, in using his astronomical telescope, he has often seen what are called falling stars, shooting through the field of view, when they were not visible to the naked eye; and when it is considered that the glass only embraced one twenty-five thousandth part of the celestial hemisphere, it will be apparent that these phenomena must be infinitely numerous, in order to occur so frequently in so small a space *.

2. *Water-spouts in the Irish Channel.*—Mr James Mackintosh, an accurate and intelligent observer, keeper of the Lower Lighthouse on the Calf of Man, in his monthly report to Robert Stevenson, Esq. engineer to the Northern Lighthouses, mentions, that "on the morning of Tuesday the 14th November (1826), at a quarter to ten o'clock, he witnessed a remarkable phenomenon. The morning was clear, the wind from the east, inclining a little to the north, when he observed a column of water rising from the sea, off Kegger Point: this column was about the

* On the subject of falling stars seen during the day, see previous Numbers of this Journal. The work of Brandes affords much information as to the vast number of luminous meteors always moving through the atmosphere.—Edit.

height and diameter of the lower lighthouse tower (which is 50 feet high, and 18 in diameter), and there was the appearance of a smoke or fine spray on the top. It seemed be in rapid revolution, and likewise made great progress out to sea, maintaining the same figure till lost in the distance. This first column was immediately followed by a similar appearance from the same point, and which took the same direction. Fahrenheit's thermometer was at 46°; and the barometer fell to 28.52 on the evening of Monday the 13th, but had risen to 29.46 when the water-spouts were observed on the morning of the 14th.

3. *Winds in the Polar Regions.*—A decrease of wind invariably takes place in passing under the lee, not merely of a close and extensive body of high and heavy ice, but even of a stream of small pieces,—and so immediate is this effect, that the moment a ship comes under the lee of such a stream, if under a press of sail, she rights considerably. Another remarkable feature observable in the Polar Regions, at least in those parts encumbered with ice, is the total absence of heavy or dangerous squalls of wind. I cannot call to my recollection, says Captain Parry, in the Polar Regions, of such squalls as, in other climates, oblige the seaman to lower his topsails during their continuance.—*Parry's third Voyage.*

We verily believe, that, at the Pole itself, neither wind nor tide, rain nor snow, thunder nor lightning, will be found to exist,—or, if any of them exist at all, it will be in the smallest possible degree.—*Barrow.*

CHEMISTRY.

4. *The presence of animal and vegetable matter, or emanations from them, not necessary for the formation of Nitre.*—M. Longchamp, in a memoir read before the French Academy of Sciences, endeavours to shew, in opposition to experiments considered as correct, 1, That nitrates are formed in places that contain neither animal nor vegetable matter, and which have never been exposed to emanations from animals: 2. That the nitric acid is formed in the open air, in materials which contain not a trace of animal or vegetable matters: 3, That the nitric acid is formed entirely from the elements of the atmosphere.

5. *Phosphorus in Kelp.*—Repeated trials, we are told, by Von Mons, have proved, that the roundish and longish veins found in the *varec-soda* or kelp, after the removal of the matter soluble in water has been removed, are principally composed of phosphorus.

GEOLOGY.

6. *Geognostical Structure of the Country around Darwar.*—"The following geological fact is curious, whether new or not. The eastern part of this country, which we call the Dooab, is composed of granite, which is succeeded to the westward by an immense series of schists, extending the whole way to the sea. But, between the granite and the schists, is a considerable tract of country, consisting of what I would call pseudo-granite, which is the debris of the original granite, again consolidated. It is composed of felspar, quartz, and mica; the grains of which are not angular, like fresh crystals, but are rounded by attrition; and I have a specimen with an imbedded mass of felspar about the size of a pigeon's egg, completely worn into a round ball. From this description, you cannot doubt that this is not original granite. And now for my curious fact: This consolidated debris is almost every where intersected by small veins of quartz, or of quartz and felspar mixed. Nor have these veins originated from subsequent eruption; for they intersect one another in all directions, and often terminate in two ends, in a small portion of rock. Moreover, this rock often displays, in a slight degree, a schistose structure, especially when acted on by the weather. There are a number of masses of original granite imbedded in this consolidated debris; and, in those places where the latter displays the schistose structure, the imbedded masses have the schistose consolidated debris; or, if you please, the pseudo-granite, surrounding it like concentric lamellæ. These facts appear to prove, that a new arrangement of particles may take place in solid bodies, giving rise to crystallization, and to different kinds of structure in rocks. There is a curious fact mentioned by Dr Clarke, in his Travels in Greece, which strongly confirms this opinion, viz. that the enormous stalactites in the Grotto of Antiparos, which have been formed by the gradual deposition of lime-water, offer concentric *layers only* towards their superficies, their interior structure exhibiting a complicated

crystallization. You will at once see that this fact, being established, will prove of importance in enabling us to explain many appearances which have hitherto puzzled geologists in their attempts to account for the origin and formation of rocks."—*Letter from Alexander Turnbull, Esq. Civil Surgeon, Darwar, East Indies.*

7. *Account of a Libellulite found at Solenhoffen.*—Last spring there was found in the famous quarries of lithographic limestone at Solenhoffen, near Pappenheim, in Bavaria, a beautiful petrifaction of an insect of the genus Libellula, represented at Fig. 4. Pl. 3. These quarries are already well known, from the numerous fossil species of marine and fresh water animals they contain. The body of the fossil libellula is disposed in the direction of the slaty structure of the limestone, and is distinguished from the stone in which it is contained, not by any particular colour, but its greater smoothness. The head is roundish, and not very broad. The neck and the first pair of legs are distinctly visible, but the other feet were not seen. The thorax is the most prominent part of the animal, but becomes gradually flatter towards its extremity. The four wings are spread out, and very well preserved, and single veins are observable in some of them. The abdomen is cylindrical, is thinner towards the middle, expands again, and terminates in a notch. The globular head, the horizontally expanded wings, the cylindrical abdomen, and the total habitat, shew that it belongs to the genus *Aeschna* of Fabricius, and is distinguished from the *Aeschna grandis* only by its greater size. The insect just mentioned, measuring from tip of one wing to tip of the other, three inches; whereas in the fossil species, the length is three and a half inches, and all the other parts are in proportion larger. In the same block of stone with the fossil libellula, was a small asterias, or sea-star,—a fact which confirms the mutual occurrence, in this rock, of land and marine animals.—*Vide Leonhardt's Zeitschrift.*

8. *Beds of Sea-shells, nearly in a fresh state, 200 feet above the level of the Sea.*—The following observations, (says Berzelius), which I had an opportunity of making on the west side of the Scandinavian peninsula, will serve as an additional proof of the gradual rise of the Scandinavian land above the level of the sea. It is known that, on the sea-coast, and in

the islands at Uddevalla, and also on the whole sea-coast of Southern Norway, there are here and there banks of sea-shells, sometimes 200 feet above the present level of the sea. The shells are, in general, well preserved, none are calcined or weathered, and all of them are of species that still live in the neighbouring sea. The horizontal beds in which they lie, shew that they have been quietly formed here, and that they were formerly the bottom of the sea. One of them, the *Lepas balanus*, is always attached to the rocks of the coast; so that, during the motions of the surface of the sea, it is momentarily above its surface. Brongniart, with whom I visited these banks at Uddevalla, remarked, that if the sea, at any time, covered these places, that we would probably find *lepades* or *barnacles* adhering, if any of the rocks could be exposed. We searched for exposed portions of rock, and soon found them, with barnacles adhering, which had remained attached from the period when Uddevalla was 200 feet under the surface of the sea. I consider this as the oldest and most certain of all those marine testimonies which go to prove that the Scandinavian land has risen above the sea; for a fall or sinking of the sea 200 feet around the whole coast is not to be thought of. What raises the land, and how and when will its elevation be finished? But who would venture to answer these questions?

9. *Greensand formation in Sweden.*—Nilson has announced, in the Stockholm Transactions, the discovery of the greensand in Schonen. It contains, besides univalve and bivalve marine shells, different fossil land plants. The green sand of Schonen may be considered as the termination of the great tertiary series of rocks which extends from Germany, under the waters of the Baltic, until it terminates in the higher lying parts of Schonen.

10. *Coal of Höganäs.*—This interesting deposite appears to occupy, in the geognostical series, a place between the old coal formation and that of the brown coal.

11. *Hill of Magnetic Iron-ore.*—Menge describes a hill of magnetic iron-ore he met with at Kuschwa, in Siberia, 400 feet high, which rises through primitive greenstone. The iron-ore is associated with sodalite and augite. On the west side of the mountain, he observed a remarkable amygdaloid rock, in which the basis is of garnet. The amygdaloidal masses are calc-spar, and the vesicular cavities are lined with crystals of scapolite.

12. *Hyæna Cave.*—M. Billaudei, civil-engineer at Bourdeaux, discovered in a quarry on the banks of the Garrone, a cavern, in which he found a quantity of the bones of various animals, among them jaws of the hyæna, of the lion, or the tiger, and of the badger, bones of the fox, &c.

MINERALOGY.

13. *Crystallizations of Sulphate and Carbonate of Lead observed by M. Hartmann.*—The following forms of sulphate of lead (Prismatic Lead Spar) were observed in a series of beautiful specimens, from a vein in transition clay-slate, near the smelting works of Tanne, five hours from Brunswick, by the translator of Beudant's Mineralogy, M. Hartmann, and by him communicated to us:—1. $(P\breve{r} + \infty)^3$. $P - \infty$. very frequent in crystals half an inch in length, which are often tabular. 2. $(P\breve{r} + \infty)_3$. $P\breve{r}$ resembling fig. 1. *Mohs's Treatise*, vol. ii. 3. $(P\breve{r} + \infty)_3$. $P\breve{r}$. $P-\infty$. 4. $(P\breve{r} + \infty)^3$. $\bar{P}r + \infty$. 5. $P+\infty$. P. 6. $(P\breve{r} + \infty)^3$. $P\breve{r}$. $\bar{P}r$. 7. $(P\breve{r} + \infty.)^3$ $P\breve{r} + \infty$. $P - \infty$. Twin crystals exhibiting the form represented in Pl. III. Fig. 5. M. Hartmann observed, from the same place, the following combinations of carbonate of lead, or white lead spar:—1. P. 2. P. $(P\breve{r} + \infty)^3$. Fig. 54. Pl. 91. *Hauy*. 3. M. l. s. (*Hauy's Letters*) 4. M. l. f. u. Fig. 36. *Hauy*. 5. M. l. s. y. Fig. 57. 6. M. e. l. f. k. u. Twin, or rather triple crystals, grouped according to the law in Fig. 65. Pl. 93. *Hauy*, and the termination of the planes P. $\breve{n}$. i.

14. *Geognostic Position of Platina in America.*—Hitherto this metal has been found, in the New World, only in the alluvial districts of Choco and of Brazil; but Mr Boussingault has discovered roundish grains of platina, mingled with native gold, in veins in the province of Antioquia. These veins traverse a formation of greenstone, diorite, and syenite.

15. *Jet discovered in Wigtonshire.*—Beautiful specimens of this mineral have been found between a bed of peat and yellow clay, in the peninsula formed by Loch Ryan and the Irish Channel, by Sir Andrew Agnew.

16. *Geognostical Distribution of Gold in the Uralian Mountains.*—The gold-bearing districts in the Uralian mountains are

almost universally composed of magnesian rocks; of these the most frequent is talc-slate, and less abundant are serpentine and ophite. The gold occurs either disseminated in these rocks, or in quartz veins which traverse them, where it is generally associated with varieties of iron pyrites, which are usually auriferous. Beresowsk is a remarkable point in the Urals: the whole of the district is talc slate, surrounded by serpentine, and traversed in all directions with an infinity of auriferous quartz veins. In one place Mr Menge found gold in decayed syenite. Erdmann, in his account of the interior of Russia, gives an interesting account of the alluvial gold of that country. The alluvial deposit, on the left bank of the Beresowka, is about thirty feet thick,—the upper layer a loam, underneath which, and forming the great mass of the alluvium, is sand, of which the coarsest kinds are lowest. The gold occurs in the sand, and in largest quantity, in the deepest seated, and coarsest varieties. Two opinions as to the mode of formation of this alluvium have been proposed;—according to the one, it is believed to be derived from the neighbouring hills, because it is intermixed with masses of quartz, and fragments of brown iron ore, both of which occur in the mountains in the vicinity;—the other opinion, that it has been brought by a flood from a distance, receives additional support from the circumstance of it sometimes containing bones of tropical looking animals, and the gold being different from that of the neighbouring mountains. This alluvium, or auriferous sand, occurs chiefly on the east side of the Urals, extending from Bogislowich smelting establishment, to the Polkowischen mine, an extent of 1000 wersts from north to south. It is very rich in the district between Nischni-Tagilskoi and Kuschtymskoi, and the district Lenowka and Lugoowka. There is over the sand a layer of peat and black earth, $1\frac{1}{2}$ archines thick. The uppermost bed is richest in gold, the middle less so, and, at the bottom, the gold is scarce. The sizes of the single pieces of gold which have been met with, are worthy of being noticed. The Governor of Perm presented the University of Dorpat a specimen worth 800 rubles. When the Emperor Alexander visited the Mines of Orenburgh, he was presented with twenty-nine different pieces, one of which weighed eight pounds. In the royal mines of Slatoust, there was raised, in April 1825, within twenty-four hours, a series of beautiful specimens. Several weighed from five to nine pounds, and one sixteen pounds. This bed of sand also affords other metals. Soon after the commencement (1819) of washing for the gold of the Urals, many grains were noticed amongst the grains of gold,—these were of magnetic iron-ore, iron-pyrites, lead-glance, brown iron-ore, &c. In the year 1823, Lubarsky detected along with these, also platina, iridium, rhodium, and osmium.

17. *Geognostic situation of the Siberian Platina.*—M. Menge of Lubec, one of the contributors to our Journal, who is at present travelling in Siberia, gives the following account of the geognostic situation of the *Siberian Platina.* Being very desirous of examining the locality of that mineral, he proceeded to the spot, on the western side of the Uralian range, with one of the officers of the mine of *Nischnin Tagil.* There he found primitive clay-slate, much traversed by quartz veins on the banks of the Utka. The ridge of the Urals where he saw it, was composed of Serpentine; at the foot of a hill, named Pugina, which is composed of serpentine, resting on talc-slate, he found, under the soil, in decomposed talc-slate, a quantity of platina associated with gold and *native lead.* Forty hundred weight of this slate afford half a pound of platina. The slate is a compound of smoke-grey quartz and common talc-slate. Grains of platina were, in all probability, also disseminated through the quartz. The serpentine abounded in grains and crystals of magnetic iron-ore; and, in decomposed varieties of the same rock, grains of platina, but none of gold, were met with. On the east side of Pugina, the serpentine appears first in diallage rocks, and in this rock platina also occurs. North-east from Kuschwa, near to Nischnin-Turah, platina occurs in blue limestone, connected with disintegrated green porphyry.—The occurrence of gold and platina, in quantity, in serpentine and talc-slate, is a fact worthy of the attention of those proprietors in Scotland, where these rocks abound, as in Shetland, and various parts of the mainland of Scotland.

18. *Cordierite found in Norway.*—This mineral has been met with in Norway associated with Wernerite, quartz, garnet, and mica. The *pierre de soleil* probably belongs to this species. The Norwegian cordierite, when cut and polished, exhibits a stellular opalescence, resembling that of the stellular sapphire.

19. *Magnificent Crystals of Sulphate of Iron, or Green Vitriol.*—Although this mineral is not of rare occurrence, it seldom appears regularly crystallized. Lately crystals, exceeding in colour, transparency, size, and form, the finest specimens produced by art, were found at Bodenmais in Bavaria, by M. Moldenhauer, and noticed by Leonhardt.

20. *Iserine and Iron-sand in Cheshire.*—"I send you a bag of mixed iserine and iron-sand, which I have, a few days ago, traced quite across the Hundred of Wirral in Cheshire, from the shores of the Mersey to those of the Dee. I found it many years ago at Seacourse in that district, opposite to Liverpool, loose on the beach, and disseminated through a bed of crumbling sandstone, which lies below the thick bed of loam which forms the Cheshire soil at that spot. I afterwards traced it along the shores of the Mersey for several miles; and lately, in a short marine excursion to the islet of Kilberry, at the mouth of the river Dee, I was pleased to recognise my old acquaintance, washed out of the sandstone rock which forms that island, and the greatest part of the ridge of the Hundred of Wirral. I conceive this stone to be the Millstone Grit of the English geologists. Its upper bed is almost a farcilite, from containing many nodules of quartz, and occasionally some of a reddish felspar. It forms the ridge of Bidstone-hill and of Wallesey. At Hilberry Isle it lies just under the scanty soil, and rests on a much softer red sandstone, which appears to be identical with that on which Liverpool stands, and which cuts off the coal-measures in the coal-fields at St Helens and Prescot, ten miles east of Liverpool, as well as that of Neston in Wirral, on the shores of the Dee, opposite to Flint, and the portions of that same basin on the Welsh shores of the Dee. Indeed, in Liverpool the hard upper bed has been quarried as millstones, while the under red or yellow sandstone, is much charged with iron, and forms but an indifferent building material, which readily corrodes, when exposed to the weather."—*Letter from Dr Traill, Liverpool, to the Editor.*

21. *Bismuth Cobalt Ore.——External Characters.*—Colour intermediate between lead-grey and steel-grey; lustre metallic, and glistening or glimmering; texture radiated, partly stellular, partly parallel. It scratches fluor-spar, but this degree of

hardness is occasioned by intermixed quartz. Streak dull, colour not changed, but the powder soils. Specific gravity = 4.5—4.7. ——*Chemical Characters.*—Before the blowpipe on charcoal, gives out white vapours of arsenious acid; deposits on it a yellow crust, during which the ore becomes of a brown colour. When well roasted before the blowpipe, and then mixed with glass of borax and melted, it communicates to it a smalt blue colour. If some small pieces of the ore are exposed to a low red heat in a glass tube it affords a considerable quantity of arsenious acid.——*Constituent Parts.*—Arsenic 77.9602; cobalt 9.8866; iron 4.7695; bismuth 3.8866; copper 1,3030; nickel 1.1063; sulphur 1.0160 = 99.9282. The characteristic ingredients of this ore are arsenic-cobalt and arsenic-bismuth, a combination of these metals hitherto not met with in the mineral kingdom.——*Geographic Situation.*—Has hitherto been found only at Shneeberg in Saxony.—We owe our knowledge of this mineral to Mr Kersten of Göttingen.

22. *Selenium in Red Copper Ore.*—Kersten of Göttingen, on exposing the capillary red copper ore of Rheinbreitenbach to the blowpipe, perceived a seleniferous smell, which, on farther examination, he found to be owing to the presence of selenium in that ore. The capillary red copper ore of the Bannet he did not find to contain any selenium.

HYDROGRAPHY.

23. *Discovery of a New Substance in Sea Water.*—M. Ballard of Montpellier, has discovered a peculiar substance in sea-water, which he names *Brome,* and considers it intermediate between iodine and chlorine. It has a disagreeable smell; hence its name, from βρωμος (fœtor)*. It occurs, in very small quantity, in sea-water: even the mother water of salt water contains but very little.

* Brome is fluid at the average temperature of the atmosphere, and even at 18° below 0° centig. In quantity its colour is reddish-brown; in small quantity it is hyacinth-red; colour of its vapour exactly similar to that of nitrous acid. It is very volatile, and is converted into vapour at 47° centig. Smell very strong, resembling that of chlorine; its density about 3. It destroys colour, as chlorine does, and is soluble in water, alcohol, and ether. Weight of its atom 9,328, that of oxygen being 1. It forms interesting compounds with different substances, and is an active poison.

Marine plants and animals also contain Brome. The ashes of the *Janthina violacea* afforded minute portions of it; also the mother-water of barilla, employed for the preparation of iodine; and it was detected in a mineral water from the Eastern Pyrenees.

24. *Iodine and Lithion in the Mineral Springs of Theodoreshall at Kreutznach.*—M. Mettentreimer of Frankfort, has detected in the waters of these springs, of which the principal constituent parts are muriate of soda, muriate of lime, and muriate of magnesia, also iodine and lithion.

25. *Thickness of Salt Water Ice.*—Lieutenant Ross tried the thickness of the salt water ice during different periods of the winter, by digging holes in that formed upon the canal by which the ships had entered, and found it to have increased in the following ratio:

Date.	Whole thickness in inches.	Thickness above the sea in inches.	Proportion of that above to that below, the latter being 100.
November 20. 1824.	30.5	3.8	14.23
December 13.	38.5	4.4	12.90
January 1. 1825.	45.3	5.2	12.97
February 2.	55.9	6.0	12.02
March 2.	73.0	7.1	10.77
April 2.	82.5	7.8	10.44
May 4.	86.5	8.0	10.19

Parry's Third Voyage.

ZOOLOGY.

26. *Sword Fish caught in the Frith of Forth.*—Mr Slight, one of the assistant engineers under Robert Stevenson, Esq. has sent to the College Museum a remarkably fine specimen of the sword fish, which was found, in the month of September last, lying on the banks of the Forth between Stirling and Alloa. It is seven feet in length; perfect in all its parts; and will form a most interesting addition to our Museum.

27. *Discovery of the Circulation of the Blood in Insects.*—Carus of Dresden, the celebrated comparative anatomist, has, it is said, discovered the circulation of the blood in insects.

28. *Turf-Leech.*—Weber has published an interesting account of a species of leech, which brings a great price, and is found in the turf-bogs in Germany; it is named Hirudo stagnalis.

29. *Notice of two new species of British Sponges.*—When on the west coast of the island of Islay, in the summer of 1825, I observed, at low water, many small pools, in the gneiss and mica-slate cliffs near Portnahaven, completely lined with millepores, from whose elevated lobes large specimens of the *Corallina officinalis*, and tufts of the delicate *Corallina rubens*, shot up their jointed branches. On the lower part of the rocks, I found some dwarfish specimens of the *Sertularia pumila*, and *Alcyonium gelatinosum*, clinging to the leaves of the *Fucus serratus* and *vesiculosus*, and, along with some flustræ, adhering to the cuplike portions of the *Fucus loreus*; the deeper parts between the precipices waved with lofty forests of the *Fucus palmatus*. At the bottom of the cliffs, which are excavated into fearful caves, and long narrow coves, by the action of an ever tempestuous sea, I perceived, amidst a rich display of marine vegetation, numerous specimens of the *Spongia papillaris*, and of the *Spongia tomentosa*, which appears to be only a variety of the same species. My attention was attracted at this place by a substance of a deep blood red colour, about two inches in diameter, and spread as a thin layer on the under surface of one of the rocks. From its dangerous situation, I could only obtain some particles of it, sufficient, however, to show that it was a species of sponge hitherto unknown to me. This summer (1826) I met again with the same blood red species on the shores of Iona, and abundantly on Staffa; and on landing at ebb-tide at the entrance of the spar cave (Macalister's Cave) in Skye, I found it in large patches on the under surface of the slaty projections, on the left side of the cove, which leads up to these magnificent subterranean vaults. I have represented the form of its spiculum magnified fifty times, (Pl. II. fig. 9.); and as the concurrent opinion of my friend Dr Fleming leaves no doubt in my mind of its being a new species, I have termed it *Spongia sanguinea*, from its very striking blood-red colour in the living state. It spreads on the under surface of rocks to the extent sometimes of six inches in diameter, with a thickness of more than half an inch, and it has always the same deep red colour. The general surface is flat; but, on minute examination, it is found to be covered with numerous small round elevations and depressions, and the fecal orifices, which are numerous and small,

are always observed in the depressed parts. The pores are very minute, and appear like perforations made by needles of different sizes. This species feels very slimy when torn, and abounds nearly as much with parenchymatous matter as the *Spongia panicea*, to which it has a close affinity in its general form and habits. Its spicula are silicious, rather long, (taking always that of the *Spongilla friabilis* (Pl. II. fig. 1.) as a standard of comparison), curved, equally thick throughout, obtuse at one end, and pointed at the other, (see Pl. II fig. 9.). The spiculum which I have represented in Pl. II. fig. 3., belongs to a sponge, which I likewise believe to be an undescribed British species, and which I have named *Spongia cinerea*, from its remarkable blackish grey colour. I met only with a single specimen of this sessile species, about two years ago, in the Firth of Forth, and I have not since observed it on any other coast. It grew on the inclined side of a rock, had an irregular outline, and was about three inches in length, one in breadth, and half an inch in thickness. My attention was attracted to this specimen, from its perfect resemblance to a dark putrid sponge, but on immersing it in water, I found it still in a high state of vitality. Its surface was smooth, convex, fleshy and transparent. Its pores required a lens to be distinctly seen, and its fecal orifices were few, very large, regularly circular, and lay rather deeper than the general surface. Its spicula were remarkably uniform in size, rather small, curved, equally thick throughout, pointed suddenly at both ends, and silicious, (see Pl. II. fig. 3.) —*Dr Grant.*

30. *South African Museum.*—(1st Series.). The attention of the public is particularly requested, by Dr Smith, Superintendent of the South African Museum, to the following Queries, and information on the points to which they allude is most earnestly solicited from such individuals as may have had opportunities of acquiring it. 1. Does the Tiger Wolf, or what is generally denominated the Cape Wolf, carry away its prey; or does it always devour it on the spot where it first finds it? 2. If he ever carries it away, what seems to be his reason or reasons for so doing? 3. When he happens to fall in with more than he can at once consume, does he simply abandon the surplus, or does he carry it away? 4. When they have young,

how do they furnish them with food; that is to say, do they carry away a portion to their haunts, or do they first swallow the whole, and then regurgitate or bring up a portion of it on their return, for the purposes stated? 5. Are bones ever found in holes, or in other spots, which form the resort of Wolves; and if so, do those ever occur in great quantities? 6. In what situation do the Cape Wolves generally live; that is to say, do they always remain exposed in the open air? 7. Does more than one ever resort to the same habitation; or are they ever found in considerable numbers in large dens? 8. At what age and size do the young generally begin to accompany their dam in search of food?

31. *South African Museum.*—(2d Series.) Out of the various important communications which have been received as answers to the preceding inquiries relative to the wolf, the following additional queries have been suggested. 1. Does the wolf ever attack the human species; and if so, under what circumstances are such attacks generally made,—that is to say, does hunger, rage, or some other particular state or situation urge them? 2. In those parts of the country where the Wolf generally sleeps in the open air, does he form any sort of artificial bed for himself; or does he simply lie down on the natural surface of the ground? (In a very interesting communication lately received from Mr Wentworth of Wynberg, it is stated, upon most respectable authority, that they usually form slight hollows in the ground for their sleeping places, somewhat similar to those that are occasionally made by dogs for like purposes.) 3. If he pursues the former plan, are such formations ever observed in considerable numbers about particular spots? 4. How many young has this animal generally at a birth? 5. During what particular time or times of the year have they their young? 6. Are they, when at their full growth, ever met with in considerable numbers together; and if so, on what occasion? 7. Do they ever swallow clay; and if so, under what circumstance? 8. In what sort of weather is the wolf most frequently, most daring, and most destructive? 9. Are animals more likely to suffer from his attacks during moon-light than in dark nights; or is the reverse the case? ANDREW SMITH, M. D. *Superintendent.* —The perusal of the above interesting queries, (communicated

by Sir James Macgrigor), circulated throughout Southern Africa, by Dr Smith, whose zeal and activity in every thing appertaining to the Natural History of Africa, cannot be too much prized, will interest our readers.

32. *Narcotic Spider.*—In the caves in Pennsylvania, there is found a black species of spider, spotted with blue over its abdomen, and which has been given internally with success in certain fevers. It has the narcotic property, although in a less degree than opium. Mr Hentz, who relates this fact, mentions another species of spider which possesses a similar property in America, in which it is also indigenous. Spiders are known that have the property of raising blisters, and others which, on being swallowed, have caused an excitement of the genital organs like that produced by cantharides.—*Journal de Pharmacie.*

33. *Power of the Stomach of Birds.*—M. Constantin, in the Archives of the Society of Pharmacy of Northern Germany, mentions as a remarkable example of the power of the stomach, in resisting a mass of undigested matter, a fowl in the stomach of which there were found three large pieces of flint, three metal buttons, fourteen iron nails, several of which were still very sharp, and a great number of small stones. With the exception of some slight scratches on the inner membrane, the stomach was in its natural state.

34. *Vulture shot in Somersetshire.*—Our intelligent friend W. C. Trevelyan, Esq. informs us, that a vulture was shot in June last, at Kilve, near Bridgwater, in Somersetshire. It was first observed walking on a road, and, on being pursued, flew towards the coast of the Bristol Channel, distant abont a mile, when it was found sitting on the beach, and shot. It had recently gorged itself with a putrid lamb, which may probably have been the cause of its allowing itself being approached within shot: on opening it for the purpose of stuffing, the smell was excessively offensive. Another bird, apparently of the same species, was seen near the place where this was killed, but it evaded pursuit. The specimen killed measured from the tip of the beak to the end of the tail, 2 feet 3 inches; from the tip of one wing to the tip of the other, 5 feet 6½ inches. A notice of the interesting fact,

here recorded, was drawn up by Mr Trevelyan's grandfather, and appeared in the Newcastle Courant, of the 21st October last.

35. *Gigantic Orang Outang.*—A female of the Gigantic Orang Outang, has lately been met with in Sumatra, and brought from thence to Calcutta, where it has been examined and described by Dr Abel.

BOTANY.

36. *Irish Furze, Broom, and Yew.*—It is not generally known that Ireland possesses varieties of the furze, the broom, and the yew, very different from any yet found in Great Britain. The *Ulex europœus* of Ireland is more upright in its growth than the common plant, more compact, but much softer, and scarcely prickly to the touch. The Irish broom is very remarkable, and seems to be really a different species from *Cytisus scoparius*, (*Spartium scoparium*, auct.). This is characterized by the pod being glabrous on the sides, but furnished with a margin of short woolly hair. The Irish one has the pod so totally covered with long woolly hairs, as to appear at a distance like balls of white cotton. It in all probability will be found to be *Cytisus grandiflorus*, a species hitherto found only in Portugal. *Lastly*, The Irish yew is merely a shrub; the leaves are not distichous, as in the common *Taxus baccati*, but are quaternate. Of all the three, the British varieties are also found in Ireland, the above mentioned being rare.

ARTS.

37. *Easy mode of Cutting Glass.*—Mr Buchner of Mayence describes in the Archives of the Society of Pharmacy of Northern Germany, a method of cutting glass, which is as follows: A thin card, one, two or three inches broad, is glued to the glass in such a manner, as to cover the line in which the fracture is intended to follow, in its whole extent. When the card is dry, a line is traced upon it by means of an iron or steel point, taking care to cut it down to the glass. In this groove a thread is then placed of a line and a half or two lines diameter, and brought round the vessel. The latter is steadied, and two people laying hold of the extremities of the thread, move it rapidly backward and forward upon the glass. In less than a minute,

and when the thread begins to smoke, the glass cracks. The author attributes this effect to the development of electricity, since, in this case, he says, we cannot admit an alternation of cold and heat, as takes place in other methods. The thickest pieces of glass may be cut in this manner.

NEW PUBLICATIONS.

1. *Mathematics practically applied to the Useful and Fine Arts;* by Baron Charles Dupin, Member of the Institute, of the Academy of Sciences, &c. &c. *Adapted to the State of the Arts in England;* by George Birkbeck, Esq. M. D., President of the London Mechanics' Institution, &c. &c.

Since the publication of our last, some of the first numbers of this truly interesting work have made their appearance. A work of the kind has been long a desideratum in this country; and considering the high characters both of the author and translator, we have reason to expect that it will be such as the title bears, and productive of the happiest effects throughout the British empire. Though written in a masterly style, it at same time possesses all that simplicity and perspicuity which are so essential to such a work, and characteristic of true science. It is remarkable, that our operative classes should have so long kept before our continental neighbours, for practical skill in the arts and manufactures, whilst we have in general been as far behind them in a scientific point of view. The present work is well calculated to rescue both parties from these equally unprofitable extremes of abstract speculation, and of human creatures labouring like inanimate machines, without understanding the *rationale* of their operations. At same time we are sure, that those who have made considerable proficiency in science, will not lose their labour by perusing this work. The specimen which we have seen both of the printing and engraving is excellent. But to most readers, the value of such a work would be almost doubled by using cuts inserted in the letter-press instead of plates. In this way, not only the task of seeking out the figure, but the far more irksome one of separately carrying every word or letter between the figure and plate, would be in a great measure saved. In books of geometry, plates, especially folding ones, are often fluttering in rags, whilst the work is otherwise entire. Baron Dupin is entitled to great praise for the pains he has taken to give a clear exposition of first principles; and, indeed, the student who considers the first rudiments of any science below his notice, is not likely to become a proficient. We think, however, that some improvement might still be made among the definitions. Thus, page 4, " A right line is the shortest distance between any two points." This, to be sure, is a characteristic feature of a straight line; but unfortunately, it is of no use at the outset of the elements of geometry. To supply the place of Euclid's tenth axiom, a second clause is added defining a right line to be " that which we trace by always proceeding in the same direction." Now, the term *direction* has more need of definition than the other; and we know of no mode of defining *direction*, but by help of a previous knowledge of a *straight line*. The tenth axiom of Euclid, or its converse, forms the only definition of a straight line which has as yet been found of any use in demonstrating the first propositions in geometry. It has therefore been adopted in this form by some authors of great note. In works exclusively devoted to elementary geometry, the demonstration of Euclid's twelfth axiom is usually passed over as impossible; and this makes it somewhat curious, that, in page 18 of Dupin, a demonstration of that notable theorem, on which so many have foundered, should have been attempted, as if it were a matter of no difficulty whatever. The demonstration, however, is not new, but it is not exactly given in its true colours; for nothing is said of the *infinite* magnitudes of the lines and areas on which the whole force of the reasoning depends. A fairer representation of it may be seen in Professor Duncan's " *Supplement* to Playfair's *Geometry* and Wood's *Algebra*." This singular demonstration is somewhat allied to the method of exhaustion, though not by infinitely small quantities; but areas *infinitely great* intercepted between lines of *infinite lengths;* and it is therefore doubtful if it be quite admissible towards the beginning of the elements of geometry, or if indeed it could be allowed in the higher branches of that science. In short, it is such as neither Euclid nor Archimedes would have tolerated; and we are not sure if the modern supporters of the ancient geometry be disposed to treat it with greater courtesy. At same time, we have here some admirable specimens of the application of the doctrine of parallels to the most useful of purposes. At page 33, the translator pays a high compliment to the French nation, on account of their skill in ship-building; and that they are well entitled to such encomiums we are not disposed to dispute. However, we beg to differ from him, in ascribing their success to the application of the mathematical sciences to the determination of the best form of a ship; because all, the little all, that is known of the best form, is merely derived from experience. An age probably will elapse, before the mathematical sciences can be applied with any certainty to this subject; for the laws of the resistance of water on a large scale are as yet only matter of speculation. The Dutch form differs exceedingly from the French; and yet competent judges admit, that it is not on that account inferior in practical utility.* But notwithstanding these criticisms, we do not hesitate strongly to recommend this work, especially to such as are desirous of acquiring the practical use of mathematics whilst studying the elements of that science.

2. *Mr Audubon's great Work on the Birds of the United States of America.*—M. Audubon devoted 22 years of his life to the study of the Natural History of the Birds of North America. During the greater part of that long period, he lived principally, and nearly alone, in the woods and wilds of the New World, drawing, describing, dissecting, and studying the appearances, habits and manners of the feathered creation. The result of this almost unparalleled labour, has been a connected series of observations equally striking and novel, and a collection of drawings admirable in execution, and absolutely marvellous in their representation of the living and intellectual attributes of the species.

* The current century has afforded some notable instances of the abuse of mathematical science; and in no case, perhaps, has the failure been more complete than in that of patent mathematical ploughs, scarcely one-half of which were ever used, but were consigned to neglect, and to be broken up for other purposes, like so many condemned wrecks. All the mathematical theories in the world are of no use in determining the best form of that part of a plough which works under ground; and we have no reason to expect that it will ever be otherwise. Like every thing else, mathematics are valuable, highly valuable, only in their own place.

Each group, even each bird, by its attitudes and expression of countenance, tells in these drawings the story of its own instincts. Did our space allow of it, we could dwell long, and with enthusiastic admiration, on these fine displays of skill and taste, and, after all, would but embody in a feeble manner the feelings of thousands who have seen Mr Audubon's pictures in the room of the Royal Institution in Liverpool, and in the Hall of the Royal Institution in this city. We are delighted to learn that these drawings are to be published, and on a scale of magnitude never before attempted in similar works in this country. Already several of the plates, admirably engraved, and beautifully and chastely coloured, have been publicly exhibited. The work, we understand, will appear in occasional numbers; the paper elephant folio, with 5 plates in each. The engravings will be accompanied with a quarto volume of letter press, containing all Mr Audubon's observations on the Natural History of the species, in the form of letters,—of which a very interesting specimen is given, in the history of the Turkey Buzzard in the present number of this Journal.

3. *The Aberdeen, Leith and London Tide-Tables for the year* 1827*; by George Innes, Astronomical Calculator, Aberdeen.*—Mr Innes, so well known for his enthusiastic devotion to Practical Astronomy and his uncommon accuracy in calculation, has just published his Tables for 1827. This little work, now so indispensable to mariners and others, although requiring no commendation from us, we cannot allow to run its career without again expressing our conviction, from experience, of the perfect accuracy (and here every thing depends on accuracy), of all its calculations and details.

List of Patents granted in England, from 18*th September to* 18*th November* 1826.

1826,

Sept. 18. To R. Williams, Norfolk Street, Strand, for an improved method of manufacturing Hats and Caps, with the assistance of machinery.

Oct. 4. To J. R. Chaid, Somersetshire, lace-manufacturer, for improvements in machinery for making Net, commonly called Bobbin or Twist Net.

To Francis Halliday of Ham, in the county of Surrey, Esquire, for certain improvements on apparatus used in drawing Boots on and off.

11. To Theodore Jones of Coleman Street, accountant, for an improvement on the Wheels of Carriages.

18. To William Mills of Hazelhouse, Bisley, Gloucestershire, gentleman, for an improvement in Fire-Arms.

To William Church, Birmingham, for improvements in Printing.

To Samuel Pratt, New Bond Street, Westminster, camp-equipage manufacturer, for improvements on Beds, Bedsteads, Couches, Seats, and other articles of Furniture.

To William Busk, Broad Street, London, Esq. for improvements in propelling Boats, Ships, or other Vessels, or floating Bodies.

To James Viney, of Shanklin, Isle of Wight, Colonel of Artillery, and George Pockock, of Bristol, gentleman, for improvements in the construction of Carts or other Carriages, and for the application of a Power, hitherto unused for that purpose, to draw the same; which power is also applicable to the drawing of ships and other vessels, and for raising weights, and for other useful purposes.

Nov. 7. To B. Newmarch, Cheltenham, for improvements on Fire-Arms.

9. To E. Thompson, Birmingham, goldsmith and silversmith, for improvements in the construction of Medals, Tokens, and Coins.

18. To H. Lacy, Manchester, coachmaker, for an apparatus on which to suspend Carriage-Bodies.

To B. Woodcroft, Manchester, silk-manufacturer, for his improvements in Wheels and Paddles for propelling boats and vessels.

List of Patents granted in Scotland from 9th September to 8th November 1826.

1826,

Oct. 10. To John Poole of Sheffield, in the county of York, shopkeeper, for "certain Improvements in Steam-engine Boilers or Steam Generators; applicable also to the Evaporation of other Fluids."

Nov. 2. To David Ramsay Hay of the city of Edinburgh, painter, and copartner with George Nicholson, painter in Edinburgh, carrying on business there as painters, under the firm of Nicholson and Hay, for "a new Process in Painting, for producing the appearance of Damask."

8. To Theodore Jones of Coleman Street, in the city of London, accountant, for "an Improvement or Improvements on Wheels for Carriages."

P. Neill, Printer.

THE

EDINBURGH NEW PHILOSOPHICAL JOURNAL.

Biographical Memoirs of CHARLES BONNET *and* HORACE BENEDICT DE SAÚSSURE. Read to the Royal Institute of France, by Baron CUVIER.

IMMEDIATELY after the new organization of the Institute, the first Class of Science, by a unanimous resolution, ordained a public eulogium to be pronounced upon the members of the Academy of Science, who had died during that fatal period, when all personal merit, all independent pre-eminence, were odious to authority, and when none were permitted to be praised but the oppressors of the country, and their contemptible satellites *.

At the moment when we were meditating the discharge of this honourable office, a multitude of meritorious individuals presented themselves to our view. Among these shone forth with a more intense lustre, not only the happy geniuses, who, in these latter times, have opened up to science paths so new and so extended; but those, also, whose valuable talents have enabled them to diffuse the light of knowledge, and teach men to appreciate its benefits. The Lavoisiers, the Baillys, the Condorcets, were the men who seemed more imperiously to demand our homage: but they were also men whose agitated life and unhappy end, would have aroused the remembrance of events which even yet excite too much grief. To expiate the crimes of that disastrous period, it would have been necessary to repeat their history; and this, we confess, we have not yet acquired sufficient courage to do.

* The fatal period of the *Revolution*.

Pardon us, therefore, ye illustrious shades! if we first present to public recognition such of your rivals, as, from superior prudence, or a happier destiny, kept themselves sheltered from the tempests of which you have been the victims. The day will soon arrive, when we shall fully acquit ourselves of the sacred duty. The hand which has repaired our evils, gradually softens the remembrance of them: it makes this epoch retrograde, if we may so speak: soon we shall no longer be the contemporaries of your executioners, and shall be able to speak of them as history will speak.

To-day I shall present a sketch of the life of two celebrated individuals, closely allied by blood, and still more by their mode of life, and the similarity of their labours;—men who, in a country that had experienced convulsions long before ours, had yet commanded the respect of all parties, by their devotedness to science, and by the practice of peaceful virtues. Charles Bonnet, and Horace Benedict de Saussure, the two men to whom Natural History has been indebted in our days for such brilliant advances, and solid improvements, were uncle and nephew,—a happy family, to which a scion already inscribed in our lists, still ensures for one generation more an heirship of talents so rarely to be met with.

Such phenomena in families could only happen in those small states whose independence is secured by the jealousy of greater powers. Confined within a narrow circle, freed of the care of providing for their safety, neither war, nor public offices, nor the other avenues to rapid success, presented sufficient allurements to turn their minds aside from those long and silent labours which lead to celebrity in science. Being to themselves their proper centre, no great metropolis drew away the geniuses which nature produced among them; while their prudent economy, and the purity of their manners, prevented talents from being stifled by luxury.

Such was the city of Geneva since the period of the Reformation; and to all the advantages of its political situation, it added that of speaking the same language as those who, of all the other European nations, have carried civilization, among the upper classes, to the highest pitch, and who, moreover, enjoy that unrestrained liberty of inquiry which the Protestants authorise even in matters connected with religion. Its laws and its customs, in fine, guaranteed to the profession of letters so high a degree of estimation, that the mere offices of instruction were considered as superior to all others.

But if, in this country, human institutions are so favourable to study in general, how much more powerfully does nature here excite the mind to the contemplation of her economy and laws! How is the traveller struck with admiration, when, on a fine summer day, after having forced his laborious progress over the summits of Jura, he arrives at that pass where the immense basin of Geneva suddenly expands before him; when he sees at a glance that beautiful lake, the waters of which reflect the azure hue of the sky still purer and deeper; that vast expanse of low country, so highly cultivated, and interspersed with such pleasant abodes; those little hills, rising gradually above each other, and clothed with so rich a vegetation; those mountains covered with forests of perpetual verdure; the towering ridge of the upper Alps, rising above this superb amphitheatre; and Mont Blanc, the monarch of the mountains of Europe, crowning it with his enormous load of snows, where the arrangement of the masses, and the opposition of the lights and shadows, produce an effect which no description could ever adequately convey to the conception of him who has not beheld this wonderful scene.

And this beautiful country, so calculated to strike the imagination, to develope the talents of the poet or the painter, is perhaps still better adapted to awaken the curiosity of the philosopher, and call forth the researches of the naturalist. It is truly here that Nature seems to delight in shewing herself under a multiplicity of aspects.

The rarest plants, from those of the temperate climates to those of the frozen zone, are displayed to the botanist within the compass of a few steps. The zoologist may there pursue insects as varied as the vegetation which nourishes them. The lake, from its depth, its extent, and even the violence of its motions, forms to the natural philosopher a sort of sea. The geologist, who elsewhere sees only the external crust of the globe, finds there the central masses rising, and protruding on all hands through their envelopes, to disclose themselves to his view. Lastly, the meteorologist can there, at all times, mark the formation of the clouds, penetrate into their interior, or raise himself above them.

But I perceive that, in thus painting the theatre in which the distinguished individuals lived of whom I am about to speak, I have unintentionally presented you with a miniature of their discoveries; and, in fact, their country is in a manner vividly impressed upon their works, even those which are the most comprehensive in their object: nor was it ever left by one of them,—and if the other sometimes separated himself from it, it was always to him the centre and point of comparison to which he referred all that he saw elsewhere;—powerful influence of first habits,—of which another of their fellow-citizens has given a different kind of example, which the events that have agitated Europe have rendered too memorable.

Charles Bonnet was born in 1720, of a rich family, distinguished for the important offices which it had filled. He was intended for the law, and received the education necessary for preparing him to practise that profession. A facility of conception, and a happy imagination, enabled him to make rapid progress in literature and science; but they did not at first permit him to devote himself with delight to the more abstract meditations of philosophy, and still less to the study of all those forms, all those little particular decisions, with which so many codes are filled.

This taste for agreeable ideas, for easy, although ingenious, researches, already indicated a disposition favourable to the study of Natural History; and accident threw him entirely into that pursuit. He read one day, in the *Spectacle de la Nature*, the history of the singular industry of the insect called the Lion Spider, *Formica Leo*. Vividly impressed with facts equally curious and new to him, he was not satisfied until he had procured one of them; and, in searching for this insect, he found many others which appeared to him not less interesting. He spoke to every body of the new world which had opened itself up to him. Being apprised of the existence of Reaumur's work, he obtained it, after much importunity, from the public librarian, who was at first unwilling to trust it to so young a man. He devoured its contents in a few days, and ran about everywhere in search of the animals with whose history Reaumur had made him acquainted. He discovered a multitude of beings, of which Reaumur had taken no notice; and now behold him, at the age of sixteen, become a naturalist. He would probably have remained so for life, had not his infirmities constrained him to give another direction to his mind.

He entered upon the career of observation with gigantic steps. At the age of eighteen he communicated to Reaumur several interesting facts, and at twenty he submitted to him his beautiful discovery of the fecundity of aphides without previous copulation. Nine successive generations, independent of sexual intercourse, were then an unheard-of wonder; but the admirable patience exercised by so young a man in determining the fact, all the precautions, and all the sagacity requisite for such an undertaking, were not less wonderful. They announced a mind of which every thing might be expected; and the Academy of Science thought it could not too speedily but inscribe the name of this young observer in the lists of its correspondents.

Soon after, a fellow-countryman of Bonnet's presented a still greater miracle to the astonished world of science; the history of the polypus, and its indefinite reproduction by cutting, were published by Abraham Trembley. Bonnet immediately applied the scissors to all the animals commonly called *imperfect.* He saw the cut parts grow again in land and fresh water worms. He also multiplied the individuals by dividing them, although no comparison could be made between their highly complicated organisation, and the almost perfect simplicity of structure of the polypus.

In this manner, a power began to shew itself in animals, which had hitherto been regarded as peculiar to plants. It was by following the views of Bonnet that Spallanzani carried the proofs of this power to their utmost limit, when he caused the head, with the tongue, jaws, and eyes, to be reproduced in a slug,—and the feet, with all their bones, muscles, nerves, and vessels, in the salamander.

This property, experimented upon in worms, presented Bonnet with several phenomena calculated to excite astonishment. The anterior extremity, on being split, afforded two heads, which, while yet scarcely formed, became enemies to each other. When the animal was cut into three distinct pieces, the middle piece commonly reproduced a head before, and a tail behind. But a sort of error of nature also sometimes manifested itself; the middle piece produced two tails, and being unable to nourish itself, was condemned to quick destruction.

It seemed as if it were the destiny of Bonnet, that the half-formed ideas, and uncompleted attempts of others, should furnish him with the subjects of great discoveries, and beautiful works; and, in fact, it is less by conceiving ingenious ideas than by unremittingly pursuing their development, that the great geniuses have gained their celebrity. The germ of the differential calculus is to be found in Barrow, and that of the central forces in Huyghens; yet Newton is not the less entitled to hold the first rank in intellectual pre-eminence.

Some experiments, undertaken with the view of making shrubs vegetate without earth, and a conjecture of Calandrini's regarding the design of the difference between the two surfaces of the leaves of trees, led Bonnet to undertake his *Traité de l'Usage des Feuilles*, one of the most important works on vegetable physiology that the eighteenth century produced.

He not only found existing in vegetables, in the highest degree, that power of reproduction, by which, from any part of an organised body, the whole may at all times be reproduced; he also observed and investigated that mutual action of the vegetable and the surrounding elements, so well adjusted by nature, that, in a multitude of circumstances, the plant would seem to act for its preservation with sensibility and discernment. Thus he saw the roots changing their direction, and stretching themselves out in quest of better nourishment; the leaves twisting themselves, when moisture was presented to them, in a different direction from the ordinary one; the branches straightening or bending in various ways in search of purer or more abundant air; all the parts of the plants moving toward the light, however narrow the apertures by which it was admitted. It seemed as if the vegetable struggled with the observer in sagacity and address; and every time that the latter presented a new allurement, or a new obstacle, he saw the plant bending itself in a different manner, and always assuming the position most suitable to its welfare. While the leaves formed the principal object of his reseaches, Bonnet examined also the functions of the other parts of the vegetable. He shewed that there is no circulation, properly so called, in plants. He made observations respecting the internal structure of the vegetable. He proved that pure water and atmospheric air are sufficient for nourishing plants,—a result which might have immediately led to the great discoveries of modern chemistry regarding the composition of water and carbonic acid, had not a knowledge of many other phenomena still been necessary to suggest the want of this solution, and to pave the way for these discoveries.

These researches occupied Bonnet for twelve years; and, from the scrupulous accuracy, and delicate sagacity so conspicuous in them, as well as the solidity of their results, they form his best title to distinction.

What secrets might not such a mind have unfolded, after so promising a commencement, had nature left him the physical powers necessary for observation? But his eyes, weakened by the use of the microscope, refused him their assistance; and his mind, too active to endure a state of absolute repose, threw itself into the field of speculative philosophy. From this period his works assumed a new character, and he now only treated of those general questions that have, in all ages, engaged the meditative faculties of the human mind, and which will probably occupy them as long as the world continues to exist.

In the writings of his maturer age, however, we recognise, by the facts which are every where incorporated with them, and the care with which he avoids losing himself in systems founded upon the abuse of abstract terms, the philosopher who has entered the region of metaphysics by the path of observation. The choice of Malebranche and Leibnitz for his guides, and the discriminating selection which he made of their views, always recall to his thoughts his first pursuits.

But what especially characterised them were those physical hypotheses which he always added after having exhausted the field of observation, and by which he still seemed anxious to present to the mind objects of external perception, when the senses refused to present them to him. This necessity of clear and almost tangible ideas, which constitutes the true spirit of Cartesianism, had been carefully inculcated in the old Academy of Science, and Bonnet had been impressed with it by his correspondence with Reaumur.

We shall now give an account of these writings, not in the order in which he published them, but in that in which we may suppose him to have conceived them; and, on reading them, it is obvious that a single principle must have predominated in the conception of all, and that the author detached its various parts in proportion as he judged them sufficiently perfect to be published.

Although these works are not connected with our ordinary studies, yet they all belong to the individual whose character it is our object to delineate; and we should present but mutilated portraits of celebrated men, did we not trace, in its details, and even in its aberrations, the progress of their ideas.

In Bonnet's youth, a great deal had been written on Generation; and this subject would, therefore, naturally occur among the first to engage his attention. It was impossible for one who had seen nine generations of pucerons succeed each other, without males, not to be, like Malebranche, an advocate for the pre-existence of germs, and not to place them in the females. His *Considérations sur les Corps organisés* are almost entirely consecrated to the defence of this system, and especially to an explanation, by partial hypotheses, of the phenomena which were at variance with it, such as those of hybrids and of certain monsters.

There is much talent in this work, in which all the objections are either solved or evaded with more or less ingenuity. Destitute, however, as it was of all proper observations, it would scarcely have prevailed against the directly opposite hypothesis, which the eloquence of Buffon had rendered popular. But the indefatigable Spallanzani brought facts to the support of Bonnet's views, by shewing the young tadpole already existing in the egg of its mother before the male had fecundated it. Haller, who had long supported the idea of the formation of organised beings, by the action of organic powers, returned to the opinion of germs, when he had seen that the chick is attached by innumerable vessels to parts of the egg, which undoubtedly existed before impregnation.

In another general work, entitled *Contemplation de la Nature*, Bonnet supported the proposition of Leibnitz, that every thing is connected in the universe, and that nature makes no leap; but, instead of confining its application, like the German philosopher, to successive events, having the relation of causes and effects, or at least to the mutual action and reaction of simultaneous beings, he also extended it to the forms of these beings, and to the gradations of their physical and moral nature.

That immense series, commencing with the ruder and more simple substances, rising by infinite degrees to the regular minerals, to plants, to zoophites, to insects, to the higher animals, to man himself, and through him to the celestial intelligences, and terminating in the bosom of the divinity; that regular gradation in the development of beings, unfolded by the talent of Bonnet, formed an enchanting picture, which could not fail to gain many admirers.

For a long period naturalists busied themselves in filling up the vacuities which the want of observations, according to their view, still left in this scale; and the discovery of an additional link, in this immense series, appeared to them an object of the greatest interest.

But, however agreeable this idea might appear to be to the imagination, it must be acknowledged, that, taken in this acceptation, and to this extent, it has no real existence. Without doubt, the beings which constitute certain families have more or less resemblance to each other; and, in some of these families, there are, undoubtedly, beings possessing certain properties in common with members of other families. The bat flies like birds, the swan swims like fishes; but it is neither to the last quadruped of the series, nor to the first bird, that the bat has most resemblance. The dolphin would connect quadrupeds and fishes still better than the swan would connect fishes and birds. Thus there are multiplied relations, but no one continued line; each being is a part which exercises a determinate influence upon the whole, but not a link that would fill a fixed place in it.

Bonnet would probably have avoided this illusion, had he applied himself more to the detailed examination of species; but, with other men of merit in his day, he participated in their unjust contempt for that ingenious art of distinguishing beings by certain marks, which was then proscribed, under the name of Nomenclature. He was not aware that this art is in Natural History the basis of all further inquiry; nor did he conceive it to be the path to a much more profound art of determining the intimate nature of beings, by establishing rational and constant relations between them.

At the present day, we find it difficult to conceive, how truths so clear could have been misunderstood; but, we must reflect, that the principles of these truths were then presented in such a defective manner, and in so absurd a style, as could not but disgust men of literary attainments, accustomed, in their writings, to please the imagination, in order to penetrate to the understanding of their readers.

Bonnet belonged completely to this last order of writers, and his Contemplation of Nature, in particular, is as remarkable for the pleasing vivacity of its style, as for the accumulation of facts which he has brought together, and presented under the most interesting relations. It is one of those books that may, with most advantage, be put into the hands of the young, as calculated at once to inspire them with a taste for study, and reverence for divine providence.

His *Essai de Psychologie*, and his *Essai analytique sur les Facultés de l'Ame*, with which he commenced the publication of his speculative researches; and his *Palingenesie Philosophique*, with which he terminated them, are but little connected with Natural History, properly so called; and, for this reason, we shall confine ourselves here to a very summary view of the principal ideas contained in these works.

The author investigates the moral and intellectual being in the development of its faculties. He concurred with the Abbé de Condillac, in the idea of determining, by a process of reasoning, what would happen to an adult and healthy man, who, like a statue animated by degrees (or gradually endowed with the senses and faculties of a rational being), should receive successively all the sensations in the order in which they would be given him; and thus he developes the history of the mind, leading it, in an ingenious manner, from the acquisition of the simplest ideas of all, namely, those derived immediately from the external world, up to the creation of those which are the most abstract, and which, from their simplicity also, though of a different kind, were so long considered as, in their origin, entirely independent of the senses. This was still following the path of observation; but he soon diverged, as was his custom, into that of hypothesis.

The undeniable facts, that external images arrive at the mind only through the medium of the senses, and that the senses act upon the mind only through the medium of the brain, led him to suppose, that the brain alone is the depository of these images, and that it reproduces them for reminiscence, and consequently also for reflection; from which he inferred the necessity of a corporeal organ to the intelligent being. But, accustomed as he was from his system of germs, to imagine organs so inconceivably small as to belong to the thousandth order in organisation, it was not difficult for him to make this organ survive the visible and terrestrial body. He accounted for the phenomena of association in the manner of Hartley, by supposing a mutual excitement among the molecules of the brain, analogous to the power which cords, when stretched in unison, possess of making one another vibrate. He admits, on the part of the mind, no action without a motive, as, says he, we see in nature no effect without a cause; and liberty, according to his view, is only the power of following, without restraint, the motives whose impulse we experience. By this definition he easily defends, as may be imagined, moral liberty against the objections derived from the Divine Prescience. But, would not the term liberty be thus changed from its natural acceptation?

It must be allowed, in fact, that Bonnet's ideas regarding the organs necessary for intelligence, and the motives requisite for action, singularly coincide with those maintained by Priestley, in support of what he, without hesitation or reserve, denominates *materialism* and *necessity*; and yet Bonnet and Priestley were both animated with a very lively feeling of religion; so true is it, that certain minds may connect opinions apparently the most opposite. Bonnet, in particular, had, in the course of his researches in Natural History, found too many proofs of the agency of an overruling Wisdom, not to be conscious of this idea predominating with him over every other. His peculiar manner of conceiving organic phenomena, the pre-existing germs which he placed everywhere, rendered this agency still more necessary in his eyes, and the tendencies of his mind in this respect were always powerfully seconded by those of his heart.

It is in his *Palingénésie*, the last of his philosophical works, that he best pourtrays the goodness of his character. The evils that exist in the present world, and the irregularity with which they are distributed, so clearly demonstrate the necessity of a future state of being, for the vindication of the Divine Justice, that he could not admit the one without the other; and he had too often seen pain the concomitant of sensibility in all beings, to wish any of them deprived of this recompense. He therefore maintains, that the faculties of the inferior animals shall be so perfected as to render them capable of enjoying another life, and that our principal recompense shall be a proportional development of our powers. Thus, all beings will rise in the scale of intellect, and happiness will consist in *knowing*. The works of God appeared to Bonnet so excellent, that to *know* was with him to love.

From this brief review will be seen the truth of what we have already stated, namely, that his last meditations were strictly connected with his first; that all of them, together, form a general system, embracing the whole of nature, and presenting it under images, if not always correct, at least always clear and easy to comprehend. Those germs, multiplied to infinity, sometimes inclosed thousands of times within each other, sometimes disseminated in the organised body, and always ready for repairing the most unforeseen accident; that original agency of the Divinity; that scale of perfections, and that ascent of developement; that necessary, intermediate, subtle organ between the mind and the world, the reservoir of the ideas, and the cause of their association; that connection of motives and actions in the moral world, similar to that of impulse and motion in the physical, formed a system of highly wrought Cartesianism, a philosophy adapted to the weakness of the human mind, which prefers suppositions to vacuities in the series of its ideas.

It is obvious, that this necessity of the influence of motives would have rendered his moral system defective, had it not led him to infer the necessity of a revelation, as an ultimate and peremptory motive; and it is with this inference that he concludes the series of his philosophical meditations. Having once drawn this inference, it is no longer difficult for him to determine what revelation is the true one. Thus, from being a naturalist, he ultimately became a theologian; and by a singular progress, it was a doctrine closely allied at least to that of necessity, that conducted him to christianity.

In tracing the progress of those meditations in which Bonnet was engaged, I have given you a full portrait of the man. To devote one's-self with such constancy to speculative researches,—to aim at forming out of his own reflections a system of ideas so subtle,—required a mind undisturbed by the concerns of this world, and not less tranquil with regard to those of another; and, in fact, he preserved, during a pretty long life, that composure of mind of which his writings bear the impress. Enjoying an easy fortune, in the society of a mild and amiable wife; called to honours in his native country, without being charged with the cares of government; esteemed by the powerful and the learned of Europe; beloved by those who had more intimate connections with him, he tasted, without interruption, all the pleasures of the heart and mind. He had no children, but he bore an affectionate regard for some of his pupils, whom he judged worthy of it;—a kind of fathership, unattended with the chagrins which are too often attached to the other.

It was thus that he passed his life without leaving his native country, doing good to all who surrounded him, and hoping to produce a greater and more general good by his works. Although his constitution had never been strong, yet his health remained unbroken during an existence so calm; and it was not until he had attained the age of seventy-three that he died, after a gradual decline, on the 20th May 1793.

The city of Geneva, proud of having had such a citizen, decreed him public honours. M. de Saussure pronounced his funeral oration. Two others of his pupils have published eulogiums full of the affectionate admiration which animated all who approached him.

But, next to his works, the monument which confers most honour upon him, are those very men whom his advice and example contributed to form; and we shall add a concluding feature to the picture of his life, by tracing immediately after it that of a nephew who was not less illustrious, and who, without having carried his ideas over so wide a field, has made bolder and surer steps in the more narrow career which he traced for himself.

Horace Benedict de Saussure was born at Geneva, on the 17th February 1740. His mother was a sister of the wife of Bonnet, and he soon become one of the favourite pupils of that philosopher. His father left some writings on agriculture. The happy penetration of his mother prescribed for him laborious exercises at an early age, which so little retarded the progress of his education, that he distinguished himself at college at the age of seven, became a candidate for a mathematical chair at twenty, and at twenty-two was appointed professor of philosophy. His pretensions in these two departments of science sufficed of themselves to shew that his studies were at once varied and profound. Of this he gave an additional proof, the same year, by choosing a question in vegetable physiology as the subject of his first essay, entitled *Observations sur l'Ecorce des Feuilles et des Petales*, which he dedicated to Haller, and published in 1762. In this essay he described the cortical net-work which envelopes these parts, the regular pores with which it is perforated, their communication with the internal substance, and their influence upon the nutrition and respiration of the plant. It was a beautiful supplement to his uncle's work on leaves; and this small performance alone has assigned to Saussure an honourable station among botanists.

Occupied afterwards with objects of greater importance, and which required more laborious exertions, he always reposed with pleasure upon those of his first predilections. In the midst of his journeys in the Alps, upon the most precipitous summits, while engaged in those profound meditations which embraced all that nature presents to us of the vast and magnificent upon the globe, he carefully collected the smallest flower, and noted it with pleasure in his book. He seemed to dwell with complacency on the view of these living beings in the vicinity of the vast ruins of nature. It was with botany that he terminated his writings, as he had commenced them; and after having submitted to the Natural History Society of Geneva, in 1790, some observations on the motion of a *tremella* of the baths of Aix, he also read, in 1796, a few months before his death, conjectures on the cause of the constant direction of the stem and root at the moment of germination.

But Saussure was destined to other studies; he was to unveil deeper secrets. For him it was reserved, first of all, to cast a truly observing eye over those rugged girdles which surround our globe, and in which the substances that compose the nucleus of our planet disclose themselves to the naturalist; to investigate in detail the nature of these substances, their order, or rather the disorder, into which they have been thrown by the catastrophes that have heaped them upon each other; lastly, to throw some light upon the events that have preceded the present state of the world, and regarding which there was nothing, before his time, but the vaguest ideas or the most extravagant theories. He had, in some measure, entered upon this study before the age of twenty years; for, in 1760, following the steps of some Englishmen, he had essayed to mount the glaciers of Chamouny. The ideas which this attempt afforded him were developed during a journey which he performed in France and England in 1768, and during a second, in which he passed through the whole of Italy in 1772. The naturalists with whom he had intercourse, the collections which he visited, the mountainous countries which he traversed, all recalled to his mind how fertile his own country was in facts illustrative of one of the most interesting subjects that could captivate the human mind. From this period he formed the project of invariably pursuing this inquiry; and all his journeys, all his labours, even his most ingenious discoveries, bear a more or less direct reference to this object.

To form a more correct estimate of the importance of Saussure's labours in this department, it will be necessary to consider the views entertained of the theory of the earth at that time. The naturalists of the sixteenth and seventeenth centuries had described minerals; they had begun to collect petrifactions, but they looked upon these latter bodies merely as sportive productions of nature, or as remains of the deluge; and, excepting in the case of metallic veins, they were far from supposing that there was any constancy in the arrangement of mineral substances. Descartes, without attending to what naturalists had previously observed, had formed his globe by incrusting a sun. Burnet, Whiston, and Woodwardt, some by breaking this crust, others by calling a comet into play, had endeavoured to explain the deluge, and to deduce from it the present state of the globe. Leibnitz was the first who had attempted to distinguish upon the earth parts raised by fire, and others deposited by water. Bourgeret, judging of the high valleys from those of level countries, had them all scooped out by currents. Buffon, lastly, combining the ideas of Whiston, Leibnitz, and Bourguet, made a comet knock off from the sun, the melted masses, of which the earth and the other planets were formed, and gave the globe thousands of ages to cool, thousands more to receive water from the atmosphere, and become the abode of incipient life, and other thousands still to have its surface elevated into mountains, or scooped into valleys. In his first volumes he made no distinction between the different orders of mountains, and appeared to believe all their strata to be horizontal. It could scarcely be said that the Pallases, the Delucs, and the German and Swedish mineralogists, had begun to make regular observations on the structure of the earth, and to draw general conclusions from what they had seen. Their labours were little known in France, and the learned who were in repute treated almost all geology as chimerical. Saussure applied himself to the labour of raising it to the dignity of a real science; and, for this purpose, resolved to carry into it that accuracy of determination which the study of mathematics had given him, together with all the advantages resulting from a profound knowledge of physics. But these aids would still have been inefficient, without the firm resolution of long and patiently observing nature on the spot.

Let those who have crossed great mountains only by regular roads, fancy to themselves the courage of the man who destined himself to spend his life among them, to scale all their peaks, to explore all their recesses, and who, for this object, abandoned all the enjoyments of friendship and fortune. To make long excursions in those high valleys which no vehicle ever approached; to partake with the poor inhabitants of their black and hard bread; to have only their smoky cabins, open to all the winds of heaven, for a place of repose; to pursue as the only path the rocky bed of a torrent; to hook one's way with hands and feet to the sharp ridges of cliffs; to leap from one point to another above a precipice; to be at times surprised by winds that blow him over, and at others by fogs that obscure the path or freeze the breast; to sound every moment the snow, which perhaps covers a gulf ready to swallow you up; to remain days and nights upon those masses of eternal snows, the extreme limits of life, and to which the love of science alone could lead animated beings;—such was the existence to which the historian of the Alps condemned himself,—such was the life which Saussure led during the ten years in which he collected the materials of his first volumes, and which he many times resumed before publishing his last.

Without doubt he was not destitute of enjoyment during this period. He describes, with a sort of enthusiasm, in his preliminary discourse, the health which the pure mountain air imparted, the admiration inspired by the simple virtues, and the noble character of the inhabitants of those high valleys. He represents himself, from the summit of Etna, viewing empires and men in all their littleness. It is true that a philosopher need not ascend so high to see matters in this light, but it would seem that, at such points of view, every good man, in spite of himself, would become a philosopher.

Had Saussure, however, taken only these vague dispositions with him on his journeys, had he only acquired these general impressions, we should not probably have had his eulogium to make here. He had, on the contrary, as we have already said, prepared himself for these expeditions by the most profound studies, and from these he was enabled to derive the most precise results.

Before describing the mountains, it was necessary for him to determine the distinctive characters of the substances of which they are composed; and, notwithstanding the attempts of Linnæus and Wallérius, the science of Mineralogy was at this period in a very low and confused state. He had, therefore, to commence with increasing its accuracy and extent, and this he effected with a success which Romé de Lisle and Werner have scarcely surpassed. His experiments on the fusion of minerals, in particular, contributed to the distinction of species that had previously been confounded. He went so far as to invent a machine for comparing the different degrees of hardness of bodies; and nearly fifteen new kinds have been added to the catalogue of the mineral kingdom in consequence of his observations. It was around Geneva itself that he found at once the specimens which instructed him in lithology, and the principal documents from which he derived his ideas respecting the history of the earth. The environs of that city were covered with rolled stones, frequently even with great masses of very diversified substances, foreign to the neighbouring mountains, and which are found *in situ* only in the high Alps. These masses became to Saussure a rich cabinet of mineralogy, and indicated to him the violent revolutions which had conveyed their materials to such a distance from their original positions.

To be perfectly convinced, however, of the existence of these ancient revolutions, it was necessary to prove that the causes at present in operation are incapable of producing such effects; and, for this purpose, he required to measure each of these causes, and to appreciate the extent of their influence. He had, therefore, to examine attentively the lake, and the rivers which empty themselves into it, and which descend from the glaciers; to determine the velocity and direction of their motions, their temperature, and the quantity and quality of the substances which they carry along with them: he had to employ, and even invent, instruments of a delicacy proportionate to the measurements which he had in view to obtain. But these running streams are the products of rains, and the melting of the glaciers, which last are themselves incessantly renewed by the snows which the clouds deposite in these high regions. It was therefore necessary to determine the quantity of these various sources, to ascend even to the cause of rain, the most important and difficult to explain of all the meteors; and as the most probable origin that can be assigned, is to suppose it to be formed from the vapours of the atmosphere, it was still farther necessary to explore all the means of appreciating the quantity and nature of these vapours in all circumstances.

It was by following out this train of ideas, joined to the desire of precision which always distinguished him, that Saussure was led to improve the thermometer, for measuring the temperature of water at all depths; the hygrometer, for indicating the greater or less abundance of watery vapours; the eudiometer, for determining the purity of the air, and for finding out whether or not there might be any other cause of rain than in the atmospheric vapours; the electrometer, for ascertaining the state of electricity, which operates so powerfully on the aqueous meteors; the anemometer, for determining at once the direction, velocity, and strength of the currents of the air; lastly, it was from these motives that he invented the cyanometer and diaphanometer, for comparing the degrees of colours and of transparency of the air at different heights. It is unnecessary for us to say that the measurements of heights by the barometer must also have been a continual object of his investigations. Thus, in examining the mountains as a natural philosopher, he explored the atmosphere as a geometrician and a chemist; and it is to him, in fact, that we owe all the positive information which we possess regarding the composition and motions of the fluid by which we are enveloped.

These different applications of physics form so many interesting digressions in the narrative of his journeys. We follow him with delight in these delicate investigations; we find him never neglecting, in the most agreeable as in the most fatiguing situations, to impress upon his observations that scrupulous accuracy which forms the seal and suretiship of correctness. He wrote, however, a separate essay upon Hygrometry, which was the most complicated and the most delicate of these measurements; and this work is one of the most beautiful with which natural philosophy was enriched at the close of the eighteenth century.

The question to be solved is, to ascertain how much water in vapour is contained in a given volume of air. In order to solve this problem, it would be necessary to separate the vapour from the air, or, in other words, to dry the air completely. This operation, however, is impossible, and the object can only be attained by approximation, and at the expence of much time, by employing substances that have a great affinity for moisture. We therefore content ourselves with a body capable of putting itself into a certain equilibrium of humidity with the surrounding air, and of indicating the moisture which it has taken up by more or less apparent changes of weight or dimensions; and as the fibres of organized bodies are eminently endowed with the property of being elongated by moisture, and contracted from dryness, it is these substances, especially, that are employed for making hygrometers, or rather hygroscopes; for, as we have seen, they do not afford an exact measure, but only an approximate indication. It is obvious that there must be great differences of sensibility and exactness between the different fibres, and it was for the purpose of ascertaining the best and most effectual means of employing them, that Saussure's experiments were made. But to attain this object, it was also necessary to examine all the possible combinations of water and air, and the influence which they experience on the application of heat and pressure; to produce, by artificial means, the maximum of humidity and the maximum of dryness; and to determine the influence which humidity exercises in its turn upon the expansion of the air and the manifestation of heat. From these experiments we therefore see an almost new science springing up, and Meteorology beginning to possess rational principles.

Saussure made choice of hair as the hygroscopic substance, possessing most sensibility and regularity. This result of his comparisons has been disputed; but what could neither be cavilled at, nor attacked, were his beautiful observations on the expansion of air in proportion as it is charged with humidity; on the relations of humidity with pressure; on the nature of the vesicular vapours or fogs which are suspended in the air like so many small balloons; and on many other points, all more or less new to science, at the period when he published this work.

Time does not permit us to lay before you the numerous mechanical details by which he at length rendered his hygrometer and other instruments capable of convenient use, while, at the same time, he gave them the necessary precision. It is sufficient to observe, that, in all these investigations, we discover a mind no less accurate than fertile in resources, and calculated to be the model of natural philosophers as much as that of naturalists.

Although Saussure had travelled for twenty years among the mountains; had fourteen times crossed the Alps, by eight different routes; had made sixteen excursions to the centre of that chain; although he had traversed the Jura range, the Vosges, the mountains of Switzerland, Germany, Italy, Sicily, and the adjacent Isles, and had visited the extinct volcanoes of France; yet had he never reached the summit of Mont Blanc, which he beheld every day from his window. Ten times he had attacked it, as it were, by all the valleys which terminate on its sides; he had gone round it, examined it from the summits of the neighbouring mountains, but had always found it inaccessible. On the 18th August 1787, he learned that two inhabitants of Chamouny, by following the most direct route, which various prejudices had hitherto made him shun, had returned the previous day from that summit which mortal foot had never before trodden. His eagerness to follow their steps may be easily imagined, when, on the 19th August, he was at Chamouny; but the rains and snows prevented him from ascending that year. It was not till the 21st July 1788 that he at length accomplished this great object of his wishes.

Accompanied by a servant and eighteen guides, whom he encouraged by his promises and example, after having ascended for two days, and lain two nights in the midst of the snows,—after having viewed horrible chasms under his feet, and heard two tremendous avalanches roll by his side, he arrived at the summit about the middle of the third day. His eyes, he says, were first turned towards Chamouny, where his family were watching his progress with a telescope, and where he had the pleasure to see a flag waving in the air, the appointed signal to assure him that his arrival had been perceived, and that their painful solicitude respecting his fate was at least suspended. He then calmly set about performing his intended experiments, and continued for several hours at this employment, although, at the height he now stood (15,000 French feet), the rarity of the air accelerated the pulse like a burning fever, and overwhelmed them with fatigue at the slightest motion, while, in those frozen regions, a cruel thirst parched their lips, as if among the sands of Africa; and the snow, by reflecting the light, dazzled the sight, and scorched the face. The inconveniences of the poles and tropics were alike experienced; and Saussure, in a journey of a few miles, braved as many hardships and dangers, as if he had gone round the world.

His last expedition, and one of the most interesting with regard to the theory of the earth, was that to Mount Rosa in the Pennine Alps, which he performed in 1789. Instead of those needles of granite, which commonly pierce their envelopes, to form the ridge of the high Alps, he there observed an enormous plateau, where the granite, which every where else appeared uncovered, was enveloped under a mass of slate and limestone, disposed, along with the granite, in horizontal strata. From this appearance the views of Saussure, regarding the formation of granite in a fluid, and the succession of the other primitive deposites, which preceding observations had long before established, were now invincibly confirmed.

Thus, every step that he advanced among the mountains discovered to him some new truth, and either enabled him better to arrange the series of those he already possessed, or to fill up some void in it. It would be interesting to trace all the metamorphoses which the system of his ideas had undergone; but time does not permit. Let us content ourselves with drawing a brief sketch of the principal acquisitions to the theory of the earth, which result from a concluding analysis of his works. He destroyed the idea, which had been very prevalent until his time, of a central fire, a source of heat situated in the interior of the earth. His experiments even prove that the water of the sea and of lakes is colder in proportion to the depth from which it is taken. He proved that granite was the oldest primitive rock, and that which serves as a basis to all the others; he shewed that it was disposed in strata, and formed by crystallization in a fluid, and that if its strata are at the present day almost all vertical, this position is owing to a posterior revolution. He proved that the strata of the lateral mountains are always inclined toward the central chain, namely, the granite chain; and that they present their precipices to this chain, as if they had been broken upon it. He ascertained that the mountains are the more rugged, and their strata depart the more from their horizontal line, in proportion to the antiquity of their formation. He shewed, that, between the mountains of different orders, there are always heaps of fragments, rolled stones, and all the other indications of violent convulsions. Lastly, he pointed out the admirable contrivance, which supplies and renews among the snows of the high mountains, the reservoirs necessary for the production of large rivers.

Had he only bestowed a little more attention on petrifactions, and their positions, it might have been said, that we owed to him all the foundations on which geology has hitherto been built; but, incessantly occupied with the great primitive chains, and the terrible catastrophes that must have taken place to have overturned their enormous masses, it would appear that he had formed a somewhat erroneous idea of those lesser mountains or hills whose repose had not been disturbed, and which contain remains of the newest epochs of the history of the globe.

Possessed of materials so numerous and important, it must have required a powerful effort to resist the temptation of forming a system. Saussure, however, had this firmness of resolution; and we shall make it the last and the principal trait in his eulogy. His mind was of too elevated a character not to take a prospective grasp, in some measure, of the whole field of the science, and not to perceive to what extent it was imperfect, notwithstanding all the facts with which he had enriched it; and it was, therefore, by pointing out what still remained to be investigated that he terminated his labours. So noble an example has not deterred his successors from drawing up, as formerly, the most romantic systems; but this is only an additional reason for paying our tribute to a mind so rare.

Saussure still seemed young enough to collect a portion of the observations which were awanting to the science; but a disease, the germ of which had perhaps originated in the fatigues of his journeys, began, a little after his fiftieth year, to undermine his constitution. It was increased by some embarrassments of fortune, occasioned by the French revolution. Three successive attacks of paralysis reduced him to great weakness, and, on the 22d January 1799, after four years of sufferings, he died, aged only 59 years.

Equally beloved and honoured as Bonnet by his fellow citizens and by strangers, Saussure had the additional happiness of living again in a son, whom he saw distinguishing himself in science, and whose beautiful discoveries have merited for him a reputation not less honourable than that of his father; and in a daughter, whose rare virtues and superior mind have rendered her an ornament to her sex.

A Description of some appearances of remarkable Rainbows. By the Reverend William Scoresby, F. R. S. Lond. and Edin. M. W. S., &c. Communicated by the Author. (With a Plate.)*

Appearances of natural phenomena, of rare occurrence, are always worthy of being recorded, both as being interesting to the

* Read before the Wernerian Natural History Society 10th February 1827.

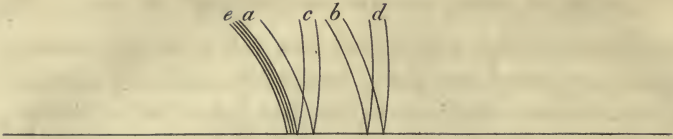
observer of nature, and as tending to the development of those beautiful principles with which the Almighty has so universally endued the vast range, and every atom of that vast range of the material creation. And they are further interesting, because, when understood, they generally resolve themselves into the effects of some laws, principles, or combinations already known, and afford additional instances of their amazing variety of operations, and of their universality of application. In this view, therefore, even modifications of the more ordinary phenomena, or extreme cases as to beauty, extent, or peculiarity of such, are not undeserving of attention, either to the naturalist or the philosopher.

Hence I am induced to offer to the Wernerian Society an account of two appearances of rainbows—though a phenomenon of such ordinary occurrence; because, in one of these cases, there was exhibited perhaps the extreme of beauty of which this brilliant arch is susceptible; and, in the other case, there was a multiplication of the segments beyond any other example of a rainbow I ever before witnessed.

The first example that I shall mention, so nearly resembled a remarkable rainbow described in a late number of the Edinburgh Philosophical Journal (a rainbow that appeared at Lengsfeldt, on the 18th of May last), that I fear the following description will seem to be little else than a repetition of what is already before the public. At all events, presuming on the interest which observers of nature always feel in such appearances as are at all of an extraordinary character, I shall not withhold the notes which I made on the occasion.

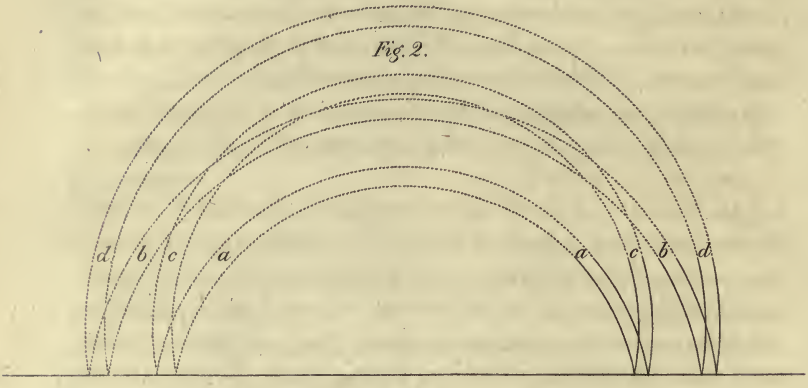
This magnificent phenomenon was seen at Bridlington Quay at 5 P. M. of the 12th of August 1826, during a brilliant sunshine, and a heavy partial shower that passed across from north to south, to the eastward of the town. Both the primary and secondary bows were complete arches, descending to the ground on the left, and to the surface of the sea on the right hand. The colours were of extraordinary brilliancy throughout. Within the arch of the primary bow, were no less than three if not four *supernumerary bows* in close and regular order, but progressively diminishing in intensity, so that the last was scarcely discernible. The primary bow was of course a series consisting

Fig. 1.



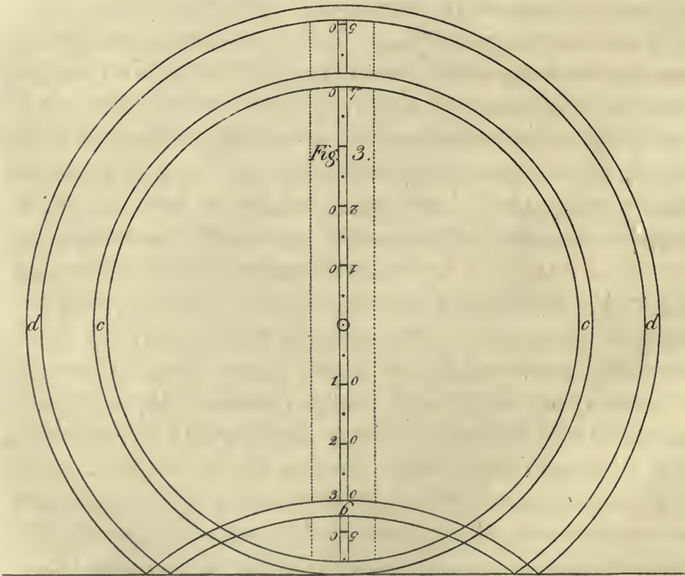
Horizon.

Fig. 2.



Horizon.

Fig. 3.



Horizon.

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of the ordinary succession of colours, reckoned from the outside, being red, orange, yellow, green, blue, indigo, and violet. Immediately in contact with the interior violet, succeeded the supernumerary stripes of different colours, consisting, most obviously, of green and purple or violet, in regular succession. The other colours of the spectrum were not observed. The whole phenomenon conveyed the idea of a splendid canopy of equal vertical arches, which seen from beneath, seemed to diminish in distinctness from the effect of the receding distance.

Another phenomenon of the same class, with a peculiarity which appeared to me to be of a very uncommon kind, may be of more importance to be described.

This consisted of two beautiful segments of primary and secondary rainbows, (called by the sailors " weather-galls," when, as in this case, they consist only of the portions next the horizon) with some supernumerary bows within the arch of the former; and likewise, which is the extraordinary part, another spectrum rising almost vertically from the base of each of the common arcs, at its apparent termination in the horizon of the sea, so as to form two figures nearly resembling the Greek ν.

The segments *a* and *b*, Fig. 1. Pl. IV. represent the portions of the primary and secondary bows, and *e* the supernumerary bows, whilst *c* and *d* represent the two vertical spectra. Perhaps I err in defining them *vertical* spectra, because the apparent form was a portion of a circle, curved in the same direction (namely, towards the left) as the irides; but not having used any means to ascertain the exact form, I cannot speak with certainty, either as to the curvature, or to the direction in which it deviated, if it deviated at all, from the perpendicular. In other respects, there is no uncertainty, not even as regards the apparent form, a sketch of the appearance being carefully made at the time.

The colours of the primary vertical spectrum *(c)* were in the same order, and almost of similar brilliancy, as the rainbow with which it was connected; and the colour of the secondary vertical spectrum *(d)*, as well as its width and general appearance, also corresponded with the colours and magnitude of its own bow.

This phenomenon was seen on the 3d of September 1821, at sea, near the northern coast of Ireland, approaching the entrance of the North Channel. It occurred about half an hour before sunset. There was not a breath of wind at the time; and the sea was *remarkably* smooth and calm. The atmosphere was full of heavy rain clouds, except in the direction where the sun was, and these were discharging showers in various quarters.

Since this description was originally written (the above account being taken in substance from my journal kept at the time), a very simple explanation has occurred to me of this phenomenon, which, at the time of its appearance, seemed to partake so much of the nature of a prodigy.

The sea, on this occasion, it has been remarked, was quite smooth and calm; its surface, indeed, was like a mirror; for our situation, being almost "land-locked," happened to shut out whatever swell there might be in the main ocean, and likewise to afford time, during a day chiefly calm, for even the smaller waves, of the "wind-lipper," to subside. In consequence of these circumstances, the sea, at the close of the day, was without the slightest undulation. The sun, at the time when the rainbows appeared, was at a very low altitude. I assumed it in my notes at 3°; though being above half an hour before sun-set (6 P. M.), it must have been at least twice as great, probably betwixt 7° and 8°.

Under such circumstances, there would be a reflection of the sun, from the surface of the water, almost half as strong as the rays proceeding direct from the sun itself *; which power of rays was fully adequate to the production of a rainbow of nearly one-half the intensity of the common bow; and the direction of these rays being from a position, as much below the horizon, as the sun was at the time above it, the arches of the direct and reflected bows, would, of course, be differently situated, as arising from circles of equal diameter, whose centres were twice the altitude of the sun, or 15° apart. The reflected bow (as to the part above the horizon) would consequently be a segment larger than a semicircle, and precisely as much *larger* as

* The quantity of rays reflected by water, according to Sir Isaac Newton, when incident at an angle 7½° inclined to the horizon, is about four-tenths of the whole quantity that reaches the surface.

the bow from the direct rays was *less* than a semicircle *. And all these circumstances are found to be realised in the phenomenon described.

Moreover, in proof that this was the real origin of the vertical spectra, I may mention the exact coincidence of the two bows on the line of the horizon—the similarity and order of the colours, and the peculiar position and curvature—with the whole of which particulars a bow produced by a reflected sun, would, under the circumstances, exactly correspond.

This is clearly shewn by the figures and diagrams. Fig. 1, already referred to, is the appearance of the various arcs, as drawn and registered at the time when they were seen. Fig. 2. is the form and appearance, which, on the same scale of curvature, these arcs, according to theory, would assume,—*a*, *b*, the primary and secondary bows being drawn from a centre $7\frac{1}{2}°$ below the horizon (equal to the supposed altitude of the sun), and *c*, *d*, the bows of reflection from a centre $7\frac{1}{2}°$ above the horizon. The resemblance, it is evident, is as near as could be desired. Had the arcs been complete, the form would have been according to the dotted lines.

From hence we derive an explanation of the cause of the *inverted rainbow*, described by some authors; a phenomenon, however, of rare occurrence, and requiring, on this principle, a variety of accommodating circumstances for its production. In respect to this phenomenon, many philosophers have either doubted its reality, or have considered it as an optical deception.

* The centre of the common rainbow being in a straight line continued from the sun, through the eye of the observer, as far as the base of the iris (when it appears to terminate at the horizon), that centre will evidently be just as much below the horizon as the sun is above it. But the bow of reflection has its centre just as far *above* the horizon. For the angles of incidence and reflection being equal, the image of the sun, that gives rays to the bow of reflection, will be at an angle, just as much below the horizon as the sun is above it, and consequently the centre of its concentric bows will be exactly at the same altitude above the horizon as the sun is. Hence, whatever portion the bow of reflection *exceeds* a semicircle, in consequence of its centre being above the horizon, the direct bow will *want* of a semicircle, by its centre being equally below the horizon. Consequently, the chord of each arc at the horizon will be equal; and, therefore, if placed together, their feet or bases will correspond. And hence, the direct and reflected bows, as regards the portion above the horizon, and terminated by it, would, if one of them could be turned downward, exactly complete the circle.

Thus Dr Hutton, in his Philosophical and Mathematical Dictionary, ascribes the appearance to a cloud happening to intercept the rays, and preventing them from shining on the upper part of the arch; in which case only the lower part appearing, the bow, he supposed, might seem as if turned upside down; "which," says he, "has probably been the case in several prodigies of this kind, related by authors."—*Article* RAINBOW.

But the preceding facts and principles afford us, I conceive, a satisfactory solution of the phenomenon, in all cases where there is a smooth reflecting surface of water, suitably situated at the place of the inverted bow being seen; and I am not aware that it has been seen under other circumstances.

Suppose the sun's altitude to be 42° (the outer semi-diameter of the primary bow nearly), and the circumstances to be favourable for the production of the bow by the sun's rays reflected from a perfectly calm surface of water, then arches, if not circles, resembling figure 3, might occur, provided the quantity of reflected rays, at such an angle of incidence, were capable of producing the iris. Here *c c*, as in the other figures, represents the primary bow of reflection, having its centre 42 degrees above the horizon; *d d* the secondary bow of reflection, which, however, in this case, from the quantity of rays absorbed by the water, might not be visible; and *b*, a segment of the common secondary rainbow, the primary one not appearing above the horizon, on account of the greatness of the sun's altitude *.

The only doubt that I conceive likely to arise against this explanation of inverted rainbows appearing entirely above the horizon, is the small number of rays which are reflected from a surface of water, at the required angle of incidence, compared to

* The relative position of the bows of reflected and direct rays, is simply illustrated by inscribing on paper the circles *c* and *d* complete, the same on both sides of the paper from the same centre. Then cut away all the blank paper *without* the outer circle *d*, and also the blank paper *within* the inner circle *c*, except a narrow slip, as a diameter *f f* (defined by dotted lines), and graduate this diameter as in the figure. If, then, the lower edge of the diagram be doubled up at the mark of 42°, a representation will be given of the reflected and direct bows, similar to fig. 3, when the sun's altitude is 42°. Or, if it be doubled up at 7½°, it will represent fig. 2, or any other appearance of the combined phenomena, according to the altitude of the sun at the time. Hence when the sun is in the horizon, the bows of direct and reflected rays will cover one another and coincide.

the quantity absorbed. For, it would appear, according to Sir Issac Newton's experiments, that, at an angle of 42° of incidence (48° from the perpendicular), only from one-thirtieth to one-fortieth part of the light impinging is reflected from water. Is this proportion of light, then, sufficient for the production of the iris ? There is good reason to suppose, I conceive, that even this proportion is abundantly adequate to the production of the phenomenon, because the light of the full-moon is occasionally sufficient for the purpose ; yet that light, according to Dr Smith, is little more than a ninety-thousandth part of the light of the sun, or, according to M. Bouquer, not above a three-hundred-thousandth part. In either case we see, that the light reflected from the sea, when the sun has an altitude of 42°, is some thousands of times greater than the quantity which is sufficient for the production of the lunar iris ; consequently we may infer that an inverted iris from the reflected rays of the sun, *may* occur even when the sun has the greatest altitude to which it ever attains in any temperate or frigid climate

This being the case, there seems to be reasonable ground for supposing, that the reflection of the sun's rays from a perfectly calm surface of water, may have a share also in the production of some of the various phenomena of haloes, such as are not otherwise explained,—a supposition which the resemblance that figures 2 and 3 bear to some of the prismatic circles, renders more than probable.

Tour to the South of France and the Pyrenees, in 1825. By G. A. Walker Arnott, Esq. A.M. F.L.S. & R.S.E. &c. In a Letter to Professor Jameson. (Continued from the preceding Volume, p. 275.)

I have taken notice of the Capouladoux *Cyclamen*, because by some it is considered as very different from the *C. hederæfolium.* The Montpellier plant is certainly the same as that found in Corsica, and I believe not unfrequently along the shores of the Mediterranean. It flowers in spring. In this respect it agrees with that said to be found wild in Britain, but which has probably escaped from some garden. I have never seen the latter, but by the description given by Sir James Smith, it appears to differ in the leaf. The English plant has the leaves "angular and finely toothed," and agrees in that respect with the character given by Roemer and Schultes. The Montpellier and Corsican species has the leaf much angled, but otherwise very entire. The nerves, however, at the angles, and here and there along the margin, project, and form each a small callous point. Whether or not this be considered a good distinctive character, the *C. neopolitanum* of Tenore is certainly different from either: this last flowers in autumn, and the petals are much shorter, and more obtuse *.

On the 14th April we went before breakfast to Mirval. Here there is a cavern, into which one is obliged to enter on all fours; but it soon becomes very spacious. In it there is said to be (for our time scarcely permitted us to enter, and we were unprovided with torches) a great body of water: it is by many supposed to be the source of a pretty large stream, which does not make its appearance for a considerable distance. *Theligonum cynocrambe*, *Lavatera maritima*, Gouan, (a plant much confused with *L. olbia*), *Asplenium glandulosum* (the two last remarkably scarce), *Linaria simplex*, *Lathyrus setifolius*, *Fumaria capreolata* (a

* On the Pic St Loup, on some stones under the brushwood, we found *Hypnum tenellum*, whilst at Vaucluse we met with a moss which in some things so resembles this species, that I felt undecided whether or not to pronounce it distinct, unless I had compared it with what I consider the true *H. tenellum*. Its occurrence on the Pic de Loup enabled me, I think, to state decidedly that the two are very different. That found at Vaucluse has been also discovered by M. Requien in several other localities about Avignon, and Bridel has given it the name of *Hypnum laxepennatum* in Requien's herbarium. I suspect, notwithstanding, that it is a species formerly collected by Bridel at Rome, and already named by him in his Species Muscorum, P. ii. p. 111. *Hyp. curvisetum*. He, however, describes the leaves as subserrate, whereas in our plant they are entire: he considers his as a variety of *H. Scleicheri* (betwixt which, again, and *H. confertum*, I can find no good difference); but ours differs, by the scabrous seta, and entire leaf. The character I propose is as follows:

H. curvisetum.—Caule vage ramoso, foliis ovato-acuminatis integerrimis e striatis, nervo supra medium evanescente, theca globosa subcernuata (v. potius æquali nutante), operculo rostrato, seta grosse muriculata.

Peristomium internum cilios inter lacinis habet: habitu multum refert H. tenellum, at foliis latioribus, et seta valde differt; refert etiam H. confertum, at differt seta muricata breviori, et foliis integerrimis.

distinct and much more beautiful species than that of Britain, which is the *F. media* of De Candolle, and perhaps only a variety of *F. officinalis*), *Cneorum tricoccum*, gigantic specimens of *Clypeola jonthlaspi*, &c. rewarded us for our morning's drive. We had gone with M. Bouchet in his carriage, and he saved us much time, as he had frequently herborized here himself, and knew the localities. M. Bouchet's herbarium is perhaps the best in the south of France. Among other rarities, it contains specimens of all the plants collected by Broussonet in the north of Africa and the Canary Isles.

On the 15th, we botanized towards Pont Juvenal, where we found a few rare native plants. Nearly all, however, that are found here, ought to be received *cum nota*. Every year a great quantity of wool is brought from Africa: it is landed at Pont Juvenal (called also Port Juvenal, for vessels come up this length to unload), and is spread out here to be bleached. Not a few seeds of African plants remain attached to the wool, and are thus sown; and the following year, when the ground for the wool is changed, they spring up. M. Delile, by searching diligently every fortnight or three weeks, has been so fortunate as to meet with several plants naturalized no where else in Europe, and some of them scarcely at all known to the botanist. We did not observe any of them. These plants ought not to be admitted into the French Flora, but ought to constitute a separate one, this spot being actually a wild garden. Notwithstanding, I fear that *Stipa micrantha*, Desf. *Psoralea palæstina* *, and several others, are no where else found in France.

Up to this period (the 15th), we had kept no account of what we dried; but as by this time I had agreed to give up Switzerland, and go to the Pyrenees, where we intended to keep a catalogue of every plant we collected, we considered it better to

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* Mr Bentham and I afterwards discovered *St. micrantha* on the Spanish side of the Pyrenees, where it was certainly wild, but exceedingly scarce. That is, as far as I know, the only locality in Europe where it is *absque dubio* indigenous. As to *Psoralea palæstina*, it was not sufficiently advanced when I was at Pont Juvenal for me to judge of it in the live state; but the dried specimen exhibits not one specific character that I can see between it and *Ps. bituminosa*, which is exceedingly common in the south of France. Is it to the *nose*, and not the *eye*, that we should trust for the distinction?

habituate ourselves to that labour. Hitherto we had dried probably not more than 1500 or 2000 specimens; but that may be reckoned a great number, when we consider the early season of the year.

22*d April*.—" In company with Delile and Dunal, we botanized to-day for a few hours about Restinclières: we now found several *Helianthema* in flower. *Polygala monspeliaca* was beginning to make its appearance, at least we only met with a very few specimens. *Euphorbia segetalis, sylvatica, characias*, and several other species, have been in flower for some time, but they are so troublesome to dry, that we have looked forward to that task with little pleasure. At first they were not in fruit, and now other plants are in abundance: to-day, however, we dried a few of *Euphorbia rubra* and *retusa* (my distinguished friend M. Roeper has, with great justice, re-united these to *E. exigua*): *Fedia auriculata* we also met with. M. Dunal, with a liberality of mind that distinguishes every true botanist, from the observations he made to-day, avowed that he now considers the *Helianthemum apenninum* is not distinguishable from *H. hispidum*: to these may perhaps be joined *H. virgatum*. *Helianthemum canum* and *penicellatum* are two species very common here. I never heard of the latter before my arrival at Montpellier; and I doubt extremely if I shall ever be able to distinguish it, unless assured that the specimens before me come from the *midi de la France*. How to separate it from the *H. alpestre*, or even from *H. œlandicum*, requires a nicer eye for discrimination than I possess. The most serious characters are, that in *H. œlandicum* the flowers are *said* to be small, and the leaves nearly smooth. This, however, is at best a contested species. I am willing to consider it as an accidental variety; but I cannot believe that the small size of the flower is constant, or ought to form a reason for distinguishing it specifically even although such had ever been observed. In *H. alpestre*, the flowers are large, the leaves various, smooth, carnose, or hirsute; while in *H. penicellatum* the leaves and the sepals are more pilose. These three, I conceive, may prudently be united, and to them be added *H. obovatum*. The characters to separate these from *H. canum* are more easily perceived: in the preceding, the leaves, though covered with hairs, are nevertheless green; while in *H. canum*, they are white and hoary. But what, then, becomes of the intermediate *H. italicum*, which partakes of both these characters * ?

"Of *Helianthemum fumama* and *procumbens* we also laid up a few specimens to-day. Dunal is certainly right when he adds the remark, that perhaps *H. ericoides* is but a variety of *H. fumama*: it is no doubt a very distinct variety, but has no claims to be ranked as a species, nor does it appear to differ in the least degree from var. α of *H. fumama*: may not even var. γ be joined to var. α? Further, on what good grounds is *H. procumbens* to be separated? Dunal rests upon the property of the seeds † remaining attached to, or being discharged from the opened capsule; but we have assuredly found both on the same plant, and as to habit there is little difference.

"Few who find *Cisti* and *Helianthema* together in the wild state, would, I think, presume to unite the two genera; yet there does exist a species which tends to ally them most intimately. I allude to the old *Cistus libanotis*. Now, it is difficult to say to which genus this should be referred, by judging only of the habit. Nay, there seem to have been two distinct species confounded together, but which Dunal has properly separated: the one has the capsule of a *Cistus*, the other of a *Helianthemum*; they differ in no other respect. Dunal has called the one *C. Clusii*, the other *Helianthemum libanotis*. In both, the styles are shorter than the stamina, and the calyx trisepalous. To *H. libanotis*, Dun. certainly belongs *Cistus calycinus*, Linn. This synonym is adduced by Willdenow under

* The *Helianthemum canum*, Dun. I believe to be the *C. canus* of Linnæus; but Sir J. Smith says that Linnæus's plant is very different from his *C. marifolius*, whereas Dunal's *H. canum* is so closely allied to it, that there is scarcely either a natural or artificial character by which it is to be separated. As to Dunal's *H. marifolium*, it certainly differs from the British *C. marifolius*, with which, however, De Candolle's plant (from Switzerland) entirely accords. There are thus three species: *Hel. canum* of Dunal and Linn.; *H. marifolium*, DC. and Linn.; and Dunal's *H. marifolium*.

† My friend M. Guillemin has recently discovered, that, in the end of the broad and narrowed *Helianthemum*, there exists two different structures of the embryo.

his *C. ericoides*, but with which plant the phrase of Linnæus has no relation. This circumstance induced Dunal to doubt that Willdenow was correct; but it was not till after the publication of De Candolle's Prodromus, that he discovered, by what he considers an authentic specimen in M. Bouchet's herbarium, that it belongs to his first section *Halimium*. It has exactly the habit and appearance of *Hel. libanotis*, and only differs by the peduncles being equal in length to the bracteæ, while in *H. libanotis* they are twice as long; but these characters seem too variable to constitute of it more than a mere variety."

26th April.—" To-day, we made an excursion for a couple of hours not far from the house. *Inter alia*, we met with *Ornithopus scorpioides*, *Lathyrus* ...... (not agreeing well with the description of any in De Candolle's Flore Française or the Supplement), *Vicia narbonensis*, and some other rare species. It is strange that Willdenow quotes England as a locality for *Vicia narbonensis;* I know not upon what authority. Smith and the other English botanists who write on the Flora of Great Britain, have prudently left it out, but take no notice of Willdenow's assertion. I suspect that many other species allowed in the British Flora, ought to be dismissed with as little ceremony. Thus, *Euphorbia characias* has surely no title to rank as indigenous; when found in France, it never gets beyond the region of the olive trees. We to-day gathered and examined a moss that Mr Bentham first observed a few weeks ago: it was not in a very perfect state, but I consider it a *Didymodon* (*D. Benthamii*, nob.) at least it accords with that genus in its peristome. Its habit is precisely that of a var. of *Tortula cirrata* (*Trichostomum barbula*, Schw. but a decided *Tortula*), that I have received from Rio Janeiro. On the rocks around the source of the Lez are a few plants of *Asplenium glandulosum*.

" As some of our plants have been very long of drying, particularly the germens of some *Irides* and *Narcissi* we gathered at the Pont du Gard, we resolved this evening to make some large packets of the whole we had at present in progress, and put them into the large oven used for baking the out-of-doors servants' bread."

27th April.—" This morning we took out our plants from the oven, and found all that had been so long of drying, now properly prepared. By this means we got rid of at least 2000 specimens. Indeed, we did not find more than 300 or 400 specimens that required farther drying, and many of these had their moisture brought by the heat to the surface of the leaves, so that they may probably be dried by the usual process in the course of a day or two. The mode of the oven gives rise to the following observations:—1. That it must be considered a good method to dry plants, (particularly in moist or cold climates), if proper precautions be used: 2. That for plants that have been long in drying, and which have little moisture remaining, from three to six sheets of paper may be sufficient (according to the thickness of the plants) to place betwixt each layer, and the plants need not be removed till quite dry, which may be in eight or ten hours: 3. Care must be taken that the oven be not too hot, otherwise the oiliness (if one may so call it) of the plant will be entirely extracted, and it will be found quite brittle, and of little use for after examination: 4. If the plants be newly gathered, nine to twelve sheets must at least be put between each layer of plants; and moreover, if these abound in juice (as did our *Vicia narbonensis*), they ought to be removed from the oven when the packet (about fifteen inches thick) is thoroughly heated to the centre, which may be in three or four hours: the wet paper is then to be removed, and the plants put in other which is dry; they ought then to be again *baked* for eight or ten hours, and will then in all probability be found to be dry, unless they belong to the very succulent tribes, in which case it may be preferable to finish the drying by the common mode: 5. All the plants put in for the first time, if full of juice, should only be under a moderate pressure, but after the paper is changed, they are to be pressed very considerably: if they have very little moisture in them, as some of the small *Lathyri*, *Polygala* and *Helianthema*, they ought at once to be subjected to a great pressure.

"We had put in the *Vicia Narbonensis* fresh, and under a great pressure, and we did not remove it from the oven to change the paper till this morning; the consequence was, that the paper was saturated with moisture, and the specimens were *stewed* in their own juice, and had got too much of the negro complexion.

Some that were towards the edge of the paper, and their moisture had easily evaporated, had dried of a fine green colour: of one or two, the outer half was green and the inner black; but we had this to comfort us, that, when dried in the common way, this plant usually turns either black or yellow. The moisture was all brought to the exterior of the plant, so that we put them up in dry paper to absorb it. All the small species of plants that we had gathered yesterday were now completely dry; several, indeed, were perhaps too much done, "*trop cuites*," and had become brittle, as the heat was rather too great for them."

On the 6th May we set off early towards the sea-shore, where we had a successful herborization. Among the

GRAMINEÆ,...I may mention the Kœleria macilenta, Sclerochloa divaricata, and Ophiurus incurvatus.

JUNCAGINEÆ,...Triglochin Barrelieri.

ORCHIDEÆ,...Orchis laxiflora, O. coriophora.

CHENOPODIACEÆ,...Chenopodium setigerum, Atriplex portulacoides and rosea, Salsola fruticosa, and Salicornia fruticosa.

PLUMBAGINEÆ,...Statice oleæfolia.

SCROPHULARINEÆ,...Euphrasia latifolia.

OROBANCHEÆ,...Orobanche caryophyllacea, and another species, O. cernua? perhaps new, growing in sand, with blue flowers.

RUBIACEÆ,...Crucianella maritima, Galium mucronatum, and Gal. murale: the fruit of this last appears to differ from the other Galia, by being elongated, and not globose.

COMPOSITÆ,...Bellis annua, Anthemis maritima, Anacyllis tomentosa (two varieties), Scorzonera, perhaps new, which I have had from Africa under the name of Apargia verna.

TAMARISCINEÆ,...Tamarix africana.

LEGUMINOSÆ,...Trifolium maritimum, hybridum, and resupinatum, Medicago maritima, littoralis, denticulata, apiculata, and maculata.

CARYOPHYLLEÆ,...Silene conica, Arenaria rubra, β marina. MM. De Candolle and Seringe are quite right in retaining this plant as a variety of A. rubra: the seeds, the root, and indeed its whole appearance, approach it to A. rubra, while it has little in common with A. media; this last has a long fusiform and almost ligneous root, so that I can scarcely credit those authors who say it is annual. A. rubra β, I believe to be merely annual.

FRANKENIACEÆ,...Frankenia pulverulenta and intermedia.

CRUCIFERÆ,...Malcomia littoralis, Alyssum maritimum (which differs from the other Alyssa in the structure of its cotyledons), Sinapis incana, and

Lepidium iberis.—Lepidium latifolium was common here, but not yet in flower.

PAPAVERACEÆ,...Papaver rubiaci, DC.—This is merely a starved variety of *P. Rhœas*, growing in a hot sandy soil *.

These are some of the more interesting plants we found in this excursion. Many more we observed, but as they occurred abundantly nearer Montpellier, we did not gather them. One plant grows here, which I was very eager to collect, the *Hutchinsia procumbens*, with which sometimes a diffuse variety of *H. petrœa* is confounded. I was however disappointed: it had already flowered, shed its seeds, and nothing remained but the scorched stems and leaves.

Before our departure for the Pyrenees, we made one more excursion to the Pic St Loup. The *Pœonia peregrina* was now in fruit. *Linum narbonense*, with its splendid blue blossom, was by no means rare; while behind the Pic, one place was quite covered with *Linum glutinosum* and *salsaloides*, DC. *Geum atlanticum* is here, but very scarce. *Erodium petræum*, and *Alyssum spinosum*, were plentiful on the rocky summits of the hill. We observed by the road-sides *Helianthemum nummulariæfolium*, and *Onobrychis cristagalli*.

The Botanical Garden of Montpellier, if not of very great extent, is in excellent condition, and contains many curious plants. The red horse-chesnut, *Æsculus rubicunda* (*Æsc. carnea* of some authors), forms one of the greatest ornaments that can be conceived. The curious *Ginkgo biloba* flowers here every spring in the open air: in the hot-house, the *Solandra grandiflora* covers a whole wall, and flowers in the utmost luxuriance. This garden was established by Henry the Fourth in 1597,

* I had afterwards occasion to see this plant in De Candolle's herbarium at Geneva. An inspection of the original specimens confirms the above opinion. I may also observe, that I can see no good character to separate from each other the *P. trilobum*, *P. turbinatum*, and *P. lævigatum*: when united, the first may be styled var. *latifolia glabra*; the second, var. *latifolia subpilosa*; and the last, var. *glabra foliorum lobis angustioribus*. These characters are merely relative. When hairs occur on any of these, they are patent, which, with other circumstances, induces me to believe that these three may prove to be only varieties of *P. Rhœas*.

about twenty-five years before that of Paris. Belleval was the first Professor of Botany; and, since his time, this establishment may boast of many other distinguished men who have taught there. Gouan, Broussonet, and De Candolle, are names not to be slightingly passed over. Perhaps the present Professor M. Delile has done more than any of his predecessors towards the advancement of the garden. M. Delile also does much towards forming an herbarium, which it were desirable should remain at Montpellier, as the private herbaria of Gouan and De Candolle are now, the one in Scotland, the other at Geneva.

Upon the whole, the state of botany in the south of France is very much advanced, and many botanists of note have studied here. As a proof of their labours, one has only to turn up a botanical work, to see that many plants have got the specific name of *monspeliacus*, from having been at first distinguished at Montpellier alone; and we believe that there is much yet to be done. At first, it is sufficient to give that name which we find in a Species Plantarum, to have a description that answers to the plant we are investigating: as, however, our herbaria enlarge, and our communications with naturalists at a distance increase, it may be supposed that we shall find that we have made many errors. Thus, we see, that, in the present day, not a few species in the south of France have been confounded with similar ones in the north of Europe. The *Peplis portula* of Montpellier is different from that of Britain *. The *Isoetes lacustris* found here, and which I believe Sir James Smith met with, is, if not a distinct species from the British one, a most remarkable variety: the leaves are remarkably long and subulate; the same has been found in the north of Africa; whilst the true *Isoetes lacustris*, even in the north of Europe, is only found in cold alpine lakes or beds of rivers. The Montpellier one has been named *Isoetes subulata*. In place of the *Arum maculatum*, we here find the *A. italicum*, the temperature of whose spadix ex-

* I have seen it in M. Gay's herbarium under the name of *Peplis australis*; and, if I recollect well, Salzman has brought it from Tangiers, under the name of *P. biflora*: this last is perhaps, however, a third species; but I have not my specimens at hand.

ceeds considerably that of the land; for the *Thymus serpyllum* we find the *Th. zygis*. *Thesium linophyllum* from Montpellier is probably different from that of Paris. *Hippocrepis comosa* is here, but *H. scorpioides*, Req. is more common *.

The difference between English and French gardens has been usually held forth as extremely great, and always in favour of the former. This I believe to be certainly true, as far as regards ornamental gardening, in which the English taste is no doubt preferable; but looking to them in a botanical point of view, the French far surpass the average in Britain. I have now examined various extensive gardens in France, and I uniformly find, that their gardeners understand more of botany than those in the same situation in England. In English and Scotch gardens, there is scarcely one person who can give the botanical name of a plant; or if they attempt it, it is ten to one a wrong one, or some barbarous jargon that they have received from some correspondent; and indeed (the Botanical Gardens and principal nurseries excepted), he who is at the head of the establishment knows least of all, being generally unable to give the name whether English or Dutch. The advantage to be derived from such gardens as have large collections of plants, I speak more of the unobtrusive than of the showy species, when a botanist procures a specimen, is thus completely annulled, as a great inducement in getting plants from a garden, is the hope of their being well determined, and of serving as a study and a type by which one is better able to recognise the species, if it should fall to his lot to meet with it in another country. In the French gardens, there is by no means so numerous an assemblage presented to the eye; but what we do find, are almost all well determined, either by some considerable herbarium, where authentic specimens may be examined, or by expensive works of plates. The proprietor is not contented with the vain-glory of spouting readily some hundreds of botanical names, but does not rest, when he has received a new plant to his establishment, under whatever name he has received it, until he has examined it attentive-

* *Hippocrepis multisiliquosa* does not grow in France, *H. ciliata* having been mistaken for it: this last, with *H. unisiliquosa*, is extremely common at Montpellier.

ly as a botanist. In Britain, a nurseryman is literally a *florist*: in France, he is a *cultivateur-botaniste*. From the latter, one receives a specimen with more pleasure, as, when put into the herbarium, it is to represent the species.

This precision of nomenclature is no doubt much facilitated by the plan adopted by the Jardin du Roi. In France, there are, in addition to the several botanical institutions in Paris, many smaller ones, also under the government, scattered through the country. I may instance those of Lyons, of Strasburg, of Montpellier, of Toulouse, and of Perpignan. When any of these receive the root of a new or rare species from another country, or its seeds, the year following either seeds or roots are transmitted to the Jardin du Roi at Paris; and also, when any new plant arrives there, it is as soon as possible disseminated through the smaller establishments in the provinces. The care and attention paid to the naming of plants at the Museum, prevents almost the possibility of an error, and thus in the government institutions in the country, the species is found well determined. Specimens from such places are of great utility in determining with exactness similar species in the private nurseries, and, as I have already said, a botanist may look forward to study in any of them. One ought never to take a specimen from a British garden for their herbaria without examining it well. In France, one may take it as an authority by which to name others.

I cannot conclude these remarks, without observing, that the probable cause of the whole is the small inducement there is in Britain for any young man to devote himself to botany as a profession. In France there are so many public establishments, that a young man, if talented, and active and efficient in his studies, may, in a few years, look forward to a public appointment. In England, on the contrary, the Government have scarcely, I think, half a dozen botanical establishments in their pay. The consequence is, that in Paris alone there are more botanists of note than in the whole of Great Britain. Britain, it is true, possesses Brown, the greatest botanist of our time; also, Smith, Hooker and Lindley, men eminently distinguished in the annals of botanical science; but when their days are numbered, it may be subject of regret that there are none worthy to succeed them *.

The face of vegetation has undergone considerable changes since I came to Montpellier. At one time, the garriques were yellow with *Genista scorpius*, and the meadows white with *Narcissi:* now, the garriques are blue in some parts with *Aphyllanthes monspeliensis*, and silvery in others with *Stipa tortilis:* the *Cistus albidus* makes some places appear red, while *C. monspeliensis* makes others white. The principal genera here in spring are *Fedia*, *Helianthemum*, *Medicago*, *Trifolium*, *Linum*, and *Euphorbia*. In summer the *Cisti*, and in autumn the *Centauriæ*, abound: of this last genus, I understand there are upwards of thirty-five species in the neighbourhood. Of the genus *Biscutella*, so common in many parts of Italy, there are here very few species: the principal is *B. ambigua*, and *B. saxatilis* β, DC †. *Lathyrus*, *Astragalus*, *Vicia*, and other genera of *Leguminosæ*, are tolerably abundant. Of *Polygala*, I do not recollect of seeing any others than *P. vulgaris* (which bears no very great resemblance to the British one of that name), and *P. monspeliaca*. The latter, though I understand it to be rare about Montpellier, is common in some parts of the property of

* We are rather disposed to believe that Mr Arnott underrates the botanical accuracy of the gardens of this country; and that, on the whole, a greater degree of precision as to nomenclature prevails in the principal gardens of Britain, than in similar establishments on the Continent. We hope to take up the subject in a future number; in which the gardens of England, France and Germany will be compared and contrasted.—Neither do we see cause to despair of the future progress of scientific botany in this country.—Edit.

† These two are only to be distinguished from each other by the asperities on the silicule. The most complete enumeration of the species of this beautiful genus is in De Candolle's Prodromus; but I doubt if all be equally valid. The characters in the first and last sections that De Candolle has made of first consequence, is the presence or absence of asperities on the silicule; and were this of less importance, a very curious combination of species would take place. I have endeavoured to arrange the following *clavis analytica*, so as to present this to the view:

Sect. I. *Calyces basi longi bisaccati.*

Silicul. disco lævibus (in stylum coeuntibus),			*B. erigerifolia.*
Silicul. disco punctis elevatis scabris,	in stylum non coeuntibus,	caule hispido,	*B. hispida.*
		caule villoso,	*B. cichorifolia.*
	in stylum coeuntibus,		*B. auriculata.*

Restinclieres; and it must not always be concluded, that the specific name *Monspessulanus*, *Monspeliensis*, or *Monspeliacus*, indicates the proximity of the plant to Montpellier: it sometimes happens that the nearest locality is in the Cevennes mountains; one plant *(Potentilla monspeliensis)* is even a North American species, and is not, that I know of, at all naturalized in this neighbourhood.

The climate of Montpellier seems to have been much misunderstood: at present, however, I believe physicians are more aware of its insalubrity. It is surprising that any person who was not accustomed from infancy to the climate, and who had

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Sect. II. § 2. *Calyces basi æquales, species perennes.*

Silic. lævibus,	foliis tomentosis (subradicalibus),		-	*B. montana.*
	fol. scabris v. lævibus,	subradicalibus,	subintegris,	*B. lævigata.*
				B. lucida.
				B. major.
			pinnatifidis,	*B. coronopifolia.*
	-	caule folioso,	- -	*B. ambigua.*
Silicul. punctis elevatis scabris,	fol. scabriusculis,	caule folioso,	- -	*B. saxatilis β.*
		subradicalibus,	pinnatifidis,	*B. saxatilis γ.*
				B. stenophylla.
			subintegris.	*B. saxatilis α.*
				B. angustifolia.
	fol. tomentosis,	subradicalibus,	- -	*B. sempervirens.*
		caule folioso,	- -	*B. tomentosa.*

A simple inspection of this table will shew how closely allied several of these species are to each other, if we pay no regard to the silicule. How far one ought to pay attention to it, is another question. At Montpellier and Avignon *B. ambigua* and *B. saxatilis β*, are found promiscuously; and in Majorca and Minorca, *B. auriculata* is so intermingled with *B. erigerifolia*, that every specimen gathered requires to be closely examined.

In the second section, De Candolle has placed less reliance on the above-mentioned structure, and I therefore prefer arranging the *clavis* in another way:

Sect. II. § 1. *Calyces basi æquales: species annuæ.*

Silicul. margine conspicue ciliatis,	disco lævibus glabris,	foliis radicalibus lyratis,	-	*B. maritima.*
		caule folioso,	elatiore,	*B. ciliata.*
			humili,	*B. depressa.*
	disco scabro-hispidis,	- -	- -	*B. microcarpa.*
Siliculis margine non ciliatis,	disco piloso-hispidis,	caule folioso,	- -	*B. eriocarpa.*
		foliis radicalibus lyratis,	-	*B. lyrata.*
	disco pube minuta scabris,	foliis radicalibus,	-	*B. columnæ.*
		caule folioso,	sil. marg. scabrido,	*B. apula.*
			— —— lævi,	*B. leiocarpa.*
	disco lævibus glabris,	foliis subradicalibus,	-	*B. obovata.*
		foliis radicalibus,	-	*B. raphanifolia.*

It

not a strong constitution, could survive a single year at Montpellier. He has to contend with a burning sun, which, even although he keeps within doors, heats the air so, that he is thrown into a violent perspiration, injurious and weakening to the patient. Nor is the climate free from damp: there is seldom rain, it is true, perhaps not once a month on an average; but when the sea wind blows, which it not unfrequently does, it produces lassitude, weakness, difficulty of breathing, coughs and colds. It is here called the *marain;* in other parts it is called *garbin* and *lebesche*, and on the coast of Italy it is usually known by the names of *libeccio* or *garbino.* I have even no doubt of its identity with the pestilential sirocco: so damp is the marain, that the very doors are observed to swell exceedingly during its continuance. Even the fine weather makes one more liable to be injured by the bad: the heats of the day seem to open the pores of the body, and render an attack of the damps more injurious. Few could be induced, I believe, to remain at Rome during the summer months. At Montpellier, the climate is not so bad; but surely it is not what an invalid ought to be exposed to.

Account of a Visit to the Glaciers of Justedal, and to the Mantle of Lodal *. By G. Bohr, of Bergen.

The journey to the Mantle of Lodal, the highest mountain summit amidst the splendid and stupendous glaciers which lie between Justedal and Olden, may be commenced either from the end of Lysterfiord, or from the farm-house of Rödnei, near the Church of Goupé. Mr Bohr chose the first of these routes,

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It will easily be seen, that *B. obovata* and *B. raphanifolia* are not distinct species; that *B. ciliata* and *B. depressa* ought not to be separated; that *B. leiocarpa* is scarcely to be distinguished from *B. apula*, &c. With regard to *B. leiocarpa*, De Candolle says, " fructu etiam nascente glaberrimo nec pube minuta scabro;" but through the author's kindness, I have been able to ascertain, that, in his own specimen, the fruit is exactly as in *B. apula*, except that in the latter it is scabrous also on the *margin*, whilst in *B. leiocarpa*, it is there perfectly smooth.

* A mountain in the interior of Norway, so called, from its being always covered with snow. It lies above 150 English miles NE. of Bergen.

although in summer it is perhaps the most difficult of the two. Through the cultivated valley of Dahl, a side branch of the cheerful and rich valley of Lyster, you come to Storhaugen, about seven English miles from Lysterfiord. Five miles farther on, you reach a picturesque elevation, about 2513 feet above the level of the sea, from which you descend to a delightful resting-place, called Störksel. Here Nidal, the first valley in Justedal, inclosed on each side by lofty snow-covered mountains, has already begun to display its enchanting scenery, combining what is most beautiful with what is most fearful. Through green fields covered with corn and grass, with the houses of the peasants scattered over them, you advance along its grey coloured stream, with its banks shaded with trees, but overhung by dark naked precipices, which threaten to fall on your head. About three miles on you reach the Church of Justedal, 621 feet above the level of the sea. Between the farm-houses of Kiervig and Kieppé, opposite to the parsonage-house, the traveller discovers five small water-falls from the rock of Kiersdal, which, in their descent, unite into one, the velocity of which, before it reach the river, is so great that it rises again in vapours.

Opposite to the farm-house of Kregé, the first large sky-blue coloured mass of ice begins to shine, called the Glacier of Berset, a branch of the huge mass which covers Lodal. Its lower margin is about 1440 feet above the level of the sea. There, where Kroudal, Krege Dal, and Melvirs Dal meet one another, is a fine and picturesque situation, abounding in all the beauties peculiar to the lower alpine regions. Every thing that nature does in these valleys is impressive. A little farther east and farther up, the road passes another majestic mass of ice, called the Glacier of Nigaard, which is at present larger, and in its former effects was more destructive than the Glacier of Berset. In addition to what Von Buch and Professor Smith have said, in their account of these glaciers, I shall quote an extract on this subject from the archives of N. Bergenhaus. "At the farm of Berset, on the 21st of August 1742, attended the Sheriff, the Bailiff of the district, and six chosen inspectors, to estimate the damage which the glacier had occasioned. Two old men declared, that, in their youth, the glacier had been high up in a cleft of the mountain, but that during the last ten years, it had descended about 600 feet upon the open plain, bearing before it all the earth and stones lying on the surface of the ground. (This mass of gravel, and sand and stone, is what the Swiss call *Moraine*). In breadth it extended about 1680 feet, so that to the west, across the valley, from the mountain to the river, all was covered with ice. From the south, too, the ice had descended into the valley, so that the farm was deprived of the greatest part of its pasture-ground, though what remained was at present very green. There was a small quantity of corn in the ear, but unripe, from the strong cold wind which now more than formerly descended from the glacier. The excessive reflection of the sun's rays, too, from the ice, was found to be injurious to the meadow ground. Within a few years all the houses on the farm had been carried away, by two successive falling masses of snow, and were set up again in new situations."

Other instances are to be found of the encroachments of the glaciers, and of the mischief occasioned by them. An old woman, who died in the year 1810, according to the parish-book of Justedal, had been often in the old farm-house of Nigaard, whose inhabitants, according to her account, and that of several other persons, did not leave it till the ice had pushed the house away. The peasant Claus Elvekragen remembers seeing, about fifty years ago, the roof of a house buried in the moraine; so that there is good reason to believe, that a great part of the valleys now covered by the glaciers has been formerly inhabited. At the same time, there is unquestionable evidence, that many of the glaciers in Justedal are at present growing less, both in depth and length. The mighty accumulation of moraine, which this very glacier of Nigaard had formerly pushed before it, is now about 1726 feet below its margin, while the bare sides of the mountain shew its depth now more than 200 feet less than it has once been. The yearly amount of the difference, however, and its periodical changes, it is impossible, from the want of accurate observations, to ascertain. The tradition, that they increase and diminish every seventh or every nineteenth year, is of equal authority with many other gratuitous hypotheses with regard to the season and the weather. The crops at Elvekragen this year were very good, while nothing but the moraine stood between the glacier and the ripe corn.

On Melvirsdal borders Stordal, over which the shealings of the inhabitants of Justedal lie spread. (These are the mountain huts to which the natives of the valleys in Norway repair in summer, when the high pastures are accessible to their cattle.) These mountain downs and plains, beneficent nature has enriched with many luxuriant trees and plants. In the beginning of July, the snow had vanished from the pastures. A beautiful summer here follows a long winter; The length of the day, the stillness of the night, the heat reflected from the sides of the mountains, concur to awaken almost instantaneously the powers of nature. The Author of Nature saw it necessary, that, in regions where the summer is sadly contracted, plants should spring up, bloom, and ripen, in the shortest possible time. On the 11th of July the peasants had begun to draw up to their friendly shealings. First came a drove of cattle, then a horse with panniers, followed by a peasant, with his little child on his back; then the mother and her household. All were jesting and singing, every thing was activity and gladness. Sometimes, indeed, masses of snow threatened to tumble down upon them from the rocky summits, and fragments of the rocks themselves which had fallen, contributed the more to awaken apprehension; but the sight of the cheerful valley banished every disagreeable impression, while the glacier seemed necessary as a contrast to the beauty of the scene. Step by step, the glacier of Biöra Steg (the Bear's Path) presented itself to our view, like an immense theatre, between ice-covered mountains, the sides of which, like the scenes of a theatre, embellished with the most picturesque groupes, inclosed this majestic mass of ice. Several objects in front of it shew beyond doubt that this, like the other glaciers in Justedal, had extended farther down, and was of greater depth in former days. The river of Justedal, which formerly went under this glacier, runs now between the ice and the moraine, which it had formerly carried down with it, and which marks its ancient limits. At one place was a sort of road, laid with stones, over which the peasants, about eighty years ago, used to pass to their shealings. About this time the glacier broke through with such force, that those who were going to the shealing, could scarcely open themselves a way with axes, through the prodigious offshots which had come from it during the foregoing day. Close beside this stone-road, under hanging rocks, and immediately before the glacier, were full grown birch, mountain-ash, and other trees, with the common subalpine shrubs and plants. This glacier ascends to near the foot of Lodal's Mantle, the inexhaustible snows of which feed this and all the other glaciers around.

If, by the north-west side of the glacier, you press forward through several wild stretches of valley-ground, whose precipitous sides some terrible giant seems in his wrath to have overlaid with a multitude of loose masses of rock, which seem just about to crush the passing wanderer, you come at last to the cheerful shealings of Faaberg, about 1280 feet above the level of the sea. Here the happy pastoral life, and the true alpine scenery, exhibit themselves in their finest and most peculiar characters. Between four and five miles from the cots of Faaberg, Stordal begins to be narrower and narrower, till at once the whole scene is changed, and every thing becomes wild and frightful. Yellow meadows and green mountain-downs now touch on large desolate fields of sand and gravel, and small stones, and masses of rock of the size of a castle. These fields are cut through by many small streams of water, gurgling from both the bottom and the surface of the glacier above. The whole is inclosed by naked columns of rock, and in the back ground the lower margins of the two proudest of the offspring of Lodal's Mantle, the glaciers of Lodal and Trangedal, present themselves, at the height of 1597 feet above the level of the sea. They are separated from one another by a small mountain, covered all over with ice and snow. The nearest verges of the glaciers exhibited innumerable clefts of the most splendid appearance, and of a sky-blue colour. The moraine shewed clearly that these glaciers, too, had formerly descended about 1700 feet farther down; while the dark naked sides of the mountain, as if the surface had been shorn off, shewed that they had been formerly about 200 feet deeper.

Our walk over the Glacier of Lodal was not difficult; you might ride, or even drive over it, if there were a road to it for carriages. You can come down on the surface of the ice from a mountain-down lying on its south side, covered with trees and plants. Summer and winter lie here smiling by one another's side. While one foot stands on the ice, the other rests on flowers and grass. Almost all the snow was thawed on the surface of the Glacier of Lodal, so that every cleft in the ice was distinctly to be seen. Towards the front of the glacier, these clefts were smaller, most of them not more than a foot across, and running parallel to the sides of the adjoining mountain. Higher up, the huge dead mass of ice shews that it has undergone strong internal commotions and violent throes, and here gravitation has performed fearful pranks. The surface of the ice was uneven, and of less uniform cohesion. The clefts run cross to one another, and were often from ten to twenty feet broad, or more. Their depth must be considerable, perhaps down to the ground, over which the ice lies, but it would not be an easy matter to measure them. In the large ones you could mark distinctly the layers by which the ice had been annually increased. We could often count twenty of these, separated from one another by a dark coloured stripe. But it is not without terror you pass over or look down into these fearful abysses, however beautiful their azure-coloured walls are. In their cold bottoms the lonely traveller has sometimes found his grave. A few years ago, a peasant crossing over from Justedal to Nordfiord, fell into one of these large clefts, which was concealed by the snow. His only companion, a faithful dog, ran down to Justedal, barking and howling, as a signal for help. Nobody, however, comprehended his meaning, till the person who had fallen down was at last missed. Several persons then followed the dog up to the glacier, who stopped at the cleft, and gave such signs as put it beyond all doubt that his master had sunk into it. They threw down a rope, and made loud cries, but in vain, the peasant had met his death in the immeasurable gulf. It was only by compulsion the dog would leave the cleft.

At three o'clock in the morning, Reaumur's thermometer was 2° above the freezing point. Only small streams of water run on the surface of the glacier. This was not slippery, but rough, large-grained, porous, easily crushed, and full of many small holes and cells, of the size of a nut, and, in short, was just like ice composed of snow, soaked with water. As the day advanced, the heat became greater than in any of the valleys below, and very oppressive, from both the direct rays of the sun and those reflected from the surface of the ice, and from the sides of the mountains covered with ice and snow. At ten o'clock in the forenoon, the thermometer covered by its frame stood at 29° R. (73¼° Fahr.), at the height of 5 feet above the surface of the ice, and about 3000 above the level of the sea. A little farther up it sunk to the freezing point, at the depth of 5 feet down, in one of the clefts of the ice: in so short a time can you experience the temperature of every season.

But in spite of the African heat which prevailed in the glacier of Lodal, the labourers in the neighbouring fields of Melversdal required their winter clothing, which they generally wear in the warmest summer day, as the melting ice absorbs the heat, and often sends down upon them blasts of cold wind. Soon after the sun had begun to shine on the glacier and its neighbouring mountains, heat, Nature's great instrument of dissolution, began to shew its mighty power. The water from the melting ice flowed in more copious streams, and cut for itself deeper runs. Masses of ice sunk down into the clefts with a noise like the loudest thunder, which rolled along the winding valleys in innumerable echoes. The surface of the ice burst with a violent crack, when the heat expanded the air inclosed in cavities of the glacier. Huge masses of ice and snow, loosened on the steep sides of the mountains, were crushed to pieces on the rocks below, tumbling down with prodigious and long reflected noise. Fourteen or fifteen such proud avalanches fell while the sun was in his power. The ice reduced to powder by the force of the fall, mounted like dust raised by a whirlwind, while the heavier parts rushed down on the glacier like a mighty waterfall. Sometimes, also, vast fragments of rock fell upon the glacier's sides. Many small streams, too, like stripes of silver playing in the colours of the rainbow, gushed from the sides of the neighbouring mountains.

A little above the moraine of the glacier, where the road bends round towards Nordfiord, Lodal's Mantle begins to stretch out its white giant head. It takes this name from the valley over which it stands, and from its perennial covering of ice and snow. My active guide was as little acquainted with the road to the top of it as I was. Our ascent from the glacier began at the foot of the mountain on the north-east, at the height of 4500 feet above the sea. About 750 feet higher up, all water had disappeared, and the depth of the snow increased, although the heat in the sun was 29½° R. The lowest point, therefore, above which snow never melts here, may be considered as about 5250 feet over the level of the sea. The steepness of the mountain made the ascent now pretty difficult: the rents in the ice, too, were deeper and broader than down on the glacier, and they were sometimes covered by snow. It became, therefore, dangerous to pass over them. You have often but a slippery footstep between you and death, and your first false step is your last in the world. From caution against such danger, we walked with a rope about our waist, and, trusting to this, we courageously crossed on a bridge of snow ten feet over. The difficulty of climbing was increased, by the inconceivable, and almost intolerable, heat of the sun, which, added to the thinness of the air, produced an uncommon weakness, and a pulse nearly doubled. We recovered our strength, however, in as short a time as we lost it, and it was not long before the naked summit was reached.

With some degree of alarm we climbed up its 150 feet high loose black head, that seemed to move under us: the top of this we reached at half past eleven A. M., on the 13th July. From a mean of six observations, which corresponded with those of Engineer Major Wetlessen, in Bergen, Dean Hertzbergen, in Hardanger, and Professor Esmark, in Christiania, and from calculations made according to the formula of La Place, the southern top of Lodal's Mantle is 6113 feet above the level of the sea. It divides itself into three elevations, the summits of which and the steepest side are naked. The rest of the mountain to the bottom is covered with an everlasting and unbroken mantle of ice and snow. By other observations, we found, that the eastern and highest top was 6408 feet above the sea. Several circum-meridian observations of the sun gave the latitude 61° 57′, though, from an accidental injury which happened to the sextant, this determination is less to be depended on.

The surface of a small stone we found on the top of the mountain was, in different places, covered with two sorts of lichen, *L. geographicus* and another. A bear, whose gloomy disposition must have conducted it to these solitudes, had left its traces on the snow which had fallen within two days, and the laugh-resembling voice of a single ptarmigan was heard. With these exceptions, organic life and vegetation had disappeared, and eternal winter had taken up its abode all around. From the summit was seen an ocean of snow, of several thousand geographic square miles extent, the waves of which seemed as if they had been instantaneously fixed, and over which single mountain-tops here and there raised their white heads, which in the valleys were hid in the clouds. Skatolstop * in Lyster, Tunderdalskirk towards Lomb, and Vangsen in Justedal, were the most remarkable. All was the stillness and desolation of death, which irresistibly filled the soul with melancholy, mingled with a powerful impression of the greatness of Nature.

The author here mentions, that, on two places in the glacier, they saw a little red snow: after which, he takes a survey of the adjoining region in all directions, in which he traces by name twenty-five distinct valleys, which, to a great extent, had been filled with layer upon layer of ice from this immense mountain. He then proceeds:—Our descent from Lodal's Mantle, after they had got past the naked rocks, was quick and easy, and, after having sojourned for nineteen hours in the regions of ice and snow, we returned to Stordal with weakened eyes, and with swollen faces and lips.

The river of Justedal has its source from the glacier of Lodal, in the upper and north-west end of Lodal. After running the whole length of Justedal, it falls into a small arm of Lysterfiord, near the farm of Rödnei. Many small rivers from the other glaciers of Justedal, and the adjoining mountains, unite with it, the most of which have fallen into it before it reaches Elvekrogen. It brings down with it great quantities of sand and mica, which are found chiefly on its banks near its source. Its waters have a greyish muddy appearance, by which rivers which come from

* This is one of those remarkable mountains called the Young Harlots. Its height is ascertained to be 6975 feet above the sea. It is south-east from Lysterfiord, and is seen very far off.

glaciers may be always easily distinguished. From the difference in the quantity of water furnished to it at different seasons of the year by the rain, and the melting of the snows on the mountains and glaciers, the width of its bed and its rapidity are continually varying. Sometimes in the course of two days it has changed its bed: in its course it exhibits many beautiful cascades. Often it sweeps before it beautiful holms, covered with trees and shrubs, overwhelming at the same time the adjoining corn-fields. In 1814, a flood in the river carried off large pieces of the meadows on its banks, rising so high, that the sand was found on the top-leaves of the trees. At Elvekrog it rose from 16 to 20 feet above its usual surface. As it descends from the icy regions in which it rises, its temperature becomes less frigid, till it reach Lyster, where the multitude of fruitful apple and cherry trees, the quantities of asparagus, &c. bespeak a warmer climate than could be there expected.

On a warm dry day, July 10, of which the mean temperature was 19°.7 R., the minimum depth of Justedal river opposite to the church was 6½ feet in the morning; its maximum depth in the evening was about 8½. Such was the difference occasioned by the melting of the snow. The velocity of the current was at the rate of 8 feet in the second, when the river was at its minimum depth, and 9 when at its maximum. Taking the mean breadth of the river, and its slope from the sides to the middle, by simple calculation, we may form an approximation to the quantity of ice and snow melted by the heat of such a day. By this calculation it will be found, that a quantity of about 31,132 cubic fathoms of water is thus added to the river every hour. Assuming, then, that the snow has fourteen times less density than the water which comes from it, with other proper allowances, the result will be, that the quantity of snow melted into this river during half a summer's day, will amount to 5,230,176 cubic fathoms, which I have no doubt is less than the reality.

Observations on Serpentine and Diallage Rocks. By Dr A. Boue'. In a Letter to Professor Jameson. Communicated by the Author.

The geological relations of serpentine are still but imperfectly known; for it is not many years since we were assured of the existence of *transition serpentines* in the form of short beds, or large masses in the veins, or bed-like veins, of the greenstone (diabase) of the Pyrenees (St Pé, and Valley of Baretons); in the greywacke of Girvan and Ballantrae in Scotland (Jameson), and of Bastberg in the Hartz; in the transition slates of the northern Fichtelgebirge, and of the Vosges; in the transition limestone of Willendorf in Austria; in the Carpatho-Appenine sandstone of Waidhofen in Lower Austria, of Monte Ferrato, near Prato, Impruneta, Creboli, &c. in Tuscany, and of Borghetta in Liguria. Veins of serpentine have been detected by the geologists of Scotland, in the old red sandstone of Forfarshire.

Some of these masses present characters illustrative of an igneous and violent origin, and throw light on the true situation and formation of other serpentines, whose contact with neighbouring rocks either has been but imperfectly seen, or not seen at all. The serpentine of Willendorf is a fine example of the injection of this rock amongst older strata. It is situated about half a mile to the west of that village, and on the right hand side of the road leading to Granbach. The limestone hills are bordered by reddish precipices, in the midst of which, the geognost sees with astonishment a thick columnar mass of serpentine rising through the limestone, to the height of 100 feet, and fairly terminating in the surrounding limestone rock. This mass is 60 feet broad below, 40 feet broad at top, has an undulating contour, and a blackish knotted surface, as if composed of irregular spherical bodies. Small veins of asbestus and calcareous spar are contained in it, but no distinct diallage rock. It is intimately united with the transition magnesian limestone which it intersects; and between the two rocks there is a breccia composed of a mixture of the limestone and serpentine. Even the limestone itself is impregnated with serpentine matter. All the neighbouring rocks are more or less vesicular, and deeply coloured with red oxide of iron, so that they present to the eye a very singular and sterile aspect. The marly or argillaceous inclined strata at their base, are partly violet and reddish, and contain small veins of micaceous iron ores. In short, this locality of serpentine may be considered as illustrating the elevation of that rock from below, in the same manner as porphyry and the accompanying breccia intimate the violence of the action.

The position of the serpentine of Tuscany has already been ably described by Brongniart, although not in a complete manner, as that distinguished observer has omitted to notice several accompanying interesting phenomena. For instance, in the Valley of Garignola, the serpentine and diallage rock or euphotide, not only cover a part of the limestones and marls, which are converted into reddish jaspideous rocks; but they rise through them, and extend over them on all sides, so that they have the shape of a wedge-shaped bed, or that of a mushroom. The breccia formed of limestone and diallage rock, which Brongniart places above the jasper, does not occur every where; but only in those places where diallage rock comes in contact with broken and bruised marls and marly limestone. The limestone is then sometimes changed into a granular mass. In Austria, about one hour's walk from Waidhofen, on the northern side of the Ips, there is a hill of serpentine apparently resting upon the same marly sandstones and marls as occur in Tuscany; and not far from it, there are in those slates which contain fossil ferns, beds of bituminous and slate coal, which are regularly worked. The lowest part of this deposite probably belongs to the independent coal formation.

If our acquaintance with these more recent serpentines be increasing, geologists have not yet fixed the age of the serpentines placed amongst slaty crystalline or primitive rocks. In this class, are generally enumerated the following masses:—the serpentines of Shetland (Jameson), and of the North Cape (Buch); the bed-like veins of Portsoy (Jameson), and of the Lizard Point in Cornwall; the great zone of serpentine of the departments of Arveiron, Lot, Correze, and Upper Vienne; the hillocks of serpentine and diallage rock in the talc slate of western Liguria, and of the base of the Piedmontese Alps; of the Alps in the department of the High Alps (Brainçon, Villard, St

Veran); of Mont Rosa and of the Grisons; the serpentinous rocks of the Tyrol; of the chain of the High Tauerngebirge in Salzburg; of the Pinzgau, of Stiria, Austria; of the Rosalingebirge near Bernstein in Hungary; of the Eastern and Western Böhmerwaldgebirge; of the Fichtelgebirge, of Saxony, Silesia; and of the Carpathian Chain and of Wallachia.

The greater number of these serpentines are situated in talcose slates, or among the most recent primitive slates; some few are associated with whitestone or leptinite, as in Saxony, between Waldenheim and Waldenberg; in Austria at Grabenhof, near Gansbach; at Altenburg on the Kamp; and at Namier in Moravia. Some others are in gneiss, or even in granite, as at Töplitz in Saxony; also in the Fichtelgebirge, Böhmerwaldgebirge, the Tyrol, and Stiria. These serpentine deposits are sometimes very considerable, forming occasionally groupes of mountains, as the Mont Rosa in Piedmont, in Liguria, and Hungary. In other quarters, they appear only under the form of bed-like veins or short beds. These last are some feet or fathoms in thickness, as at Lettowitz in Moravia, Portsoy in Scotland, &c.; or they are so thick as to form hills, or the summits of hills, during many miles, as in Liguria, near Genoa, Savona, in the Fichtelgebirge, and in the Shetland islands.

Serpentine hills have a sterile, dark, and knotted surface, not unlike that of hypersthene syenite; and their immediate junction with the primitive slate is seldom visible. On the other hand, the great beds of serpentine usually contain imbedded masses of slate and limestone; and these differ somewhat in structure from the neighbouring rocks of the same kinds. In this way, the bed-like veins of Portsoy contain blackish green talcose rocks, which are slightly slaty, and seem to have been fused in the serpentine mass; and this last rock is closely united with hornblende rocks. In western Liguria, great beds of serpentine inclose quartzose and talcose slates, which are much broken and contorted; or they contain immense masses of limestone, which are to be viewed as *fragments* or *displaced masses*, because their stratification is not the same as in the limestone next to the serpentine vein; and besides this, limestone is cracked, granular, foliated, and magnesian.

These elliptical serpentine masses are separated from the talc slates or mica slates, by layers of a singular talcose or brecciated rock. These brecciated rocks remind us of the breccia of basalt and talc-slate, which border some basaltic bed-like veins of talc-slate, near Recoaro, in the Vicentine; but these breccias are never so distinct as those which separate the euphotide and the jaspideous rocks near Borghetto in Liguria, which are described by M. Brongniart.

The nature of serpentine rocks is not every where the same. There are three sets of these rocks, viz. *Serpentine, with diallage and diallage rock; Hornblendic serpentines, with diallage, chromate of iron, and diorite or transition greenstone,* (Pyrenees); and, *Serpentine originating from augite rocks, through a superabundance of magnesia, as those of Inch Columb, discovered by Jameson.* Of these sets of rocks, the first mentioned are the most common, the last the least frequent. In the second class may be placed those small nests of serpentine included in the granular limestones of some mica-slate districts, as that of Glen Tilt. No diallage occurs in them, but the limestone contains hornblende and augite, and the imbedded masses of precious serpentine may have been produced by the vicinity of granitose or syenitic rocks, as at Canzacoli in the Tyrol, where a Jurassic dolomite limestone has been in this way changed into a granular limestone with serpentine veins. *The diallage serpentines* are not every where associated with euphotide or diallage rock: thus it is not met with in the *small veins* or *small beds* of serpentine, and even diallage is rare in those serpentines, as in Moravia, at Portsoy, in Transylvania, &c. In the leptinite, or even in the granitic gneiss, the serpentine is without diallage; but there it frequently contains garnets, as at Zöblitz, Grabenhof, Mezeborz, and Jungeroschiz in Moravia. On the other hand, when serpentine occurs in *great hills,* it is mixed with euphotide or diallage rock, as in the Hartz, Liguria, Appenines, Carpathians, Silesia, and north of Europe. It is further worthy of remark, that these great masses of serpentine are not every where accompanied with those dark diallage porphyries, with saussurite and diallage and variolites, which are met with in Piedmont, Briançon, Western Liguria, the Hartz, Southern Scotland, and England. These variolites bring to recollection the globular form and stellular structure of the porphyries of Corsica and the Thuringerwald, of the pitchstones of Arran and Meissen, and of the pearlstone of Hungary. These interesting rocks generally border the greater masses of serpentine, as is seen near to Genoa; but they do not appear along the serpentine hillocks of the marly and arenaceous deposite of eastern Liguria and Tuscany.

Euphotide sometimes appears in isolated hills beside the serpentine; in other cases the rocks pass into each other, or they are so interwoven with each other that the one rock forms dikes or distinct veins in the other. The hills between Braco and Matorana, in Liguria, afford a fine example of this appearance. The whole may be explained on the principle of the slow cooling of the mass.

Lastly, The numerous simple minerals met with in serpentine do not occur in it every where. Diallage and asbestus, derived from hornblende and augite, are of these by far the most frequent. Garnets, augites, and hornblendes, are principally met with in the small beds, as those of Portsoy, Heidenberg, Fichtelgebirge. Chromate of iron occurs in the great bodies of serpentine connected with the talcose formation, as in the island of Unst in Shetland, central France, Golsen near Leoben, and Kraubach in Stiria: the same is the case with the native copper of America, &c. and the workable nests of pyrites at Monte Ramazzo, near to Genoa. Magnesite abounds much in some localities, as Hrubschitz in Moravia, Gurhof in Austria, Baldissero, Castellamonte, &c.; when this is the case, the serpentine contains semi-opals and calcedony, as at Gersec in Moravia, and chrysoprase, as at Kozemutz in Silesia, and Besenoro in Syrinia. These siliceous minerals are to the serpentine in the same secondary relation as the small similar veins in the granite, with kaolin and scapolite, at Hafnerzell in Bavaria.

Are we to admit that there are five different formations of serpentine; and, consequently, that it has been erupted at five different periods? In this view we would have, first, a serpentine, posterior to the marls and sandstones of the Appenines and Carpathians; a second, posterior to the transition red sandstone; a third, posterior to the greywacke; a fourth, to the mica slate; and, a fifth, to the gneiss and leptinite. But has serpentine truly been formed at so many epochs, or must we view it as we do porphyry, without any reference to the surrounding rocks? Shall we rather admit only one eruption of serpentine posterior to the transition red sandstone; or shall we give to it one more ancient and anterior to the newer greywacke, or even to the transition slate? These are questions difficult to be answered. It would be absurd to admit five eruptions of serpentine. We are of opinion, that the formation of serpentine is not so ancient as has been imagined, and will not in all probability be far from the truth, if we limit the appearance of serpentine to the great transition era, from the termination of the talco-schistose deposites, to the beginning of the independent coal formation.

We may here add, that the true relations of potstone to serpentine have not hitherto been ascertained in a satisfactory manner. It is probable that potstone bears the same relation to serpentine that *schaalstein*, a particular calcareous amygdaloidal trap, does to transition trap. It is well known that these last-mentioned rocks, viz. the schaalstein and transition trap in Westphalia and in Cumberland, form the transition from the slate or limestone to the trap, and even occur separately from this last rock, and are rarely brecciated. Many geologists confound it with true amygdaloid, which generally forms the upper and under parts of trap-veins, and bed-like veins and masses. The schaalstone seems to be transition rock altered by the emanation of the heat of the melted trap. If this view be correct, it could be employed, in the way of analogy, in the explanation of rocks associated with serpentine, and similarly situated, in interrupted small masses.

Observations on the Natural History of the Alligator. In a Letter to Sir WILLIAM JARDINE, Baronet, and PRIDEAUX JOHN SELBY, Esq. By JOHN J. AUDUBON, Esq. Member of the Wernerian Natural History Society, &c.

MY DEAR SIRS,

ONE of the most remarkable objects connected with the Natural History of the United States, that attracts the traveller's eye, as he he ascends through the mouths of the mighty sea-like river Mississippi, is the Alligator. There, along the muddy shores, and on the large floating logs, these animals are seen either lying basking and asleep, stretched to their full length, or crossing to and fro the stream in search of food, with only the head out of water. It is here neither wild nor shy, neither is it the very dangerous animal represented by travellers. But, to give you details that probably may not be uninteresting to you, I shall take you to their more private haunts, and relate what I have experienced and seen respecting them and their habits.

In Louisiana, all our lagoons, bayous, creeks, ponds, lakes, and rivers, are well stocked with them,—they are found where-ever there is a sufficient quantity of water to hide them, or to furnish them with food, and they continue thus, in great numbers, as high as the mouth of the Arkansas River, extending east to North Carolina, and as far west as I have penetrated. On the Red River, before it was navigated by steam-vessels, they were so extremely abundant, that, to see hundreds at a sight along the shores, or on the immense rafts of floating or stranded timber, was quite a common occurrence, the smaller on the backs of the larger, groaning and uttering their bellowing noise, like thousands of irritated bulls about to meet in fight, but all so careless of man, that unless shot at, or positively disturbed, they remained motionless, suffering boats or canoes to pass within a few yards of them, without noticing them in the least. The shores are yet trampled by them in such a manner, that their large tracks are seen as plentiful as those of sheep in a fold. It was on that river particularly that thousands of the largest size were killed, when the mania of having either shoes, boots, or saddle-seats, made of their hides, lasted. It had become an article of trade, and many of the squatters and strolling Indians followed for a time no other business. The discovery that the skins are not sufficiently firm and close-grained, to prevent water or dampness long, put a stop to their general destruction, which had already become very apparent. The leather prepared from these skins was handsome and very pliant, exhibiting all the regular lozenges of the scales, and able to receive the highest degree of polish and finishing.

The usual motion of the alligator, when on land, is slow and sluggish; it is a kind of laboured crawling, performed by moving alternately each leg, in the manner of a quadruped when walking, scarce able to keep up their weighty bodies from dragging on the earth, and leaving the track of their long tail on the mud, as if that of the keel of a small vessel. Thus they emerge from the water, and go about the shores and the woods, or the fields, in search of food, or of a different place of abode, or one of safety to deposit their eggs. If, at such times, when at all distant from the water, an enemy is perceived by them, they droop and lie flat, with their nose on the ground, watching the intruder's movements with their eyes, which are able to move considerably round, without affecting the position of the head. Should a man then approach them, they do not attempt either to make away or attack, but merely raise their body from the ground for an instant, swelling themselves, and issuing a dull blowing sound, not unlike that of a blacksmith's bellows. Not the least danger need be apprehended; then you either kill them with ease or leave them. But, to give you a better idea of the slowness of their movements and progress of travels on land, when arrived at a large size, say 12 to 15 feet, believe me when I tell you, that, having found one in the morning 50 yards from a lake going to another in sight, I have left him unmolested, hunted through the surrounding swamps all the day, and met the same alligator within 500 yards of the spot, when returning to my camp at dusk. On this account they usually travel during the night, they being then less likely to be disturbed, and having a better chance to surprise a litter of pigs, or of land-tortoises, for prey.

The power of the alligator is in his great strength; and the chief means of his attack or defence is his large tail, so well contrived by nature to supply his wants, or guard him from danger, that it reaches, when curved into half a circle, his enormous mouth. Woe be to him who goes within the reach of this tremendous thrashing instrument, for no matter how strong or muscular; if human, he must suffer greatly, if he escapes with life. The monster, as he strikes with this, forces all objects within the circle towards his jaws, which, as the tail makes a motion, are open to their full stretch, thrown a little sidewise, to receive the object, and, like battering-rams, to bruise it shockingly in a moment.

The alligator, when after prey in the water, or at its edge, swims so slowly towards it, as not to ruffle the water. It approaches the object sidewise, body and head all concealed, till sure of his stroke; then, with a tremendous blow, as quick as thought, the object is secured, as I described before.

When alligators are fishing, the flapping of their tails about the water may be heard at half a mile; but, to describe this in a more graphic way, suffer me to take you along with me, in one of my hunting excursions, accompanied by friends and negroes. In the immediate neighbourhood of Bayou Sarah, on the Mississippi, are extensive shallow lakes and morasses, that are yearly overflowed by the dreadful floods of that river, and supplied with myriads of fishes of many kinds, amongst which trouts are most abundant, white-perch, cat-fish, and alligator-gars, or devil-fish. Thither, in the early part of autumn, when the heat of a southern sun has exhaled much of the water, the squatter, the planter, the hunter, all go in search of sport. The lakes are then about 2 feet deep, having a fine sandy bottom; frequently much grass grows in them, bearing crops of seeds, for which multitudes of water-fowls resort to those places. The edges of these lakes are deep swamps, muddy for some distance, overgrown with heavy large timber, principally cypress, hung with Spanish beard, and tangled with different vines, creeping plants and cane, so as to render them almost dark during the day, and very difficult to the hunter's progress. Here and there in the lakes are small islands, with clusters of the same trees, on which flocks of snake-birds, wood-ducks, and different species of herons, build their nests. Fishing-lines, guns, and rifles, some salt and some *water*, are all the hunters take. Two negroes precede them,—the woods are crossed,—the scampering deer is seen,—the racoon and the opossum cross before you,—the black, the grey, and the fox squirrel, are heard barking,—here on a tree close at hand, is seen an old male pursuing intensely a younger one; he seizes it, they fight desperately, but the older attains his end, *vincit, castratque juniorem.* (Now, my dear Sirs, if this is not mental power illustrated, what shall we call it)? As you proceed farther on, the *hunk*

hunk of the lesser ibis is heard from different parts, as they rise from the puddles that supply them with cray-fishes. At last the opening of the lake is seen ; it has now become necessary to drag one's-self along through the deep mud, making the best of the way, with the head bent, through the small brushy growth, caring about nought but the lock of your gun. The long narrow Indian canoe kept to hunt those lakes, and taken into them during the fresh, is soon launched, and the party seated in the bottom is paddled or poled in search of water-game. There, at a sight, hundreds of alligators are seen dispersed over all the lake, their head, and all the upper part of the body, floating like a log, and, in many instances, so resembling one, that it requires to be accustomed to see them to know the distinction. Millions of the large wood-ibis are seen wading through the water, mudding it up, and striking deadly blows with their bills on the fish within. Here are a hoard of blue herons,—the sand-hill-crane rises with his hoarse note,—the snake-birds are perched here and there on the dead timber of the trees,—the cormorants are fishing,—buzzards and carion-crows exhibit a mourning train, patiently waiting for the water to dry and leave food for them,—and far in the horizon the eagle overtakes a devoted wood-duck, singled from the clouded flocks that have been bred there. It is then that you see and hear the alligator at his work,—each lake has a spot deeper than the rest, rendered so by those animals who work at it, and always situate at the lower end of the lake near the connecting bayous, that, as drainers, pass through all those lakes, and discharge sometimes many miles below where the water had made its entrance above, thereby ensuring to themselves water as long as any will remain. This is called by the hunters the Alligator's Hole. You see them there lying close together. The fish that are already dying by thousands, through the insufferable heat and stench of the water, and the wounds of the different winged enemies constantly in pursuit of them, resort to the Alligator's Hole to receive refreshment, with a hope of finding security also, and follow down the little currents flowing through the connecting sluices: but, no! for, as the water recedes in the lake, they are here confined. The alligators thrash them and devour them whenever they feel hungry, while the ibis destroys all that make towards the shore. By looking for a little on this spot, you plainly see the tails of the alligators moving to and fro, splashing, and now and then, when missing a fish, throwing it up in the air. The hunter, anxious to prove the value of his rifle, marks one of the eyes of the largest alligator, and, as the hair-trigger is touched, the alligator dies. Should the ball strike one inch astray from the eye, the animal flounces, rolls over and over, beating furiously with his tail all about him, frightening all his companions, who sink immediately, whilst the fishes, like blades of burnished metal, leap in all directions out of the water, so terrified are they at this uproar *. Another and another receives the shot in the eyes, and expires; yet those that do not feel the fatal bullet, pay no attention to the death of their companions till the hunter approaches very close, when they hide themselves for a few moments, by sinking backward.

So truly gentle are the alligators at this season, that I have waded through such lakes in company of my friend Augustin Bourgeat, Esq. to whom I owe much information, merely holding a stick in one hand to drive them off, had they attempted to attack me. When first I saw this way of travelling through the lakes, waist-deep, sometimes with hundreds of these animals about me, I acknowledge to you that I felt great uneasiness, and thought it fool-hardiness to do so; but my friend, who is a most experienced hunter in that country, removed my fears by leading the way, and, after a few days, I thought nothing of it. If you go towards the head of the alligator, there is no danger, and you may safely strike it with a club, four feet long, until you drive it away, merely watching the operations of the point of the tail, that, at each blow you give, thrashes to the right and left most furiously.

The drivers of cattle from the Appelousas, and those of mules from Mexico, on reaching a lagoon or creek, send several of their party into the water, armed merely each with a club, for the purpose of driving away the alligators from the cattle; and you may then see men, mules, and those monsters, all swimming

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* This so alarms the remaining alligators, that, regularly, in the course of the following night, every one, large and small, removes to another hole, going to it by water, and probably for a week not one will be seen there.

together, the men striking the alligators, that would otherwise attack the cattle, of which they are very fond, and those latter hurrying towards the opposite shores, to escape those powerful enemies. They will swim swiftly after a dog, or a deer, or a horse, before attempting the destruction of man, of which I have always remarked they were afraid, if the man feared not them.

Although I have told you how easily an alligator may be killed with a single rifle ball, if well aimed, that is to say, if it strike either in the eye or very immediately above it, yet they are quite as difficult if not shot properly; and, to give you an idea of this, I shall mention two striking facts.

My good friend, Richard Harlan, M. D. of Philadelphia, having intimated a wish to have the heart of one of those animals to study its comparative anatomy, I one afternoon went out about half a mile from the plantation, and seeing an alligator that I thought I could put whole into a hogshead of spirits, I shot it immediately on the skull bone. It tumbled over from the log on which it had been basking into the water, and, with the assistance of two negroes, I had it out in a few minutes, apparently dead. A strong rope was fastened round its neck, and, in this condition, I had it dragged home across logs, thrown over fences, and handled without the least fear. Some young ladies there, anxious to see the inside of its mouth, requested that the mouth should be propped open with a stick put in vertically; this was attempted, but at this instant the first stunning effect of the wound was over, and the animal thrashed and snapped its jaws furiously, although it did not advance a foot. The rope being still around the neck, I had it thrown over a strong branch of a tree in the yard, and hauled the poor creature up, swinging free from all about it, and left it twisting itself, and scratching with its fore-feet to disengage the rope. It remained in this condition until the next morning, when finding it still alive, though very weak, the hogshead of spirits was put under it, and the alligator fairly lowered into it with a surge. It twisted about a little, but the cooper secured the cask, and it was shipped to Philadelphia, where it arrived in course.

Again, being in company with Augustin Bourgeat, Esq. we met an extraordinary large alligator in the woods whilst hunting; and, for the sake of destruction I may say, we alighted from our horses and approached it with full intention to kill it. The alligator was put between us, each of us provided with a long stick to irritate it, and, by making it turn its head partly on one side, afford us the means of shooting it immediately behind the fore-leg and through the heart. We both discharged five heavy loads of duck-shot into its body, and almost all into the same hole, without any other effect than that of exciting regular strokes of the tail, and snapping of the jaws, at each discharge, and the flow of a great quantity of blood out of the wound, and mouth and nostrils of the animal; but it was still full of life and vigour, and to have touched it with the hand would have been madness; but as we were anxious to measure it, and to knock off some of its larger teeth, to make powder chargers, it was shot with a single ball just over the eye, when it bounded a few inches off the ground, and was dead when it reached it again. Its length was seventeen feet; it was apparently centuries old; many of its teeth measured three inches. The shots taken were without a few feet only of the circle that we knew the tail could form, and our shots went *en masse*.

As the lakes become dry, and even the deeper connecting bayous empty themselves into the rivers, the alligators congregate into the deepest hole in vast numbers; and, to this day, in such places, are shot for the sake of their oil, now used for greasing the machinery of steam-engines and cotton-mills, though formerly, when indigo was made in Louisiana, the oil was used to assuage the overflowing of the boiling juice, by throwing a ladleful into the kettle whenever this was about to take place. The alligators are caught frequently in nets by fishermen: they then come without struggling to the shore, and are killed by blows on the head given with axes.

When autumn has heightened the colouring of the foliage of our woods, and the air feels more rarified during the nights and earlier part of the day, the alligators leave the lakes to seek for winter quarters, by burrowing under the roots of trees, or covering themselves simply with earth along their edges. They become then very languid and inactive, and, at this period, to sit or ride on one, would not be more difficult than for a child to mount his wooden rocking-horse. The Negroes who now kill them, put all danger aside by separating, at one blow with an axe, the tail from the body. They are afterwards cut up in large pieces, and boiled whole in a good qnantity of water, from the surface of which the fat is collected with large ladles. One single man kills oftentimes a dozen or more of large alligators in the evening, prepares his fire in the woods, where he has erected a camp for the purpose, and by morning has the oil rendered.

I have frequently been very much amused when fishing in a bayou, where alligators were numerous, by throwing a blown bladder on the water towards the nearest to me. The alligator makes for it at once, flaps it towards its mouth, or attempts seizing it at once, but all in vain. The light bladder slides off; in a few minutes many alligators are trying to seize this, and their evolutions are quite interesting. They then put one in mind of a crowd of boys running after a football. A black bottle is sometimes thrown also, tightly corked; but the alligator seizes this easily, and you hear the glass give way under its teeth as if ground in a coarse mill. They are easily caught by Negroes, who most expertly throw a rope over their heads when swimming close to shore, and haul them out instantly.

But, my dear sirs, you most not conclude that alligators are always thus easily conquered: there is a season when they are dreadfully dangerous; it is during spring, during the love season. The waters have again submerged the low countries; fish are difficult of access; the greater portion of the game has left for the northern latitudes; the quadrupeds have retired to the high lands; and the heat of passion, joined to the difficulty of procuring food, render these animals now ferocious and very considerably more active. The males have dreadful fights together, both in the water and on the land. Their strength and weight adding much to their present courage, exhibit them like colossuses wrestling. At this time no man swims or wades among them; they are usually left alone at this season.

About the first days of June the female prepares a nest; a place is chosen forty or fifty yards from the water, in thick bramble or cane, and she gathers leaves, sticks, and rubbish of all kinds, to form a bed to deposite her eggs; she carries the materials in her mouth, as a hog does straw. As soon as a proper nest is finished, she lays about ten eggs, then covers them with more rubbish and mud, and goes on depositing in different layers until fifty, or sixty, or more eggs are laid. The whole is then covered up, matted and tangled with long grasses, in such a manner that it is very difficult to break it up. These eggs are the size of that of a goose, more elongated, and, instead of being contained in a shell, are in a bladder, or thin transparent parchment-like substance, yielding to the pressure of the fingers, yet resuming its shape at once, like the eggs of snakes and tortoises. They are not eaten even by hogs. The female now keeps watch near the spot, and is very wary and ferocious, going to the water from time to time only for food. Her nest is easily discovered, as she always goes and returns the same way, and forms quite a path by the dragging of her heavy body. The heat of the nest, from its forming a mass of putrescent manure, cause the hatching of the eggs, not that of the sun, as is usually believed.

Some European writers say, that at this juncture the vultures feed on the eggs, and thereby put a stop to the increase of those animals. In the United States, I assure you, it is not so, nor can it be so, were the vultures ever so anxiously inclined; for, as I have told you before, the nest is so hard, and matted, and plastered together, that a man needs his superior strength, with a strong sharp stick, to demolish it.

The little alligators, as soon as hatched (and they all break shell within a few hours from the first to last), force themselves through, and issue forth all beautiful, lively, and as brisk as lizards. The female leads them to the lake, but more frequently into small detached bayous for security's sake; for now the males, if they can get at them, devour them by hundreds, and the wood ibis and the sand-hill cranes also feast on them.

I believe that the growth of alligators takes place very slowly, and that an alligator of twelve feet long, for instance, will most probably be fifty or more years old. My reasons for believing this to be fact is founded on many experiments, but I shall relate to you one made by my friend Bourgeat. That gentleman, anxious to send some young alligators as a present to an acquaintance in New York, had a bag of young ones, quite small, brought to his house. They were put out on the floor, to shew the ladies how beautiful they were when young. One accidentally made its way out into a servant's room, and lodged itself snug from notice into an old shoe. The alligator was not missed, but, upwards of twelve months after this, it was discovered about the house, full of life, and, apparently, scarcely grown bigger; one of his brothers, that had been kept in a tub and fed plentifully, had grown only a few inches during the same period.

Few animals emit a stronger odour than the alligator; and, when it has arrived at great size, you may easily discover one in the woods in passing fifty or sixty yards from it. This smell is highly musky, and so strong, that, when near, it becomes insufferable; but this I never experienced when the animal is in the water, although I have, whilst fishing, been so very close to them, as to throw the cork of my fishing line on their heads, to tease them. In those that I have killed, and, I assure you, I have killed a great many, if opened, to see the contents of the stomach, or take fresh fish out of them, I regularly have found round masses of a hard substance, resembling petrified wood. These masses appeared to be useful to the animal in the process of digestion, like those found in the craws of some species of birds. I have broken some of them with a hammer, and found them brittle, and as hard as stones, which they resemble outwardly also very much. And, as neither our lakes nor rivers, in the portion of the country I have hunted them in, afford even a pebble as large as a common egg, I have not been able to conceive how they are procured by the animals, if positively stones, or by what power wood can become stone in their stomachs.

Observations and Experiments on the Different Kinds of Coal. By M. Karsten.

The celebrated Chief of Mines in Prussia, Karsten, some time ago published, in his "*Archiv für Bergbau und Hüttenwesen,*" a valuable series of observations and experiments on the different kinds of coal met with in the mineral kingdom. This important treatise has been reprinted in a separate form, and sent to us. On reading it carefully, we feel convinced that a condensed view of its most important facts and inferences will be read with interest by chemists, mineralogists, geologists, and, particularly, by all those who are concerned with coal mines. We shall arrange our view of this work under the following heads:

1. Preliminary Researches and General Considerations regarding Coal, and other combustibles.
2. Chemical Examination of Mineral Coal in general.
3. Application of the foregoing principles to the Coal-mines of England, France and Germany.
4. Observations on the Theory of the Formation of Coal.

1. *Preliminary Researches and General Considerations regarding Coal and other Combustibles.*

Some naturalists have asserted, that coal constitutes a true rock formation, or *original* deposite, and therefore not deriving its origin from vegetables or any other organic matter. A more accurate knowledge of the nature of organic combinations, an advantage which we owe to the progress of chemical sciences, does not permit us any longer to consider coal as a combination of carbon with bitumen.

The transition of vegetable wood to the mineral which is called *Bituminous Wood*, or more properly *Fossil Wood*, is so manifest, that, in many cases, one might think he could determine with certainty the species of wood which gave rise to the existence of the mineral; but the more complete the alteration of the vegetable fibres has become, the less striking do the passages of the one substance into the other appear, and the more difficult to recognise. The fossil wood of Iceland, known under the name of *Surturbrand*, has scarcely any resemblance to wood, at least in cabinet specimens. This substance appears to be a fibrous brown coal or lignite *; and frequently brown coal is distinguishable from true or black coal only, because it is surrounded by brown coal less completely altered. By the denomination *pitch-coal* or *jet*, is sometimes designated a true coal, sometimes brown coal; and the *columnar coal* (stangenkohle) of Mount Meissner, in Hesse, is introduced into all the systems of mineralogy as a true or black coal, although it is nothing else than a brown coal altered by the action of basalt. Brown coal has no-

* Vide Jameson's System of Mineralogy, and Manuel of Mineralogy.

where yet been found in a natural deposit of true or black coal, any more than true or black coal has been found in a deposite of brown coal.

The transition of black coal to glance coal or anthracite, is not less insensible than that of brown coal to black coal. True glance coal, as well as graphite, is a formation of rare occurrence; and, it would be difficult to point out any instances of their being associated with black coal. Yet this could never be a reason for rejecting, as improbable, the idea that glance coal and graphite may have arisen from the alteration of vegetable fibres, if there be nothing in the intimate nature of these bodies contrary to such an idea.

In unaltered vegetable fibres, the quantity of carbon is less, while the proportion of oxygen and hydrogen is greater, than in vegetable fibres that have undergone alteration. It is from a necessary consequence of this fact that the former, when put in contact with other bodies in a heated furnace, are so differently affected by them from the latter. The greater the alteration the fibres have experienced, the more apparent does the difference become; in other terms, this difference keeps pace with the increase of the relation which the quantity of carbon has to the quantity of the other constituent parts. In glance coal and graphite, this relation appears to have obtained its maximum; and these two substances, or at least the latter, are regarded as a carbon entirely deprived of oxygen and hydrogen.

According to the ideas generally admitted, graphite is a carbon, and its difference of chemical character from carbon is explained by considering it as a chemical combination of ninety-five parts of carbon with five parts of iron, whence result 100 parts of graphite or percarburet of iron. As to the difference between glance coal and pure carbon, this is less obvious. It appears, in reality, that it is a difficult problem in chemistry, to explain the difference which exists between diamond, graphite, glance coal, and pure charcoal.

Peat, brown coal, and black coal, submitted to distillation in the dry way, almost always afford more or less distinct traces of ammonia. Such a result is not obtained from the distillation of unaltered vegetable fibre. Thus, azote appears to present itself as a new constituent part of altered vegetable fibre. However, the proportion of azote is so small, in all the varieties of brown coal and black coal that have been submitted to examination by Mr Karsten, that this substance does not appear to be an essential constituent part of them.

Several brown coals and black coals yield an acid liquor by distillation; but most kinds of black coal furnish none. Peat, in the dry distillation, furnishes so great a quantity of acid water, that it is difficult to recognise clearly in that substance the ammoniacal basis which occurs in it, and this even on saturating the acid with potash.

Mr Karsten has carefully investigated and described the very different effects which are produced, whether on wood, and, in general, on unaltered vegetable fibre, or on altered vegetable fibres, on peat, brown coal, and black coal, by the different chemical re-agents, such as water, alcohol, sulphuric ether, caustic ammonia, hydrosulphuret of ammonia, nitric acid, and concentrated sulphuric acid. In his work we even find detailed accounts of the processes followed in these investigations. We shall confine ourselves, however, to the principal results. Those which are obtained on making the acids act upon vegetable fibres, whether altered or recent, are perfectly in accordance with the manner in which acids comport themselves, and the circumstances of the body upon which they act. Nitric acid, which is easily decomposed, and, from this very circumstance, capable of oxidising, produces more promptly, and in a higher degree, the oxidation of vegetable fibres. This acid changes them into a substance analogous to tannin, or even into an acid, while sulphuric acid can only operate a conversion of the fibres into gum, and finally into sugar. Unaltered fibre undergoes its metamorphoses more quickly and more completely, because the greater proportion of the quantity of oxygen and hydrogen to the quantity of carbon facilitates the action of acids.

In proportion as the quantity of carbon increases, the chemical effect of acids becomes more and more feeble, and perfectly pure charcoal appears no longer susceptible of alteration from acids, excepting in a single case, which happens when this substance occurs, as it does in wood-charcoal, in a loose state of mechanical aggregation.

Glance coal, graphite and diamond resist the action of acids;

and this perhaps solely on account of their great density. Diamond, which is the densest kind of charcoal known, only burns at a very high temperature, and by means of pure oxygen. Glance coal and graphite are incomparably more easy to be destroyed; and the charcoal which is obtained on distilling black coal, brown coal, and unaltered vegetable fibres in the dry way, burns the more readily the looser the state of aggregation it assumes during the process of carbonization, or the less the quantity of carbon the body contains which has been employed for producing the charcoal. A coal that is carbonised in a furnace, or still better in a close vessel, affords a charcoal much more compact and more difficult to be burnt, than that which comes from the same coal carbonised in the open air.

Elevation of temperature causes a decomposition of the combustible, and the formation of new combinations. This process has received the name of carbonization, because in this operation the residuum consists of pure charcoal. If hydrogen, oxygen and carbon, on being subjected to different degrees of temperature, also obey different laws of combination, the quantity of pure charcoal which remains after the carbonization, must depend, not only upon the state of the body which is to be carbonised, but also upon the different degrees of temperature which have been employed during this operation. This is actually what takes places. Several resins and fats, which contain much more carbon than vegetable fibres, leave no trace of charcoal in their spontaneous decomposition at a high temperature; and in the same vegetable fibre, the quantity of charcoal residuum depends entirely upon the degree of heat employed during the carbonization.

It is not the quantity of the carbonaceous residuum alone that must vary according to the different degrees of the temperature employed. The same cause must render more variable still the quantity and condition of the other combinations which are formed during distillation in the dry way, that is to say, during carbonization. This is the case precisely, because the quantity of the charcoal residuum is but a consequence of the nature and condition of the gaseous combinations and fluids, or vapours, which are formed during the operation. This difference in the manner in which organic combinations are affected under the different degrees of a high temperature, is of some importance, even in an economical point of view. From the same oil may be obtained for lighting, either a larger quantity of gas of bad quality, or a smaller quantity of incomparably better gas, according as the carbonization is effected by means of a weaker or stronger heat.

If the principal object of the operation were to obtain charcoal, it would be necessary to employ at first as low a heat as possible, and not to make it rise till near the end, in order to lose only the smallest possible quantity of charcoal in the gaseous combinations and fluids which are formed. This also shews that the products of dry distillation, with reference to the same organic body, must present differences as well of quantity as of kind, according as the temperatures employed have been different. This is a circumstance which, in a great number of cases, would require to be more taken into consideration than it has hitherto been.

It is known that the products of the distillation of unaltered and perfectly dry vegetable fibres in the air, are an empyreumatic acid, water, oil, a very small quantity of alcoholic substance, and a gaseous mixture, consisting of carbonic acid gas, carbonic oxide gas, carburetted hydrogen gas, and olefiant gas. The mutual relation of all these combinations, and the quantity of carbonaceous residuum, depend upon the temperature.

If shavings of wood be exposed for a long time to a temperature which does not rise above 120° of Reaumur, a period arrives when there is no longer observed any change of weight. In this operation, wood dried at the temperature of the air, but not at the temperature of boiling water, loses from 66 to 69 per cent. of its weight. Dried at the latter temperature, the wood would lose at the most from 56 to 59. Thus the residuum, which perfectly resembles common wood-charcoal, only that it presents a somewhat duller aspect, weighs from 41 to 44 per cent. of the real quantity of wood which has been employed, allowance being made for moisture. This carbonaceous substance is what M. de Rumford has named the frame-work, or skeleton, of plants. That philosopher considered it as a pure charcoal, which he imagined to exist in equal quantity in all plants. But M. Karsten concludes, from his own researches, that the pretended skeleton of plants is only an imperfectly decomposed vegetable fibre, and that it is not at all a pure charcoal.

In reality, says M. Karsten, vegetable fibres, after the disunion of their elements, preserve the external form of undecomposed fibres, and they experience no other change in their form than a diminution of size; but it is a consequence of the fact which has been mentioned; it is because the disunion of the elements of these vegetable fibres, at a temperature of about 120° of Reaumur, cannot be carried beyond a loss of weight which varies from 66 to 69 per cent. There results from this, that, if the temperature be raised above that point, then a new loss of weight commences, which, in its turn, remains constant for the new degree, until, at length, at the temperature of incandescence, the disunion of the elements of these fibres is completely effected; and after this no diminution of weight takes place.

The products of this slow decomposition are very different from those which are obtained by a decomposition effected by a rapidly increased heat. Wood of hornbeam (*Carpinus betulus)*, which, under a rapid carbonization, yields the ordinary products of distilled wood, and furnishes 13.3 per cent. of charcoal, developes, under a slow elevation of the temperature, much more water, carburetted hydrogen gas, and carbonic acid gas. It then furnishes 26.1 per cent. of charcoal, that is to say, nearly twice as much as in the case of a rapid carbonization. The decomposition of unaltered vegetable fibres commences, therefore, at a pretty low temperature; and the reason of this is, that, in wood-fibres, the quantity of oxygen and hydrogen, as is known by the analyses of MM. Gay Lussac and Thenard, occurs pretty nearly in the relation necessary for the formation of water.

The charcoal obtained from vegetable fibre by means of dry distillation, or by carbonization, appears to vary but little in our common woods. In a synoptical table, the author presents the results of experiments upon twenty-one kinds of unaltered vegetable fibres, such as oak, beech, hornbeam, birch, pine, lime, straw, fern, reed, and a piece of birch-wood which had served as a prop in a mine for an hundred years, but was still in good preservation. In all these trials, the matter was employed in the state of shavings, which had been perfectly dried in the open air, at a temperature of from 12° to 15° of Reaumur. The same species of matter was, on the one hand, submitted to a very rapid carbonization, for which, from the commencement of the distillation, an incandescent heat was employed; and, on the other hand, to a temperature which was made to rise very slowly to this point. The contents in ashes were carefully determined, by means of the incineration of charcoal under the muffle of an assay furnace. The weight of the ashes is deducted from that of the charcoal in the following table.

Wood submitted to carbonization.	Quantities obtained from 100 parts of wood.			
	By rapid carbonization.		*By slow carbonization.*	
	Charcoal.	Ashes.	Charcoal.	Ashes.
Young oak,	16.39	0.15	25.45	0.15
Old oak,	15.80	0.11	25.60	0.11
Young beech, *Fagus sylvatica*,	14.50	0.375	25.50	0.375
Old beech,	13.75	0.4	25.75	0.4
Young hornbeam, *Carpinus betulus*,	12.80	0.32	24.90	0.32
Old hornbeam,	13.30	0.35	26.10	0.35
Young alder,	14.10	0.35	25.30	0.35
Old alder,	14.90	0.40	25.25	0.40
Young birch,	12.80	0.25	24.80	0.25
Old birch,	11.90	0.30	24.40	0.30
Young pine, *Pinus picea*,	14.10	0.15	25.10	0.15
Old pine,	13.90	0.15	24.85	0.15
Young Norwegian pine, *Pinus abies*,	16.00	0.225	27.50	0.225
Old Norwegian pine,	15.10	0.25	24.50	0.25
Young Scotch fir, *Pinus sylvestris*,	15.40	0.12	25.95	0.12
Old fir,	13.60	0.15	25.80	0.15
Lime,	12.90	0.40	24.20	0.40
Rye straw,	13.10	0.30	24.30	0.30
Fern,	14.25	2.75	25.20	2.75
Reed,	12.95	1.70	24.75	1.70
Old birch *.	12.15		25.10	

It is sufficient to cast a glance upon this table to observe a general result, which is as follows:—Whatever difference the vegetable fibres of gramineæ, ferns, and different species of wood, present to the eye, these matters all afford nearly equal quantities of charcoal by dry distillation. The differences which are observed here and there, may arise from the impossibility of

* Instead of Old Birch, say Birch-wood, which, for upwards of 100 years, had been used as a support in a mine, and was still in good preservation.

constantly keeping the sand-bath at the same degree of temperature. It was in the rapid carbonization that the results differed most from each other, because, in this case, it is still more difficult to regulate the temperature. The quantity of charcoal obtained by means of the rapid carbonization varies, for 100 parts of the matter employed, between 11.90 (the produce of old oak), and 16.39 (that of young oak); but, in the slow carbonization, the quantity of charcoal obtained is nearly double, or at the least one-half more. It varies from 24.20 (the produce of lime-wood), to 27.50 (the produce of young Norwegian spruce). In both modes of carbonization, the quantity of ashes remains the same: it varies, in general, from 2.75 (the produce of fern) to 0.11 (the produce of old oak wood); but, in most cases, it is below 0.4.

Like unaltered vegetable fibre, fossil wood, on being carbonised, retains its external form completely, and only undergoes a diminution of size. This preservation of the external form after carbonization, that is to say, after a complete decomposition, is a phenomenon without example in inorganic nature, and one exclusively peculiar to unaltered vegetable fibre, fossil wood, brown coal, and some sorts of black coal. Other kinds of coal, in the process of decomposition by an ardent heat, lose more or less their form; and, by the difference which they thus exhibit, they already afford an indication beforehand of what their composition must be.

It may be without rashness asserted, that fossil wood and lignite, or brown coal, are still at the present day, so to speak, in a train of developement. This is proved by the frequent occurrence, in brown coal mines, of pieces of combustible, which present an evident transition from fossil wood to brown coal,—one extremity of the specimen being fossil wood, the other brown coal. With regard to black coal, there is not equal reason for supposing that the formation of that combustible is still going on, or that a change of relation in its elements still continues to be effected, although this is not improbable.

From the frequent variations which fossil wood presents in its passages into brown coal or lignite, it might already be expected not to afford, as the residuum of its carbonization, a constant quantity of charcoal, as was seen to be the case with regard to unaltered vegetable fibre. According as fossil wood approaches more or less to the nature of brown coal, it furnishes a greater or less quantity of charcoal; but, in the carbonization of fossil wood, as well as in that of brown coal, the quantity and kind of the products formed depend upon the degree of the temperature, although, in the species which come nearest to brown coal, the limits are already much more restricted. In general, fossil wood, submitted to distillation in the dry way, affords the same quantities of gas as the fibre of unaltered wood; but it yields less water, and still less of that oil, of a peculiar and disagreeable smell, by which all the brown coals are instantly recognised. The empyreumatic acid is then only formed in very small quantity; but, on the other hand, the formation of alcohol is much more considerable than in the case of unaltered vegetable fibre. Those lignites or brown coals, which, from their external characters, visibly present a passage into black coal, afford in the dry distillation water, with a very small quantity of fetid oil, and often furnish so much as 70 per cent. of pure charcoal.

Thus, therefore, says M. Karsten, those brown coals, the common *Braunkohle* of Werner, from which the *Moorkohle* of the same mineralogist does not differ, in distillation surpass a great many black coals, as to the quantity of charcoal obtained from them. Add to this, that the specific gravity of these brown coals rises to 1.2881, and is consequently higher than that of several varieties of black coal, which cannot be attributed to the quantity of earthy matter and oxide of iron, since these brown coals frequently do not contain one per cent. of them.

The quantity of ashes afforded by fossil wood and brown coal is very variable. In the species submitted to examination by M. Karsten, it varies from three-fourths to more than fifty per cent., which latter is the case with earthy brown coal. This produces a serious inconvenience in the employment of these combustibles; for the ashes, by resting upon the substance which is burning, oppose combustion to such a degree, that a stronger current of air must be employed, than the proper nature of the combustible, without this circumstance, would require. Hence the great difficulty of employing this substance advantageously for the purpose in view. The ashes of fossil wood and brown coal contain no traces of fixed alkali. Silica, alumina, oxide of iron, sulphate of lime, a little lime and magnesia, are the substances which are found in the residua of the combustion of fossil wood and brown coal. They present themselves in very different and very variable proportions, which depend upon the local circumstances under the influence of which the deposition of matter has been effected in the natural beds of these combustibles.

In black coal, the quantity of charcoal which may be obtained, by means of distillation in the dry way, varies still more than in the different sorts of brown coal, comprising also fossil wood. M. Karsten has not met with any black coal, which, on being distilled, has furnished less than 48 per cent. of charcoal. From this number, the quantity of residuum in charcoal rises to 90 per cent. Between these two limits there is scarcely a number to be found that would not answer for the produce in charcoal, or coke, of some kind of coal. Striking differences, however, are remarked in the external form of the carbonized coals called cokes.

In some the form of the coal remains unchanged, the volume only being diminished, as in charcoal from fresh vegetable fibre, fossil wood, and brown coal. Others remain unchanged in form and volume, while some swell and expand more or less. In order to observe correctly these different relations, it is necessary to use the coal we intend submitting to dry distillation in the state of powder. Coal of the first kind affords a coke in a dusty pulverulent state, without the least cohesion, just as in brown coal. In coal of the second kind, the powder is conglutinated into a cake, often very solid and tough, but without any swelling or intumescence. The fine powder, in coal of the third kind, melts, and forms a homogeneous mass, which takes the form of the retort in which it is distilled, and frequently swells so much as to choke up the retort.

Here the author divides coals into three classes, which he establishes from the external appearance of the charcoals or cokes which are produced by them. For the object which he proposes to himself, M. Karsten distinguishes,

1*st*, The coals with pulverulent coke, *(Sand Kohlen)*;
2*dly*, Those with conglutinated coke, *(Sinter Kohlen)*; and,
3*dly*, Those with an intumesced coke, *(Back Kohlen)*.

These three denominations sufficiently indicate the aspect and mode of existence of each of the three sorts of coke, as well as the transition which may take place from one kind to the other.

In all these kinds of coal, as in unaltered vegetable fibres, the quantity of charcoal obtained, differs according as a slow or quick heat is employed during distillation. In general, this difference of product is so much the greater, that the coals contain less charcoal. The coals with intumesced coke, however, form an exception. These often, with a greater quantity of charcoal, present greater differences of product in the two modes of carbonization, than with a less quantity of charcoal the coals with pulverulent coke do, and especially than those with conglutinated coke. At the most, these differences of product, in all the varietiès of coal examined by M. Karsten, do not exceed 6 per cent., and even this maximum of difference was only observed in a coal with an intumesced coke, which presented a mean quantity of charcoal. The produce in coke of coals of this class, when they possess a greater quantity of charcoal, does not vary more than 4 per cent. in the two modes of carbonization.

Another remarkable fact is, that the application of a low heat, raised very slowly to the strongest red heat, diminished in coals the property of furnishing either a conglutinated or an intumesced coke. A coal which, on being subjected to a rapid incandescence, announces itself as belonging to the second class (coal with conglutinated coke), may, by means of a heat raised very slowly, present the aspect of a coal of the first class (that with pulverulent coke). It is chiefly in the transitions from the one to the other class, that this fact is observed. In like manner, by means of a slow heat, a coal of the third class presents the aspect of the second, and especially if the coal in question possesses only in a feeble degree the property of furnishing an intumesced coke. In every case, if the heat be produced but slowly, the swelling of the coals with vesicular coke is diminished. They then form a less loose, less bulky, and less light mass, than if an ardent heat had been rapidly applied.

A distinction between the coals which swell, and those which do not, has long been established in the arts, because these two kinds of combustibles act very differently. Manufacturers have readily observed the great influence which the manner that different kinds of coal have in comporting themselves, exercises over their use. They have remarked, that the coals which swell cannot always be substituted by those which do not, and the reverse. But, between the one and the other, common opinion establishes no other difference than the following:—The coals, it is said, which swell, are only distinguished by a greater quantity of constituent parts, which are not carbonaceous, parts which have been designated by the name of Bitumen; in other words, it is the quantity of charcoal which decides whether a coal possesses the property of swelling or not.

This opinion is incorrect; and, so far from this being the case, it is most commonly observed, that the quantity of charcoal is greater in those coals which swell, than in others. There are coals of the first and second classes (with pulverulent and conglutinated coke), which, on being carbonised, do not yield more than about 50 per cent. of coke, and very few coals of the third class (with intumesced coke) yield so little. On the contrary, a great number of these coals with intumesced coke, furnish upwards of 80 per cent. of a very loose and swollen coke. Such a coal cannot contain so many constituent parts, which are not charcoal, as a coal with pulverulent or conglutinated coke, from which there is only obtained about 50 per cent. of coke.

The products of the distillation of coal in the dry way are well known. The greater the quantity of charcoal, the thicker is the consistence of the oil which is formed. All the varieties of coal, without exception, on being subjected to dry distillation, give feeble traces of ammonia. The coals with pulverulent coke, when they have a small proportion of charcoal, present traces of an acid. In all the varieties of coal belonging to this first class, the proportion which the aqueous fluid bears to the oily fluid, is greater than in those of the second class; and, in these latter, the proportion is greater than in the coals of the third class (those with intumesced coke). The quantity of gaseous substances, and of fluids or vapours which is formed, is in the inverse ratio of the contents in charcoal. A smaller quantity of gas is disengaged by the varieties of black coal, than by most of the brown coals; but, in the former, the combinations of carburetted hydrogen are more predominant. Sulphuretted hydrogen gas is only formed when the coal is mixed with iron pyrites, which it very generally is. The more capable the coal is of swelling (the third class), the more does the proportion of oil gas increase in the gaseous mixture.

It is only in those coals of the first and second classes in which the quantity of charcoal is small, that a decomposition of the combustible is effected before it has experienced a red heat; and even in these coals the decomposition does not make a marked progress at a low temperature.

The oily substance never begins to be developed until the heat has attained the degree of deep red. To all the coals of the two first classes, as well as those of the third, which contain much carbon, a low red heat must be applied to begin the decomposition, and a very strong red heat to terminate it. All the varieties of coal, besides oil and gas, also disengage water, on being distilled in the dry way.

In the ordinary trials of coals, the object of which is to determine the quantity and kind of coke or charcoal which they are capable of furnishing by dry distillation, the coals are usually employed in a state of desiccation in the air. This method is sufficient for common purposes; but it does not answer for chemical analysis, properly so called. In this latter case, M. Karsten found it necessary to dry, at the temperature of boiling water, the various combustibles which he intended to analyse chemically, with the view of comparing the results of the analysis, with the effects which the same coals produce on being submitted to dry distillation.

The author had at first presumed, that all varieties of coal, taken in their ordinary state of desiccation in the air, and such as they are employed for carbonisation, would not undergo a great loss of weight at any temperature below that of boiling water; or that, at least, this loss of weight would be nearly equal in all. But in order to attain his object, he found himself obliged to enquire what loss of weight coals experience from desiccation, at the temperature of boiling water. Hence a series of comparative trials which M. Karsten also extended to some other substances.

All these matters reduced to powder, were first exposed during five days, under the same circumstances, to a temperature of from 11 to 12 degrees of Reaumur's thermometer. When they were all thus reduced to the same degree of desiccation, an equal quantity of each of them was weighed, and then dried at the temperature of boiling water; the matter, while still warm, was afterwards weighed a second time, and the difference of weight ascertained. At this high temperature, no decomposition of the bodies under trial had taken place, as was proved by all these substances resuming their original weight, after being exposed to the air for 36 hours.

The following table shews the weight, after desiccation, at the temperature of boiling water, of several substances experimented upon, viz:—

Substances submitted to Desiccation at the Temperature of Boiling Water, their original Weight being represented by 100.	Weight retained after Dessication.
Sharings of common hornbeam, - - - - -	90.7
Wood charcoal, - - - - - - - -	91.6
Fossil wood, passing into brown coal, of the country of Aix-la-Chapelle, - - - - - - -	80.2
Columnar coal (stangenkohle) of Mount Meissner in Hesse, - - - - - - - - -	97.2
Brown coal of Uttweiler, right bank of the Rhine, -	95.05
Mineral charcoal (faserkohle) from Ibbenbuhren in Prussia, (Westphalia), - - - - - - - -	99.1
Fibrous brown coal (surterbrand) of Iceland, - - -	86.95
Compact coal (kennelkohle) of Lancashire, with highly intumesced coke, - - - - - - -	98.4
The same, with slight intumesced coke, - - -	97.6
The same, with pulverulent coke, - - - - -	94.4
Newcastle coal, with intumesced coke, - - - -	98.7
Mons coal (low countries) with conglutinated coke, -	99.3
Coal of the country of Essen and Werden, with intumesced coke, - - - - - - - - -	98.75
The same, with conglutinated coke, - - - -	99.05
The same, with pulverulent coke, - - - -	99.3
Coal of Upper Silesia, with pulverulent coke, - -	91.15
The same, with pulverulent coke, - - - -	87.3
Coal of the Canton of Bardenburg, country of Aix-la-Chapelle, with pulverulent coke, - - - - -	98.2
Coal of Sulzbach, near Dultweiler, with intumesced coke,	98.
Coal of the country of Saarbruck, with conglutinated coke,	94.

(*Table continued.*)

Substances submitted to Desiccation at the Temperature of Boiling Water, their original Weight being represented by 100.	Weight retained after Desiccation.
Coal of Loebejun, in the circle of the Saale in Prussia, with pulverulent coke, - - - - - - -	99.
Piciform coal of Planitz, kingdom of Saxony, with conglutinated coke, - - - - - - -	94.3
Coal of Pottschapel, near Dresden, with intumesced coke,	94.4
Glance coal of the country of Tecklenburg, Lingen, -	98.3
Glance coal (glanzkohle) pretended anthracite of Schonfeld in Saxony, with pulverulent coke, - - - -	95.95
Glance coal of Lischwitz, near Jena, in Saxony, - -	94.8
Conchoidal anthracite of Rhode Island, United States, -	94.9
Pretended anthracite of La Motte, department of the Isère, with pulverulent coke, - - - - -	95.5
Coal of the country of Waldenburg, Lower Silesia, with intumesced coke, - - - - - - -	97.8
Coal from Westphalia, with pulverulent coke, - -	99.
Coal from Brazil, with pulverulent coke, - - -	89.4
Coal from Upper Silesia, with pulverulent coke, - -	93.2
Another variety of the same, with pulverulent coke, -	97.1
Coal of the country of Waldenburg, passing from coal with vesicular coke, to coal with intumesced coke, - -	98.5
Coal of Upper Silesia, with intumesced coke, - -	97.1
Coal of the country of Waldenburg, with pulverulent coke, - - - - - - - - -	96.4
Coal of Upper Silesia, with conglutinated coke, - -	95.9
Coal of the neighbourhood of Beuthen, Upper Silesia, with pulverulent coke, - - - - - - -	93.1
Coal of the country of Saarbruck, with intumesced coke,	95.1
Coal of Eschweiler, country of Aix-la-Chapelle, with intumesced coke, - - - - - - - -	99.1
Coal of Eschweiler, another bed, with intumesced coke, -	99.1
Coal of Wellesweiler, country of Saarbruck, with intumesced coke, - - - - - - - -	97.85
Coal of the country of Waldenburg, Lower Silesia, with intumesced coke, - - - - - - -	97.8
Intumesced coke, - - - - - - - -	95.55
Conglutinated coke, - - - - - - -	95.6
Pulverulent coke, - - - - - - -	95.5
Graphite, or plumbago, from Borrowdale, - - -	100.
Sugar, - - - - - - - - - -	100.
Saltpetre (nitrate of potash) - - - - - -	100.
Sulphate of potash, - - - - - - -	100.

The loss of weight indicated by this table, whatever differences it may present, does not appear to have any relation to the properties of the varieties of coal, and in general of the matters subjected to experiment. The greatest loss was experienced by the fossil wood and by the coal with conglutinated coke having but a small proportion of charcoal. The former substance losses 19.8, and the latter 6 per cent. The more the quantity of charcoal increases, the smaller does the loss of weight become. M. Karsten, however, was surprised to see that a coal analogous to anthracite, and anthracite itself, experienced a considerable loss (from 5 to 6 per cent.), which would not have been presumed from their hardness and semimetallic lustre.

In general, the lightness, that is to say the porous and loose state of a body, does not appear to have any influence upon this loss of weight, or at least it does not always exert an influence upon it; for if it did so, mineral charcoal, which, of all the substances submitted to trial, is the lightest and loosest, perhaps, without excepting even wood charcoal, would have experienced the greatest loss. The charcoal of mineral wood, however, does not lose more than 1, while the hard and shining anthracite of Rhode Island loses upwards of 5 per cent. On the other hand, graphite, rendered very loose by bruising and pulverization, preserves its weight unaltered. Are the loss of weight which charcoals experience, and their subsequent increase on exposure to the atmosphere, owing to the emission and absorption of atmospheric air and humidity, or of humidity only? The author has not entered upon this inquiry; but he thinks, that, with the view of elucidating the cause of the differences which are observed in the manner in which mineral combustibles comport themselves, it would be interesting to try them thus at the moment of their being taken from the mine, and particularly those which in the open air increase considerably in weight. With regard to such coals as experience a very considerable diminution of weight, on being dried at the temperature of boiling water, their produce in coke by carbonization ought to be very small, and not to agree with the results of chemical analysis, if, as is commonly done, coals dried in the air be employed in the carbonization, and in the chemical analysis, coals dried at the temperature of boiling water.

(To be continued.)

Considerations regarding the shining of the Eyes of the Cat, and several other Animals. By M. Benedict Prevost.

Every body knows that the eyes of the cat shine in the dark. Our domestic cats afford us so frequent opportunities of observing this phenomenon, that it seems peculiar to them ; but there are several other animals which equally present it, and I have seen it in the dog, the sheep, the cow, the horse, the polecat, and even in several serpents, and in some insects, among others in the species of sphynx commonly known by the name of the Death's-head Moth.

Buffon says that " the eyes of the cat shine in the dark somewhat like diamonds, which throw out, during the night, the light with which they were in a manner impregnated during the day." Valmont de Bomare says, that " the pupil of the cat is during the night still deeply imbued with the light of the day," and some lines lower he adds, " the eyes of the cat are during the night so imbued with light, that they then appear very shining and luminous." Spallanzani says that " the eyes of cats, polecats, and several other animals, shine in the dark like two small tapers, and that this light is phosphoric." M. Dessaignes, in his memoir on phosphorescence, which was crowned by the Institute on the 5th April 1809, says that " the eyes of certain animals have the faculty of inflaming, and of appearing like a fire in the dark.

Thus the most eminent naturalists and philosophers are of one mind with the vulgar in regard to this fact, that the eyes of cats and some other animals shine in the dark with a light which is peculiar to them, or with which they have been impregnated during the day. I myself, also, was long in the habit of acquiescing in this opinion, taking the matter partly upon the authority of others, and partly observing the phenomenon for myself in the vague way in which every person sometimes observes things, and men of science as well as others ; which would not, however, be productive of great inconveniences, were not more importance attached to the citing such observations than to the making them. " Every body," says Montaigne, " is subject to say foolish things ; the misfortune is to say them curiously."

I am quite certain, that neither Buffon, nor Spallanzani, nor M. Dessaignes, ever observed on purpose the shining of the eyes of the cat, and that they never saw this phenomenon otherwise than cursorily, as one sees when he does not attend to a thing, or when one only partially attends to it; otherwise, they would immediately have perceived that the eyes of cats never shine in intense darkness, and that it is sufficient for them to shine, that too great a light does not prevent the pupil of the animal from dilating much; that, in reality, the phenomenon is only sensible to the observer, when his eye receives little light from surrounding objects.

The case, then, is the same with the eye which shines, as with the light which the pictures of a panorama reflect, and which appears to have all the intensity of that of the objects which they represent, although much inferior to it.

The less light the eye of the observer receives, the more is it sensible to that which the eye of the cat projects, and the less need has the latter of receiving any; it must receive more to produce an equal effect, if the former be situated in a lighter place. These are the conditions of the phenomenon. They appear to me to reduce this pretended phosphorescence to light reflected by a shining object. I shall give two examples, which I select from among the best adapted to render me understood.

1*st*, In a long and narrow passage, closed on all sides excepting the entrance, from which, during a very dark night, there could come but little light, I saw the eyes of a cat shine. They projected strongly upon the dark ground of a sort of deep nich, which made them appear like burning coals. The light which the eyes of the cat then received, and that which they sent back to me, was without doubt very weak; but to balance this, mine not being affected by any other light, would necessarily be very sensible to it. It was from a similar reason, that I once thought I saw from my bed something which shone like a star of second or third magnitude. It was nothing, however, but the back of a chair not very well smoothed, which reflected some rays of the moon; but having at the time my head almost entirely enveloped in my covering, and my eyes receiving no other light, these rays produced so much the more effect upon my retina, that they arrived the more isolated at it.

2d, In the other example which I have to adduce, the circumstances were in some measure the reverse. It was in a room where the sun shone, but the head of the cat was turned toward one of the corners, and I looked at it myself in such a manner as not to receive either the direct rays of the sun, or the light directly reflected. Here the eye of the animal received much more light than in the other example, and transmitted more to me, but my eyes receiving more light from another direction, and being on this account less sensible to it, the eyes of the cat did not appear so shining.

Valmont de Bomare, in the article *Chat* of his Dictionary, (the edition in 15 vols.), says, after what we have already quoted, "it seems that the lustre, the splendour, which is observed in the day time in the eyes of the cat, comes from the shining part of the retina, at the place where it surrounds the optic nerve." This does not agree very well with what precedes; for in full day-light the retina of the cat is not visible, and if he means to speak of the lustre that is visible in a weak light, it is certainly of the same nature as that which is observed in darkness, and which Valmont de Bomare attributes to the imbibing of the light of day. Nor does this author speak here from his own observation: what he says of the eyes of the cat is taken almost word for word from Buffon's works, and from the first edition of the Encyclopedie. We also find in the Geneva edition of 39 vols. 4to, article *Chat*, the following words: "It appears that the lustre, the shining, the splendour, which are observed in the eyes of the cat, come from a sort of velvet, which lines the bottom of the eye, or from the shining of the retina at the place where it surrounds the optic nerve." The phenomenon can be imitated with all its peculiarities, by placing bits of tinsel under suitable circumstances, or by other similar means. It is not therefore necessary to have recourse to phosphorescence for an explanation of it.

It is certain enough, that a great number of substances become luminous in the dark, after having been exposed some moments to the light of the sun, or only to the ordinary day-light, or to the light of a lamp, or of the moon. But it is not probable that the eyes of the cat are of this class; for, like those of other animals, they are filled with various humours; and there results from M.

Dessaigne's experiments, that neither the fluids nor the substances which have imbibed them manifest this property.

Besides, as I have already insinuated, the eyes of the cat do not shine either in absolute darkness, or even in a very intense although imperfect darkness. A certain degree of light is always requisite, which may indeed be very feeble, but still quite perceptible. I have kept myself several times, thirty or forty minutes together, in dark places with cats, which mewed to each other, or devoured their prey in their usual grumbling manner, yet without their eyes manifesting any luminousness. I have caressed, provoked, tickled, pinched and frightened in the dark a very good natured cat, which has bitten and scratched me in frolic or in anger, but without its eyes having ever shone. Yet some instant before or after, the eyes of all these cats shone as usual, when they were suitably exposed to a certain degree of light. But what convinced me fully that the eyes which shine in the dark, owe this property only to the faculty of reflecting the light more strongly, is, that the eyes of all the animals that are susceptible of presenting this phenomenon, are evidently, and as appears to me exclusively, organized for this purpose.

It is known that " the inner layer of the choroid coat, which appears to be of a firmer texture than the rest of its thickness, and which bears the name of *Ruyischian membrane*, is lined in man and in several other animals, with a blackish, or even absolutely black and dull mucosity, which may be detached or wiped off with the finger or a pencil, and which serves to prevent the rays reflected by the internal walls of the eye from disturbing the vision. Now, the bottom of the Ruyischian membrane is only covered with a layer of that varnish through which its colour, which varies in a singular degree according to the species, is perceived. In man, and the monkey tribe, it is brown or blackish ; in hares, rabbits, and hogs, of a chocolate brown ; but the carnivora, the ruminantia, the pachydermata, the solipeda, and the cetacea, have bright and shining colours in this part. The ox has it of a beautiful gold green, changing into sky blue ; the horse, the goat, the buffalo, the deer, of a silvery blue, changing into violet ; the sheep of a pale gold green, sometimes bluish ; the lion, the cat, the bear, and the dolphin, have it of a pale gold yellow ; the dog, the wolf, and the badger, of a pure white, edged with blue. This coloured part of the Ruyischian membrane is named the *Tapis*. Birds have it not *."

We see from this description, that the eyes of animals which do not shine like those of cats, have no tapis, or have it only of a dark colour. The eye of man does not shine, or only shines in a very slight degree †. I have often tried to ascertain whether it does, and in the most favourable circumstances have only at the most perceived an extremely feeble and doubtful light. I have never seen the eyes of hogs, rabbits, or hares, which have the tapis of a chocolate brown, emitting light; while I have very frequently seen the eyes of sheep, oxen, and horses, sparkle with the most lively colours. I have often had nocturnal birds at my disposal, and have often observed them, but without ever seeing their eyes shine like those of cats; and Spallanzani, who made numerous experiments upon these animals, and who examined them with reference to this subject, by night, by day, and during the twilight, both captive and in a state of liberty, never remarked either that their eyes were susceptible of shining in the dark, with that sort of lustre which he imagined to be phosphoric. It is true, that the tapis of the dog does not agree with the colour of the shining of its eyes; but this colour may be modified by that of the crystalline humour, or of some of the other humours of the eye.

It is astonishing that M. Cuvier, after this description, does not say a word of the phenomenon of which the tapis appears to me to be the cause; but this celebrated anatomist, whose genius knows to subject itself to the laws of a rigorous accuracy, not having probably observed it himself with sufficient care, has rather chosen to say nothing, than to repeat the opinions of others respecting a subject which, at bottom, belongs much less to anatomy than to Natural History.

M. Dessaignes not only says that the eyes of certain animals kindle and appear as if on fire in the dark; but, according to him, they owe this faculty to the expansive effect of the lively passions with which the animal is affected. But he is certainly deceived,

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* Cuvier's Leçons. d'Anat. Comp. t. ii. p. 397, 402.

† This luminous property we have remarked in eyes of several individuals, principally females.—Ed.

or at least this is subject to numerous exceptions. Besides what I have said of the cat in which I certainly excited lively passions, and whose eyes yet gave no sign of luminosity, it is easy to prove directly that the phenomenon may take place independently of the passions; for the animals whose eyes shine in the dark do not lose this property with life, and are susceptible of it even long after they are dead. I have seen two polecats that had been dead fifteen or twenty hours, whose eyes shone nearly like those of living cats. I have remarked the same thing in serpents and insects. I have also seen the eyes shine in some collared snakes which I extracted from the egg a considerable time before the period when they would naturally have come forth. There was no appearance then of their being susceptible of lively passions. It may be added that the animals whose eyes shine most, are often very tranquil at the moment when the phenomenon is most striking.

It was not enough to consider the shining of the eyes as phosphoric; it has also been pretended that it serves as a light to the animals which possess it, and that it assists them in seeing and guiding themselves in the dark. But the place which the reflectors occupy is reasonably a matter of astonishment, for it is not the light which proceeds from the eye to an object that enables the eye to perceive that object, but the light which arrives in the eye from it.

Spallanzani thought that cats, polecats, and some other animals, move with promptitude and certainty in a medium totally deprived of light, and this is also a subject of pretty general belief. I cannot help doubting it however. But should this really be the case, it ought not to be attributed to the shining of their eyes, since this aid, as we have seen, fails them when they have most need of it. Animals in the state of nature are never placed in such circumstances. Nor is it even probable that such an occurrence takes place in a state of domesticity. In whatever part they may happen to be, there is always a little light, and in order to see, they only require to have their pupil susceptible of great dilatation, and their retina of an extreme sensibility. It is said that a man shut up for a long time in a very dark dungeon becomes at length able to read. The nocturnal birds which Spallanzani reared, saw very well in a place in which he himself could distinguish no object; and he admits that the eyes of these birds do not shine in the dark. Besides sheep, cows, horses, and several other animals which have the eyes shining, would no doubt find themselves much embarrassed in absolute darkness. If some quadrupeds, in fact, move with promptitude and security in complete darkness, it is certainly not to their eyes that they are indebted for it, but to some other sense. The bats in which Spallanzani discovered this faculty, owe it, according to him, to a sixth sense, of which we have no idea; and, according to Cuvier,* to the extent of the membrane which their wing presents to the air, and which renders it capable of feeling its resistance, motion and temperature.

It is true that the animals whose eyes shine in the dark are all of the number of those whose motions the night rather favours than impedes, when its shades are not too thick, and although several others which feed, take their diversion, or provide for their subsistence, during the night, have not the eyes shining, one is yet tempted to search the cause of the agreement or concurrence of these two circumstances, which we observe so frequently to take place.

The light does not act upon the retina by impulsion, as some physiologists seem to think; its action, although its nature is not very well known, appears to be purely chemical; and the sensibility of the eye to the light, being on this account susceptible of a sort of saturation, it was necessary, in order to let it have all the delicacy which it would require to serve the animal in profound darkness, either to take care that the eye should receive but very little light during the day, or that this light, at least what was superabundant, should be immediately sent off by some reflector, which would not allow it to enter into combination. If, on the contrary, it were useful for the cat, that its eye should be filled with light in the night-time, nature would take care to prevent it from entering the light during the day, or provide that the little which its Ruyischian membrane might receive through a contracted pupil, should be instantly thrown out.

To conclude, the preceding observations seem to me sufficiently to prove, 1st, That the shining of the eyes of the cat and of other animals, which present the same phenomenon, does not arise from a phosphoric light, but only from a reflected light;

that, consequently, 2d, It is not by an effect of the will of the animal or by that of certain passions, that this light emanates from its eyes; 3d, That this shining does not manifest itself in absolute or too profound darkness; 4th, That it cannot enable the animal to move with security in the dark.—*Biblioth. Britannique, T.* 45.

Remarks on the Rhubarb of Commerce, the Purple-coned Fir of Nepal, and the Mustard Tree. By Mr David Don, Librarian of the Linnean Society, Member of the Imperial Academy Naturæ Curiosorum, of the Wernerian Society, &c. Communicated by the Author.

1. *On the Rhubarb of Commerce.*

It is well known that the plant which yields the rhubarb of commerce has been hitherto involved in much obscurity, and hence there have arisen many discordant opinions, both among botanists and pharmacologists, respecting the species of *Rheum* which affords this valuable medicinal root. They judged it rightly to be the produce of a species of *Rheum*, but of what particular species, without authentic materials it was impossible for them to decide. Linnæus considered it at first as the produce of his *Rheum rhabarbarum* or *undulatum*, but he afterwards appears to have altered his opinion in favour of *Rheum palmatum*; while Pallas, who certainly had better opportunities of gaining correct information on the subject, regarded it as composed chiefly of the roots of *Rheum undulatum* and *compactum*. Mr Sievers, an enterprising assistant of Professor Pallas, and well known by his interesting Letters on Siberia, published in the *Nordische Beyträge*, was sent by the Empress Catharine II. purposely to try to obtain the true rhubarb plant from its native country; and although, after travelling for seven years in the countries adjacent to that in which it is found, he was unable to effect the object of his mission, yet he obtained sufficient information to convince him that the plant was then unknown to botanists. But it was reserved for Dr Wallich, the zealous superintendent of the Calcutta Botanic Garden, to set this long agitated question at rest, by the transmission of seeds and dried specimens of the true rhubarb plant to Europe. Last spring, Mr Colebrooke received a quantity of the ripe seeds from Dr Wallich, and presented a portion of them to Mr Lambert, who has been so fortunate as to raise a number of plants of this valuable vegetable. The seeds were sown in pots, and, by the aid of artificial heat, soon vegetated. The young seedlings were transplanted into separate pots filled with rich earth, and the pots were gradually changed as the plants increased in size. By this treatment, as might well be imagined, the young plants grew vigorously, and, at the end of autumn, the leaves were from fifteen inches to a foot in breadth, and the footstalks nine inches long, with half an inch of diameter. The plant, on examination, proved to be identical with my *Rheum australe* *, from Gosaingsthan in the Himalaya Alps. I find Dr Wallich calls it *Rheum Emodi*, a name which I should certainly have adopted, had I been aware of it before the publication of my work. The whole plant is thickly beset with numerous, small, bristle-shaped, cartilaginous points, which give it a rough feel. The leaves are of a dull green, and the footstalks are red and deeply furrowed. The native samples I have seen appear to be smaller in all their parts, and the leaves, although flowering specimens, frequently not more than three or four inches broad; the footstalks four inches long, and slender, and the flowering stem not above two feet high. It is curious to observe how well this description accords with what Sievers has given us. The *Rheum australe* appears to be peculiar to the great table lands of central Asia, between the latitudes of 31° and 40°, where it is found to flourish at an elevation of 11,000 feet above the level of the sea; and there is little doubt, therefore, of its proving perfectly hardy in our own country. Large quantities of the roots are annually collected for exportation in the Chinese provinces within the lofty range of the Himalaya. The best is that which comes by way of Russia, as greater care is taken in the selection; and on its arrival at Kiachta, within the Russian frontiers, the roots are all carefully examined, and the damaged pieces destroyed. This is the fine rhubarb of the shops, called improperly Turkey Rhubarb. We have yet to

* *R. australe*, foliis subrotundo-cordatis obtusis planis subtus margineque scabris sinu baseos dilatatis, petiolis sulcatis teretiusculis cum ramis pedunculisque-papilloso scabris, perianthii foliolis ovali-oblongis apice crenulatis. —*Don, Prod. Fl. Nepal*, p. 75.

regret the want of much interesting information respecting the mode of collecting and preparing the roots, and other details interesting in a commercial point of view. The unfortunate fate of Mr Moorcroft, whose zeal and multifarious knowledge well fitted him for a scientific traveller, has deprived us of much valuable information on this as well as on many other subjects.

2. *On the Purple-coned Fir of Nepal.*

Mr Lambert has raised two plants of this interesting species from seeds received from Dr Wallich, alongwith those of the rhubarb plant above described. These are the first that have been raised in Europe; for, although quantities of the seeds had been received from time to time, from the difficulty of transporting the seeds of coniferous trees, especially through the Tropics, all previous attempts to raise this valuable fir proved unsuccessful. This, which may be regarded as the silver-fir of Nepal, surpasses all others of the fir tribe in beauty. Its lofty and pyramidal form; its numerous long, erect, cylindrical, purple cones, studded with drops of pellucid resin; and its flat leaves, silvery underneath, and of a bright shining green above, which thickly adorn its ash-coloured branches, render it a truly picturesque object. The trunk is from 70 to 80 feet high, perfectly straight, covered with a smoothish grey bark, and having a circumference of 7 or 8 cubits. The wood is light, compact, and of a rose-colour, resembling in grain and colour the pencil cedar, *Juniperus Bermudiana.* Its cones afford by expression a purple dye. The resin, especially that of the seeds, is highly pungent to the taste; and its scent is very powerful, not inferior to that of the *Deodara.* The elevation at which it is found, namely, of from 8000 to 10,000 feet above the level of the sea, induces us to hope, that it will be found capable of enduring our severest winters. A magnificent plate of this species, accompanied by a complete description, will be found in the second volume of Mr Lambert's monograph of the genus, under the name of *Pinus spectabilis.*

3. *On the Mustard Tree.*

Captains Irby and Mangles, in their interesting Travels *,

* Travels in Egypt and Nubia, Syria, and Asia Minor, during the years 1817 and 1818, by the Honourable Charles Leonard Irby and James Mangles, Commanders in the Royal Navy.—*Printed for private distribution. London*, 1823. 1 vol. 8vo.

make mention of a tree observed by them in the vicinity of the Dead Sea, which they were led, from certain circumstances, to suppose might be identical with the mustard plant of the Sacred Scriptures. As the passage is instructive, and the work itself in but few hands, I shall here, for the sake of illustration, insert the whole of it. They remark, (*Letter* v. p. 354, 355.) on leaving the shores of the Dead Sea, "We now entered into a very prettily wooded country, with high rushes * and marshes; leaving these, the variety of bushes and wild plants became very great; some of the latter were rare, and of remarkable appearance." And, again, "There was one curious tree, which we observed in great plenty, and which bore a fruit in bunches resembling, in appearance, the currant, with the colour of the plum. It has a pleasant, though strong aromatic taste, exactly resembling mustard; and, if taken in any quantity, produces a similar irritability in the nose and eyes, to that which is caused by taking mustard. The leaves of this tree have the same pungent flavour as the fruit, though not so strong. We think it probable that this is the tree our Saviour alluded to in the parable of the mustard seed, and not the mustard plant which we have in the north; for, although in our journey from Byson to Adjeloun, mentioned in the Jerusalem Letter, we met with the mustard plant † growing wild, as high as our horses' heads, still, being an annual, it did not deserve the appellation of a tree; whereas the other is really such, and birds might easily, and actually do, take shelter under its shadow." On reading this passage, both Mr Lambert and myself felt interested in ascertaining what the tree might be, and, at first, we were inclined to suppose it was a species of *Phytolacca*; with which genus the habit of the plant, as far as could be learnt from the above description, pretty well accords; but the examination of an authentic sample, in the possession of Mr Bankes, has proved the supposition was unfounded, and that the tree is the *Salvadora persica* of Linnæus, the *Embelia Grossularia* of Retzius, and the *Cissus arborea* of Forskahl.

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* Scirpus lacustris L. which is abundant in the marshes on the shores of the Dead Sea.

† Probably *Sinapis nigra*, which in Spain grows to the height of from ten to fifteen feet, as I am informed by my learned friend Don Mariano Lagasca.

It is figured and described by the late Dr Roxburgh in his splendid work on the plants of the coast of Coromandel —a work which we regret to see discontinued by the Court of Directors. In that work the following interesting remarks on the *Salvadora persica* are given, which will be found to coincide entirely with what Captains Irby and Mangles have observed. "This is a middle sized tree, a native of most parts of the Circars, though by no means common; it seems to grow equally well in every soil: flowers, and bears ripe fruit all the year round. The berries have a strong aromatic smell, and taste much like garden-cresses. The bark of the root is remarkably acrid; bruised and applied to the skin it soon raises blisters, for which purpose the natives often use it; as a stimulant it promises to be a medicine possessed of very considerable powers." The *Salvadora persica* has an extensive geographical range, being found in Arabia, Syria, Persia, and India, between the parallels of 18° and 31° north latitude. The parallel of 31° appears to be its ultimate limit towards the north. I am far from assuming this tree to be identical with the apocryphal mustard plant of the Sacred Scriptures: indeed, the whole passage in the Gospel by St Matthew * appears to militate against such an opinion, and it would seem that some common agricultural herb, of large growth, had been intended by our Saviour in the parable; but whether the plant belongs to the same family with *Sinapis* of Linnæus, and for what purposes it was cultivated, are questions rendered quite problematical at this distant date. We are pretty certain, however, that it cannot be a *Phytolacca;* for it does not appear that any real species of that genus has been observed in Palestine. It is true, that, in an academical dissertation of Linnæus, entitled, "*Flora Palæstina*," published in the year 1756, and professing to embrace all the plants observed by Hasselquist, we find the name of *Phytolacca asiatica*, by which is probably intended the *Salvadora persica*, a plant with which Linnæus does not appear to have ever been well acquainted, and of which he probably derived all his knowledge from Garcin's description, published in the Philosophical Transactions of the Royal Society of

* "A mustard-seed.... which indeed is the least of all seeds; but when it is grown, it is the greatest among herbs, and becometh a tree; so that the birds of the air come and lodge in the branches thereof."

London for 1749; for, in the *first* edition of the *Species Plantarum*, published at Stockholm in 1753, we find *Phytolacca asiatica* for the first time noticed, with the following specific character, "*Phytolacca foliis serratis;*" and a reference made to the *Kalagu* of Rheede, (*Hort. Malab.* ii. *t.* 26.), which has a pinnate leaf, and is evidently nothing else than *Leea sambucina.* Linnæus appears to have been soon aware of his error, as in the subsequent editions of the *Species Plantarum*, the name is discontinued. My only object in this communication was to point out precisely the plant noticed by Captains Irby and Mangles. This object, I trust, I have satisfactorily fulfilled; but, as to attempting to ascertain the precise plant mentioned in the Sacred Scriptures, the difficulties that present themselves appear to me not to be lessened.

Addition to the Botanical Notices, published in No. XXVI. *of the Philosophical Journal, October* 1825.

In my article on the leaves used by the Chinese in lining tea-chests, there is some obscurity in the description of the nerves, which I think it necessary to remove. It seems as if I denied the existence of a midrib, but this I did not intend; for I meant to say, that the leaves agreed with the genus *Pharus*, and differed from most other *Gramineæ*, in the presence of a midrib, and that their straight parallel nerves, running longitudinally from the base to the apex of the leaf, distinguished them essentially from those of *Scitamineæ*, wherein the nerves arise laterally from the midrib, traversing the leaf in an obliquely transverse direction from the centre to the margin.

On the Structure and Characters of the Octopus ventricosus, Gr. (Sepia octopodia, Pent.), a rare species of Octopus from the Firth of Forth. By R. E. Grant, M. D., F. R. S. E., F. L. S., M. W. S., Fellow of the Royal College of Physicians of Edinburgh, Honorary Member of the Northern Institution, &c. Communicated by the Author *.

THE species of Octopus, of which I now present two specimens from the Firth of Forth, is of rare occurrence on our coasts,

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* Read before the Wernerian Natural History Society 13th January 1827.

and is not to be found among the species of that animal described by Lamarck, nor among those described by Carus, as occurring in the Mediterranean. It possesses the characters of the genus Octopus of Lamarck, but differs from his *O. vulgaris* and *O. granulatus*, in having only a single in place of a double row of suckers on each arm. It differs from his *O. cirrhosus*, in having the upper margin of the mantle fixed behind, and continuous with the back of the head, in place of being free and detached all round. And it differs from his only other species, the *O. moschatus*, in being entirely free from that remarkable musky odour ascribed to that species by every author, and from which it has received its specific name. Pennant has pretty accurately represented our present species under the Linnæan name of Sepia octopodia, (Br. Zool. iv. pl. 28). But, from the description he has given, and from the name he has applied to it, it is obvious, that he was unaware of the existence of any other species of octopus, and mistook this for the *O. vulgaris*, which has a double range of suckers, and is much more common. The figure given by Carus of the *O. moschites* (Nova Acta Acad. Cæs. vol. xii. tab. 32.) agrees with Pennant's species in its external characters, excepting that the body of the moschites is a little more lengthened and cylindrical, the base more tapered, the eyes larger, and the arms more slender. But Carus mentions, that his species smells so strongly of musk as to fill quickly a whole apartment, whether the animal be dead or alive; and the same remarkable property is ascribed to it by Cuvier, Lamarck, and other writers. Aristotle, Aldrovandus, and some later authors, have divided the Octopoda into two genera, applying the term Eledona (Ελεδωνη Arist.) to those species, which, like the present, have only a single row of suckers on each arm; but this unnecessary subdivision of the well marked genus Octopus is probably not justified by the importance of the character proposed, and the most distinguished naturalists, as Cuvier, Lamarck, Blainville, and Carus, have not adopted it. As Pennant's species has neither the white skin, the smooth surface, the lengthened body, nor the musky odour of the *O. moschatus*, and differs, in more obvious characters, from the other species, we are compelled either to retain its specific name *octopodia* given by Pennant, or to devise a new epithet more consistent with our present knowledge of these animals. It must be obvious, that the term *octopodia*, though very appropriate for one of the sepiæ of Linnæus and Pennant, cannot be applied to a species of Octopus without a plain tautology, and because the specific name, being then synonymous with the generic, would be equally applicable to all the species. Until a more determinate character, founded on structure, be discovered by a careful dissection of the other species, I have called the present species *O. ventricosus*, from the rounded appearance of the body in both the specimens I have seen, and in the figure of it represented by Pennant.

Many excellent details of the structure and habits of the Sepia, the Loligo, and the Octopus vulgaris have been given by Aristotle, Swammerdam, Monro *secundus*, Scarpa, Tilesius, and Cuvier; but, so far as I know, none of the species of octopus, with a single row of suckers, have yet been opened by anatomists. The O. ventricosus is the fifth species of cephalopodous animals I have already procured from the Firth of Forth, the other species being the *Octopus vulgaris*, *Loligo sagittata*, *Loligo vulgaris*, and *Loligo sepiola*; and it is interesting to observe, that these species are nearly all the same as those met with by Carus in the Mediterranean. That naturalist observed in the Gulf of Genoa, specimens of the Oct. vulgaris, Oct. moschatus, Loligo sagittata, L. sepiola, L. vulgaris, and Sepia officinalis.

The following observations are chiefly taken from a recent adult female specimen of the *O. ventricosus*, lately presented to me by my friend Mr Coldstream, and to abridge the anatomical details, I have compared its organs with those of the *O. vulgaris*, already fully described by Cuvier in his elaborate memoir on that animal, (*Mem. sur les Moll.* p. 1.)

The body of the *ventricosus* is short, broad, slightly depressed, rounded, and a little dilated posteriorly, granulated and deeply coloured with small reddish brown spots on the back, smooth and light coloured on the fore-part. The upper margin of the mantle is connected behind, across the whole breadth of the head, and has no lateral expansions to assist in swimming. In the other genera *Loligo* and *Sepia*, the mantle is free behind, and in these as well as in the *Loligopsis*, it is armed with lateral expansions to assist in swimming. These expansions are supplied in the *O. ventricosus* by the muscular web connecting the base of the arms. The funnel is long, narrow, rather soft, and light coloured. The head is broad, short, covered with spots and minute granules on the back part like the body, white on the fore part with few spots. It expands without any previous contraction into eight strong arms, like an inverted cone. Pennant has represented a slight contraction of the head between the eyes and the arms. The eyes are very small, almost concealed under the folds of the skin forming the longitudinal eyelids, and they are placed rather towards the back than the sides of the head. The iris is white, has a shining silvery lustre, and is almost covered with small round spots of a deep reddish brown colour like those of the skin. The eight arms have all the same length, form and structure, but the two interior are much whiter than the others. The arms are about three times the length of the body, much compressed throughout their whole length, very strong at their base, and tapering regularly to almost imperceptible filaments at their free ends. They are deeply spotted externally, nearly white on their central aspect, and are armed with a single range of suckers on their inner surface, extending from their base to their extreme points. The bases of the arms are connected to each other, by a strong muscular web spotted externally, and white within, like the arms, and extending between the arms to about the twelfth sucker from the mouth. The suckers commence about half an inch from the fringed lip of the mouth ; they are sessile, broad, and very short. The suckers next the mouth are nearly a line in breadth, they increase regularly in size to the sixth from the base which is the largest on all the arms, and measures nearly three quarters of an inch in diameter. From the sixth sucker they again diminish regularly in size, till they become quite invisible to the naked eye near the points of the arms. With a lens they may be counted to within half a line from the points, and about 111 are found on each arm, making 888 on the animal. The first four suckers from the base, are about two lines distant from each other, the rest are placed in close contact. In the *O. vulgaris* the first three or four suckers from the mouth are likewise placed in a single row, and a little distant from each other, but from these to the points of the arms there is a double range ; in that species there are about 240 on each arm, making in all 1920. In the *O. granulatus,* Cuvier states that there are 180 suckers (90 pairs) on each arm, making 1440 suckers on that species. It might be useful to observe this external character in all the species. Each sucker of the ventricosus consists of a central cartilaginous hemispherical cup, surrounded by a very broad flat muscular margin, which is deeply marked like the inner edge of the cup, with from fifteen to seventeen distinct radiating grooves. Cuvier has made no mention of these thick white, firm cartilaginous cups, in describing the suckers of the *O. vulgaris.* They can be taken out entire with great ease from the centre of the suckers, particularly after immersing them in boiling water. There is no horny circle nor sharp converging teeth within these cups, as we find in the pedunculated suckers of the *Sepia* and *Loligo.*

The external dimensions of the adult animal are—from the upper margin of the mantle to the lower end of the body 4½ inches; greatest breadth of the body from right to left 3½ inches ; length of the arms from the mouth 12 inches; extent of the muscular web between the arms 3 inches; breadth of the web between each pair of arms 4 inches; breadth of the head at the eyes $2\frac{1}{4}$ inches; external aperture of the eyelids when expanded into a circle only $\frac{1}{4}$th of an inch. The coloured spots of the skin are of a deep reddish brown colour. In the *cirrhosus,* Lamarck states that they are of a bluish grey colour. In the *O. vulgaris* they are brown. Lamarck states that the whole skin of the *moschatus* is white, but Carus has represented it spotted with red. In the *ventricosus* they are so minute and crowded together on the back, as to be almost undistinguishable without a lens; the largest are about the tenth of a line in diameter, and between these are crowded others infinitely smaller. On the fore parts of the body they are few, and placed at greater distances from each other. The colour is of different intensity in different spots, and even in different parts of the same spot. They are confined to a thin layer on the outer surface of the true skin, which may be compared to the rete mucosum of the higher animals. When a part of the surface is plunged into boiling water, the coloured superficial film is easily removed. In the living state, the spots appear and disappear in rapid succession, as in other cephalopodous animals. In a young specimen of the *ventricosus* only about 4 inches in total length (now in the Museum of the University), which I kept alive for some hours in a basin of sea water, I observed, that, when the surface of the body was touched with the finger, the neighbouring parts quickly and rapidly changed colour, clouds of a bright red colour spread rapidly in every direction over the surface, from the part touched. This diffused redness, which was like a blush on the human skin, appeared to be produced by some coloured fluid passing repeatedly to and from minute vesicles on the surface of the skin. The animal swam several times hurriedly across the basin, always with its posterior extremity forward, by repeatedly striking forward the whole of its webbed arms at the same instant. Swimming seemed as unnatural to it, as to a pea-crab, which likewise swims hurriedly backward by striking the water with its tail, or to many bivalve mollusca, which swim backward by flapping their shells. It likewise climbed up the sides of the basin, out of the water, by spreading its arms in every direction, fixing its tender suckers to the sides of the vessel, and carrying the posterior part of its body erect. The granules on the back parts of the adult animal are about the size of a grain of sand, situate in the true skin, and are seen on the mantle, head, arms and webs. The *O. granulatus* is distinguished by these tubercles or granules of the skin, but they are not confined to that species, and Lamarck suspects that it may be only a variety of the *vulgaris.* There is still a necessity for minuter observations than we at present possess, for the accurate discrimination of these singular and interesting animals.

The cartilaginous frame-work of the head is very soft and transparent: it forms rather small orbits, very large spherical cavities for the ears, and a small recess between these two shut cavities for lodging the ganglion of the æsophagus, compared to the brain of vertebral animals. In place of the osseous or cartilaginous plates extending down the back of the mantle in the other genera, we find two small cylindrical stiliform cartilages, about the thickness of a crow quill, extending down the sides of the lower half of the mantle. These bodies are thickest where they commence at the bottom of the branchiæ, and become quite filiform as they descend in a curved direction to near the base of the mantle. They are not connected with the muscular fibres of the mantle, as might be expected, but are placed in distinct cavities. On clipping open the capsules which contained them, they fell out in loose transparent fragments of an amber-colour. The muscular system presents nothing peculiar. The fleshy membranes within the sac immediately enveloping the viscera, are comparatively strong. Cuvier states that the fringed lip in the *O. vulgaris* is only a fold of the skin (*Mem.* p. 25.) On laying open the lip in the *ventricosus*, a strong sphincter muscle is seen surrounding its upper margin, and very delicate muscular bands descend from the sphincter to the sides of the bills. Strong muscular bands are seen passing from arm to arm across the connecting webs; and within these a thin layer of muscular fibres extends longitudinally to the free margin of the webs. The whole convex outer margin of the cartilaginous cups of the suckers is covered with the insertions of oblique muscular bands for the varied motions of these organs; and a distinct set arises from the margin of the cups, radiating outward to assist the external bands in moving the broad disk of the suckers. The muscular structure of the arms, the mantle, the funnel, the bands connecting these, and the fleshy peritoneal coverings, is the same as described by Cuvier in the *O. vulgaris*. On laying open these peritoneal coverings, we observe the great length of the glandular-like bodies attached to the superior and inferior trunks of the veins leading to the lateral hearts. When the parts are floating loosely in water, these singular glands extend nearly half an inch from the sides of the veins, and appear as empty white pear-shaped sacs, attached by their tapering ends to the coats of the veins. In place of these long pear-shaped bodies, we find in the *Loligo sagittata* only a thick soft sponginess of the coats of the veins, which, however, is of the same glandular nature, and secretes a thick white fluid, whose use is entirely unknown. The fluid which escapes by pressing these glands is always more thick and turbid than the blood which we find circulating in the bloodvessels. On cutting open a living *L. sagittata,* these glandular parts of the veins exhibit a remarkable peristaltic motion, which continues as long as any other motions of the body. The two branchial hearts have the same remarkable blackish-grey colour as in the *O. vulgaris,* which is probably peculiar to this genus. Those of the *L. sagittata* have always a pale-red colour. In the *ventricosus,* these organs are pretty large, destitute of the white appendices we find in the *L. sagittata,* dark-coloured through their whole texture, and deeply marked internally with columnæ carneæ, which form innumerable small pits in the parietes. The branchiæ, about 2¼ inches long, and pretty broad, are immediately connected with a thick fleshy band, which hangs by a thin fibrous membrane to the sides of the mantle; and along the thick margin of this fleshy band the branchial artery is firmly connected, from the lateral heart to the upper end of the gill on each side. They are ramified in the same manner as in the *vulgaris,* and they suffered an injection of size and vermilion to pass with great ease both through the vein and the artery. I have often found the vein burst in the *L. sagittata* in forcing the same injection through that vessel, in a direction contrary to the natural course of the blood. The central heart has very thin white firm walls, slightly marked internally with columnæ carneæ; and its capacity is more than three times that of each lateral heart. The distribution of the arteries and veins, as might be expected, was similar to that of the *vulgaris*, so far as I could trace them.

The white fringed lip surrounding the two bills is rather short; the bills, of a deep brown colour, are likewise short and powerful; the lower one is much expanded at its base. The tongue is covered with an amber-coloured hard, horny, membrane, which has several longitudinal rows of sharp reflected teeth. The upper pair of salivary glands are round, flat, deeply lobed on the margins, of a white colour, bound to the fleshy sides of the mouth, and they send their ducts through these fleshy parietes into the mouth. By remaining some weeks in spirits, these glands acquired a purple colour, while the lower pair, equally exposed, were not affected. The lower pair of salivary glands are of a pale-red colour, about an inch long, and three quarters of an inch broad, compressed, smooth, not lobed like those of the *vulgaris,* firm in texture, somewhat triangular or heart-shaped, and they are loosely suspended behind the upper margin of the liver, by means of their vessels, nerves, and ducts. On cutting open these large compact glands, we find a small cavity, like the pelvis of a kidney, at their upper part, from which the ducts commence. They are about ten times as large as the upper pair. Their two ducts unite into one, which passes up on the fore part of the œsophagus for nearly two inches, to enter the mouth at the root of the tongue. When the œsophagus reaches the upper and back part of the liver, it becomes firmly connected to that organ, and expands into a wide membranous crop, deeply marked internally with longitudinal folds, and covered with a villous appearance. The part of the crop which is most intimately connected with the substance of the liver is drawn upwards in the form of a cœcum, and has a glandular texture. The crop tapers as it descends obliquely to the gizzard. This membranous crop is not present in the *Loligo sagittata,* where the œsophagus passes without dilatation to the stomach, at the bottom of the liver, next to the spinal sac. The muscular sides of the gizzard are of great thickness, and as strong in proportion as those of a domestic fowl. Its two fleshy sides are placed nearer the upper than the lower end; the under end is thin and membranous. The hard cartilaginous lining of the gizzard I found quite detached from the sides; and, on examining its contents carefully in a watch-glass, I collected some undigested muscular parts of a pale-red colour, fragments of the crustaceous covering and joints of young crabs, and some coarse particles of sand. I have no doubt, from the appearance of these parts through the microscope, that the particles of sand aided in the comminution of the hard shells. In the *L. sagittata* there is only a thin, wide, membranous stomach in the place of this thick fleshy gizzard. The upper and left side of the gizzard opens into the spiral stomach, which has nothing peculiar. The large intestine, on leaving the spiral stomach, makes a long curve downwards behind the left branchial heart, like another cœcum, before it mounts upwards on the fore part of the liver, to terminate at the base of the funnel. The liver is short, spherical, of the usual orange-yellow colour, composed of the ramifications of vessels filled with a coloured fluid. In the *O. vulgaris* it is cylindrical, from the greater length of the body ; and, for the same reason, it is very long and cylindrical in the *L. sagittata*. Its canals are not surrounded by the pancreatic glands, which I have shewn, in the *L. sagittata*, to embrace and communicate with these ducts during their whole passage from the liver to the spiral stomach, and which were mistaken for the ovarium at a period when the structure of these animals was very little known, (*See Edin. Phil. Journ.*, vol. xiii. p. 197). The want of these glands in the *O. ventricosus* is compensated for by the very large inferior pair of salivary glands. The ink-bag is deeply imbedded and nearly concealed in the substance of the liver, but it sends out its excretory duct from the lower and fore part of that organ, to terminate as usual in the anus. The colour of the ink is quite different from that of the *L. sagittata* ; and as the colour of this substance is constant in each of the cephalopodous animals, a more intimate acquaintance with this character might be useful in tracing relations among the different species. The colour of the ink in the *L. sagittata* is a deep brown, approaching to yellowish-brown, when much diluted, and corresponds remarkably with the coloured spots on the skin of that species. In the *O. ventricosus*, the colour of the ink is pure black, and is blackish-grey when diluted on paper. The ink, brought in a solid state from China, has the same pure black colour as in the *ventricosus*, and differs entirely in its shade, when diluted, from that of the *L. sagittata*, as may be seen from specimens of these three colours on drawing-paper. Swammerdam suspected the China ink to be made from that of the *Sepia*, Cuvier found it more like that of the *Octopus* and *Loligo* ; but different kinds of that substance are brought from China, probably made from different genera of these animals, where they abound of gigantic size. Ink is at present made from these animals in Italy (*Cuv. Mem.* p. 4), and from the immense shoals of the *L. sagittata* cast ashore every spring in the Firth of Forth, it might likewise be manufactured here. The ink is not contained in a simple cavity attached to the liver, but is diffused through a soft cellular substance which fills the ink-bag, and must render more tedious the preparation of this substance for the arts.

The œsophageal ganglia, compared to the brain and cerebellum of vertebral animals, were small, white, soft, without internal cavities, lodged in open recesses of the cartilaginous ring surrounding the œsophagus, and were separated from the œsophagus only by a thin transparent membrane, to which they firmly adhered. The large reniform optic ganglia, the band of nerves proceeding from these to the retina, the white pulpy glandular masses within the back part of the sclerotic, the division of the lens, and the general structure of the eye, are the same as in the *vulgaris*. At the bottom of the large shut spherical cavities of the ears, which were capable of containing a garden pea, lay a very delicate membranous sac, containing a little fluid, and a small red-coloured stone shaped like a limpet, the only earthy matter in this animal. These small bones of the ear are conical, solid, of a rose-red colour on the sides, flat and white on the base; their apex is rounded and curved backward, their length, breadth, and height, are about half a line. When cut, they appear white and translucent within, like the inner layers of an oyster shell; they are very slightly excavated in the centre of their flat base, and they dissolve with effervescence when touched with nitric acid, like other substances composed of carbonate of lime. The great nervous trunk accompanying the small artery in the central tube of the arms, the great ganglion, with about twenty nerves radiating from it, placed within the upper and back part of the mantle, and the other nerves and ganglia, were very conspicuous, and corresponded in distribution to those of the *vulgaris*.

The specimen I dissected was a female, and the ovarium, consisting of beautiful detached ramified trunks, enclosed in a wide membranous sac, occupied the lowest part of the general cavity of the body, as in the other cephalopodous animals. The ova, instead of being attached by their peduncles to a single point, as in the *vulgaris (See Cuv. Mem. p. 31.)*, were attached to the extreme ramifications of about twenty branched trunks, which hung by separate stalks from the upper end of the membranous sac. The two reniform glands through which the oviducts pass, and which very probably secret the coverings of the ova, as in the skate and other fishes, and connect them together, were about the size of a pea, of the same dark colour as the lateral hearts, and were placed about half an inch from the lower end of the oviducts. The oviducts opened on each side about half way between the lateral hearts and the anus.

Meteorological Observations made in Jamaica by the late John Lindsay, *Esq. Surgeon, Jamaica.* Communicated by W. C. Trevelyan, Esq. M. W. S. &c.

The author of the following Tables is well known to the public. He published an account of the Epidemic Catarrh of the latter end of the year 1789, as it appeared in Jamaica, in Med. Com. vol. xvii. p. 499, 1792. Also, an account of the Germination and Raising of Ferns from Seed, Trans. Lin. Soc. vol. xi. p. 93, 1792; of the Quassia Polygama, or Bitter Wood of Jamaica; and, of the Cinchona brachycarpa, a new species of Jesuit's Bark, found in the same island, Trans. Soc. Edin. vol. iii. p. 205, 1794.

A TABLE, shewing the Highest, Lowest and Medium Heat at Sunrise; between One and Two o'Clock, P. M.; and between Eight and Nine o'Clock at Night, by Fahrenheit's Thermometer, for Five Years, viz. 1786, 1787, 1788, 1789 and 1790.

		A. D. 1786.			A. D. 1787.			A. D. 1788.			A. D. 1789.			A. D. 1790.		
		Highest.	Lowest.	Medium	Highest.	Lowest.	Medium.	Highest.	Lowest.	Medium.	Highest.	Lowest.	Medium.	Highest.	Lowest.	Medium.
Jan.	M.	73	66	70	75	69	71	72	68	70	74	69	71	71	67	69
	N	85	83	84	82	74	81	85	77	81	85	80	82	82	80	81
	N.	79	75	77	78	69	74	77	73	75	80	72	76			
Feb.	M.	72	67	70	72	69	70	72	69	71	72	67	70	71	68	69
	N.	84	77	81	83	80	82	85	82	83	84	81	82	84	82	83
	N.	78	73	75	76	71	72	78	75	76	77	75	76	77	73	75
Mar.	M.	75	64	69	72	69	70	74	71	72	71	67	68	72	68	70
	N.	87	83	85	85	82	83	87	86	84	84	80	82	87	82	83
	N.	79	73	76	81	75	78	80	76	75	78	74	75	78	73	75
April.	M.	79	71	74	75	70	74	74	70	71	73	68	70	74	68	71
	N.	89	86	87	85	83	84	87	82	85	88	81	84	86	77	83
	N.	82	77	79	80	77	78	86	77	78	79	76	78	78	74	76
May.	M.	79	70	75	77	70	73	75	72	73	79	71	74	80	71	74
	N.	92	82	90	88	83	86	88	85	86	88	79	85	88	86	85
	N.	84	75	80	83	80	82	79	76	77	84	76	81	84	74	80
June.	M.	80	73	77	78	74	75	77	73	74	76	74	75	76	73	74
	N.	91	76	86	89	87	88	89	84	87	88	86	87	88	82	86
	N.	82	75	81	84	80	82	84	74	78	82	79	80	82	76	79
July.	M.	80	75	77	79	74	75	78	74	75	77	72	75	76	72	74
	N.	92	87	90	89	86	87	90	86	88	90	82	87	91	86	88
	N.	85	77	82	84	80	81	85	78	81	86	76	82	86	79	83
Aug.	M.	82	75	77	78	76	77	80	74	76	77	73	75	78	73	74
	N.	91	86	88	90	81	84	90	88	89	90	86	87	90	84	87
	N.	84	78	81	83	76	81	85	79	82	80	76	77	84	77	80
Sept.	M.	80	75	77	79	75	76	78	75	76	77	74	75	77	73	74
	N.	89	85	87	89	86	87	88	81	84	90	80	88	92	86	88
	N.	83	76	81	84	78	79	81	78	79	82	77	81	84	78	79
Oct.	M.	81	74	77	78	72	76	80	74	75	76	74	75	78	70	74
	N.	91	82	86	84	77	82	89	77	83	90	82	87	88	81	86
	N.	84	77	81	82	77	78	81	77	79	81	78	80	82	73	78
Nov.	M.	79	76	77	77	69	73	75	71	73	74	72	73	76	71	73
	N.	89	86	87	88	80	84	86	82	84	84	80	82	86	84	85
	N.	82	77	80	86	75	78	81	77	79	76	74	75	82	73	78
Dec.	M.	76	71	73	76	68	72	74	67	71	75	66	72	74	70	71
	N.	86	80	84	85	73	82	85	80	82	84	76	81	82	80	81
	N	80	76	77	78	70	74	80	72	76	77	74	75	80	74	76
		92	64		90	68		90	67		90	66		92	67	

Monthly and Annual number of Days on which Rain or Thunder is mentioned in Mr LINDSAY'S *Meteorological Journal, to have fallen from August* 1785 *to June* 1792.

	1785.		1786.		1787.		1788.		1789.		1790.		1791.		1792.	
	Rain.	Thun.	Rain.	Thun.	Rain.	Thun.	Rain.	Thun.	Rain.	Thun.	Rain.	Thun.	Rain.	Thun.	Rain.	Thun.
January	—	—	15	1	19	5	12	2	14	4	19	9	13	1	16	1
February	—	—	22	—	16	2	16	—	9	1	19	2	20	2	11	1
March	—	—	12	—	16	—	10	—	9	—	25	3	19	—	14	9
April	—	—	10	—	29	8	14	1	16	—	27	5	10	—	19	4
May	—	—	17	10	23	10	19	3	23	13	22	11	25	20	23	4
June	—	—	25	15	21	16	22	19	21	19	23	23	24	13	14	12
July	—	—	28	14	26	21	28	21	23	15	29	17	21	12		
August	26	20	23	17	26	17	22	17	22	15	27	27	27	19		
September	25	19	25	12	25	16	29	16	22	17	24	20	30	18		
October	30	20	20	6	18	10	24	3	25	9	23	11	25	7		
November	18	7	12	1	16	6	23	10	—	—	20	9	24	12		
December	17	6	13	3	9	1	19	3	18	4	25	—	16	4		
Total.	116	72	222	79	244	112	238	95	207	97	283	137	254	108	97	31

The greatest quantity of rain appears to have fallen between the months of May and November. Hail is mentioned in Mr Lindsay's Notes to have fallen on the 27th and 28th of August 1791. A smart shock of an earthquake, which lasted about half a minute, happened on 21st October. Another is mentioned on 1st July 1791.

A Description of the genus Malesherbia of the Flora Peruviana; with Remarks on its Affinities. By Mr David Don, Libr. L. S.; Member of the Imperial Academy Naturæ Curiosorum, of the Wernerian Nat. Hist. Society, &c.

The characters and habit of *Malesherbia* appear to me sufficiently important to establish it as the type of a distinct natural group, to which the name of *Malesherbiaceæ* may be given. The necessity of attending minutely to the structure, both of the flower and fruit, is now universally admitted; and I wish it were as generally allowed, that the object of the botanist should be rather to point out the real structure and affinities of individuals, than to attempt extensive and unnatural combinations, in the present infantine state of botanic science: for it must be admitted, that nothing is more injurious to a system, than the unnatural association, either of genera or species; and perhaps nothing has tended more to retard the advancement of systematic botany, than the fear of an unnecessary multiplication of names, thereby inducing the contracted notion of retaining entire many heterogeneous orders and genera. If we but turn our eyes over the pages of works professing to be general Systems of Plants, we will find abundant evidence of the justness of what has been advanced; and if we but consider how few individuals in any of the extensive genera or orders have been investigated with that care and precision by which the true nature of their parts, and their relative affinities, can alone be ascertained, we should not perhaps be so averse to their separation into smaller groups. The *Malesherbiaceæ* agree on the one hand with *Passifloreæ*, and on the other with *Turneraceæ*. They differ from the former in their erect ovula; in the insertion of the styles; in their ascending incumbent anthers; in the placentæ not extending above the separation of the valves; in their naked seeds; in their thick, fleshy, almost hemispherical cotyledons; and finally, by their great difference in habit, and by the absence of stipules at the base of the leaves. From the latter (*Turneraceæ*), with which they agree well in habit, and in the structure of their fruit, in their erect ovula, in the structure of the anthers, and in the furrowed nature of their seed-covering; they are essentially distinguished by the presence of a corona, and in the persistent nature of the inner series of the floral envelope; by their incumbent anthers; by the insertion of the styles; by the placentæ being confined to the lower half of the capsule; by their straight embryo, and by the form of the cotyledons; and, lastly, by the absence of the fleshy scale (probably the rudiment of an arillus) at the base of the seed. The *Malesherbiaceæ* appear to be related also in a certain degree to *Loaseæ*, whose characters and affinities are yet but imperfectly understood. M. Auguste de St. Hilaire, in his valuable memoir on the affinities of the *Cucurbitaceæ*, has already pointed out the affinity of *Turneraceæ* and *Loaseæ* to *Passifloreæ*.

The genus *Malesherbia* was established by Ruiz and Pavon in their *Genera Plantarum Floræ Peruvianæ et Chilensis*, published in the year 1794, and dedicated to the memory of the unfortunate M. Lamoignon de Malesherbes, a distinguished philosopher, and a great lover of botany, who fell a victim to his zeal for the cause of justice and humanity, and for the honour and glory of his country, in the early part of the French Revolution. The genus was subsequently published by Cavanilles, in the fourth volume of his *Icones Plantarum*, under the name of *Gynopleura*; but what was his object in changing the name does not appear, neither is it a matter of any importance. I shall now proceed to give a botanical description of the group, which may equally be considered as that of the genus.

MALESHERBIACEÆ.

PASSIFLOREARUM genus, *Juss.*

Perianthium monophyllum, tubulosum, membranaceum, inflatum, coloratum, nervis decem in limbo diffusè ramosissimis, è basi sursum peragratum: *faux* coronâ continuatâ brevissimâ membranaceâ v. acutè dentatâ v. 10-lobâ, laciniis 2–4-dentatis, ornata: *limbus* duplici ordine 10-fidus, uterque persistens, patulus, æstivatione imbricatâ; *interiore* petaloideo, æstivatione convolutâ.

Stamina 5, hypogyna, exserta, apici columnæ inserta, laciniis interioribus perianthii opposita: *filamenta* filiformia, glabra, compressiuscula: *antheræ* lineares, retusæ, biloculares, filamentis mediatè annexæ, incumbenti-erectæ: *loculis* parallelis, margine longitudinaliter dehiscentibus, ab insertione filamenti ad apicem ferè usque confluentibus.

Pistillum: ovarium apici columnæ adnatum, subglobosum, obscurè triangulare, uniloculare: *ovulis* erectis, biseriatim indefinitis, funiculo umbilicali stipitatis: *styli* 3, longissimi, capillares, glabri, persistentes, valvis capsulæ alternantes, et inter ipsarum bases inserti: *stigmata* simplicia, clavata, disco concavo pruinoso.

Capsula elongata, trigona, 1-locularis, apice trivalvis, dehiscens, polysperma, basi membranacea: *valvis* crustaceis.

Placentæ: costæ 3, prominentes, funiculis persistentibus seminiferis stipatæ, parieti capsulæ infra dehiscentiæ locum insertæ, axique valvarum perpendiculares.

Semina erecta, obovata, ventricosa, duplici serie ordinata, fuscescentia, funiculo umbilicali stipitata, apice strophiolâ fungosâ laceratâ, basi umbilico tuberculiformi aucta, extùs sulcis plurimis parallelis æquidistantibus longitudinalibus transversè rugulosis notata: *testa* duplex; *exteriore* crustaceâ, crassiusculâ; *interiore* cartilagineâ membranaceâ: *albumen* copiosum, carnosum, aqueo-pallidum.

Embryo erectus, teres, axilis, lutescens, albuminis ferè longitudine: *cotyledones* orbiculatæ, crassæ, hinc convexæ, inde planæ, penè hemisphæricæ: *radicula* teres, crassa, obtusissima, recta, cotyledonibus longior, centrifuga.

Plantæ (Peruviæ v. Chili apricis propriæ) *erectæ, ramosissimæ, pubescentes, caule infernè suffruticoso.* Folia *alterna, simplicia, exstipulata.* Flores *numerosissimi, axillares v. terminales, solitarii, sessiles, lutei.*

MALESHERBIA, *Ruiz et Pavon, Gen. Plant. Fl. Peruv. et Chil.* p. 45.

Gynopleura, *Cav. Icon.* iv. p. 52.

Obs. Character idem ut in ordine.

SPECIES.

1. *M. thyrsiflora*, foliis lineari-lanceolatis acutis sinuato-dentatis tomentosis, perianthii fauce coarctatâ, coronâ decemfidâ: laciniis 2–4-dentatis.

Malesherbia thyrsiflora, *Ruiz et Pavon, Fl. Peruv. et Chil.* iii. p. 30. t. 254.—*Syst. Veg. Fl. Peruv. et Chil.* p. 79.

Gynopleura tubulosa, *Cav. Icon.* iv. p. 52. t. 375.

HAB. In Peruviæ apricis argillosis provinciarum Cantæ, Huarocheri, et Caxatambo (*Ruiz et Pavon, Dombey*); prope oppidum Purruchuco, 18 leucis à Limâ frequens, etiamque juxta Obragillo et San Buenaventura.—*Ludovicus Née.* ♄.

Floret Aprili et Maio.

Planta suffruticosa, 2–3-pedalis, fœtida, hirsutissima. *Folia* conferta, sessilia, lineari-lanceolata, acuta, obtusè sinuato-dentata, suprà leviter canaliculata, basi aliquantulum attenuata, 2–3-uncialia. *Flores* flavi. *Perianthium* tubulatum, sesquipollicare. *Coronæ laciniis alternis* exterioribus segmentis perianthii oppositis angustioribus, plerumque bidentatis.

2. *M. paniculata*, foliis oblongis obtusis pinnatifidis ciliatis, perianthii fauce dilatatâ, coronâ simplici acutè dentatâ.

Gynopleura linearifolia, *Cav. Icon.* iv. p. 52. t. 376.?

Hab. In Chili boreali.—*Alexander Caldcleugh.* ♄. (v. s. in Herb. Lamb.)

Planta erecta, pyramidato-ramosissima, leviter canescens, 3–4-pedalis. *Rami* teretes, pube subtili vestiti. *Folia* alterna, sessilia, nunc basi auriculatâ amplexicaulia, oblonga v. lanceolata, obtusa, pinnatifida, pube sericeâ pilis plurimis setaceis intermixtâ potissimùm ad margines ornata, uninervia, nervo pinnatè ramoso, patentia, semipollicem v. pollicem longa, et 3 lineas v. semiunciam lata; *ultima* lineari-oblonga, sæpe integra: *laciniis* oblongis obtusissimis; *infimis duabus* majoribus, stipulas simulantibus. *Flores* paniculæ modo dispositi, numerosissimi, pallidè lutei, siccitate violacei! pedicello brevissimo crasso suffulti. *Perianthium* copiosè villosum, unciale: *tubus* angustus, cylindraceus, imâ basi callosâ: *faux* dilatata, campanulata, tubo duplò triplòve longior: *coronâ* simplici, tenuissimè membranaceâ, multidentatâ, dentibus brevibus acutis inæqualibus, è nervorum calycinorum ramis lateralibus arcuatis ortum ducente: *limbus* duplici ordine 10-partitus, uterque persistens, coloratus; *laciniis exterioribus* calycinis, lanceolatis, obtusis, æstivatione imbricatis; *interioribus* petaloideis, alternantibus, ovato-lanceolatis, mucronulatis, lateribus parum inæqualibus, magis coloratis, æstivatione convoluto-imbricatis, basi aliquanto attenuatis. *Nervi perianthii* adhuc simplices, ad summitatem tubi in ramos tres divisi; *alternis* ramulo intermedio in laciniis petaloideis ramosissimè diffuso; *calycinarum laciniarum* ramulis lateralibus brevissimè distinctis, arcuatis, cæterùm confluentibus. Cætera ut in ordine.

For numerous specimens, both in flower and fruit, of this curious species, we are indebted to our highly valued friend Alexander Caldcleugh, Esq. F. R. S. & F. L. S. whose zeal in the cause of science is known and appreciated. He discovered it in the neighbourhood of Coquimbo in Chili, together with many other new and equally interesting plants, a complete collection of which he has transmitted to Mr Lambert. It may possibly prove to be the same with the plant of Cavanilles above quoted, notwithstanding the discrepancies in the description and figure; but, as I have never seen specimens of it to compare, I dare not venture to affirm them to be identical.

Account of a Gelatinous Quartz or Siliceous Sinter, which forms the basis of varieties of Old Red Sandstone. By M. T. Guillemin.

As this interesting mineral occurs in some of the sandstone of this country, we have drawn up the following account from a memoir of Guillemin, published in the Annales des Mines for 1826.

External Characters.—This mineral is of a pretty pure white colour, which, in some varieties, passes into greyish or yellowish white; it has a resinous or semiresinous lustre, and passes into dull; it presents itself in irregular masses; its fracture is sometimes conchoidal, sometimes subconchoidal or even; it is scarcely translucid on the edges; when dull, it is opaque; it scratches glass with difficulty, and is scratched by steel; it is easily frangible; it adheres to the tongue, and is capable of absorbing a large quantity of water; its specific gravity varies according to the quantity of liquid which it contains.

When immersed in distilled water, gaseous bubbles are speedily disengaged, which rise after one another; and, at very short intervals, a whizzing noise is emitted, and from time to time cracks are heard; a fissure then forms, and gives rise to a new column of bubbles. At the end of twelves hours, there are still bubbles escaping; after eighteen hours the absorption appears complete. If boiling water be used, the disengagement is much more rapid, and by means of it bubbles are still made to rise from a fragment that has been immersed in cold water for several hours, and which appears saturated. A fragment of about five grammes weight, already containing 11.11 per cent. of water, according to a trial made at the moment, still absorbed 14.36, in all 25.47 per cent. at the temperature of six degrees of the centigrade thermometer. A hundred parts of this substance, therefore, saturated with water, contain 20.30. Another fragment of about 10 grammes, dried before immersion, absorbed 24.51 per cent. of water at zero, or about a fourth of its weight, as in the preceding experiment.

These specimens, left to themselves for two or three hours, returned to their original state, that is to say, came to contain only 11 or 12 per cent. of water.

The density of a fragment saturated with water was 1.80 at $6\frac{1}{2}$ degrees, 1.812 at 6 degrees, 1.797 at 13 degrees; that of a fragment containing 0.111 of water, 1.67 at 2 degrees; and that of a dried fragment 1.53 at 5 degrees. In the two last experiments, the absorption of water, and the disengagement of gases were prevented, by covering the surface of the fragments with a thin coat of olive oil. Lastly, the density of this substance, when weighed dry out of the water, and under the water, after an absorption of eighteen hours, was found to be 2.215 at 13 degrees of the centigrade thermometer.

Chemical Characters.—Exposed to the heat of a lamp in a small matrass, this mineral affords water; gently heated in a platina crucible, it gives out all its water without losing its resinous lustre; it becomes a little more translucent, with a tint of yellow opaline colour; when quickly heated, it decrepitates, splits, whitens, and becomes opaque by the intrusion of the air into the fissures which are formed.

It is infusible before the blowpipe. The thinnest splinters, when strongly heated, become transparent, and assume the vitreous lustre and hardness of hyaline quartz. It is affected, like pure silica, with all the chemical agents. Caustic potash in concentrated solution very readily attacks it at a boiling heat; it is dissolved almost instantaneously. Muriatic acid precipitates it in large white gelatinous flakes, when the liquor is concentrated; and, on the contrary, when a sufficient quantity of water is used, a precipitate is not immediately obtained, and by evaporation a transparent jelly is procured.

Analysis.—The water is not combined in this siliceous substance. I thought, at first, that it was; having been deceived by the difficulty of chasing the last portions of this fluid, which is experienced when the heat of boiling water only is employed; but, I found, that, by a prolonged desiccation, the water always diminished, and at length was entirely expelled. The results of its analysis are the following:

$$\left.\begin{array}{lr} \text{Silica,} \quad - & 97.70 \\ \text{Alumina,} & 2.30 \end{array}\right\} 100$$

It contains no lime, nor have the oxides of iron or of manganese been detected in it. I have in vain searched for alkalies by means of carbonate of lead.

Observations.—This siliceous substance differs from the quartzes and flints in many of its characters, and especially in the density, which, in these minerals, is about 2.65; but it has a great resemblance to the siliceous sinter (*Quartz concretionné thermogène* of Haüy). Both have the same lustre, the same hardness, the some fracture. The density differs but little; Klaproth found that of the thermogenous quartz to be 1.807. These two minerals appear to be a siliceous jelly scarcely consolidated; they are both equally soluble in potash, and they have both the property of retaining water, and the power of absorbing a new dose of it. The difference which exists between these two substances is the manner in which they appear in nature. The siliceous sinter or thermogenous quartz is almost always in stalactites or concretions in the neighbourhood of hot springs, particularly those of the Geysers in Iceland. A subspecies occurs in the island of Ischia, upon a decomposed granite, and is considered as a volcanic production *. The position of the gelatinous quartz is different.

Geognostical and geographical positions.—It occurs in the Commune of Tortezais, in the Department of the Allier, and is very abundantly diffused there, sometimes serving as a cement to sandstones, and sometimes occurring in the midst of these sandstones, in masses often of considerable size. On the route from Noyant to Cosne, between Bussière and Tortezais, one of these masses is seen intersecting the road for a length of 30 metres, and recurring on each side in the fields in detached pieces over a great extent.

It is fissured in various directions, without any appearance of regularity. The surfaces exposed to the air are always more or less altered, and pass into floatstone (nectic quartz) I have not been able to meet with it in the form of concretions. If this

* Vide Jameson's System of Mineralogy, and Manual of Mineralogy.

substance has been deposited by hot springs, they must have been very large and very numerous, and it would be astonishing should no remains of them be still visible. None of those which I saw were either saline, or warm, or incrusting. The nearest warm spring is that of Bourbon l'Archambault, and it does not form siliceous deposits.

The sandstones which contain this gelatinous quartz must have been deposited at the same time with itself, for they are intimately mixed. The gelatinous part always contains rounded grains of quartz, and it is rare that the sandstones have not this jelly, which serves as a cement to it, although it is only in small quantity; and there is a transition from the one to the other by a change in the proportions of the rounded grains, and of the dissolved portion.

The variety of sandstone which abounds most in gelatinous silica, is formed of grains of hyaline and milk-white quartz, rounded, and of a small size; some grains of opal also are seen in it, but there is no felspar or kaolin. When the silica is in the nectic state, it is difficult to determine whether there be kaolin or not, from the mutual resemblance which these two white and friable substances possess. Another variety of sandstone, is, in a great measure, formed of grains of hyaline quartz; some scales of mica and spots of red oxides of iron are also perceived in it. The red spots are seen to increase in size and number; they are formed of a siliceous paste, coloured with tritoxide of iron. The red colour at length predominates, and the mass becomes entirely of that tint; a multitude of small grains of quartz and of gelatinous spots are, however, seen in it.

These sandstones are supported by conglomerates composed of blocks of quartz, granite and micaslate. These conglomerates rest immediately upon the primitive formations. Above the red-sandstones there occur strata of sandstone and bituminous slate, with impressions of ferns and junci, containing beds of black coal and iron-ore. They have the same direction and inclination as the coal-sandstones which they support. No rock of volcanic origin is found in all these formations. It is, therefore, in an intermediate deposit, which might be referred to the old red-sandstone, or the lower beds of a coal-formation, that this gelatinous silica occurs. This position is very different from that of the thermogenous quartz of the islands of Iceland and Ischia.—*Annales des Mines* 1826.

Experiments to compare the specific Heat of Air, under a constant volume, with its specific Heat under a constant pressure. By Mr Henry Meikle. (Communicated by the Author.)

It has been long known, that gaseous bodies emit heat when compressed, and absorb it when dilated,—a property, by the by, which is not easily reconcileable with the creed of those who suppose heat to be mere motion. Little, however, was ascertained, for a considerable time, regarding the amount of the change of temperature accompanying a given change of density. The earliest experiments to determine this question seem to have been those of Professor Leslie. Mr Dalton and M. Gay Lussac have also engaged in the same inquiry *. As the heat evolved or absorbed by a change of density, depends on the difference between the specific heat under a constant pressure, and that under a constant volume, if we could find the ratio of these quantities, we should be enabled to determine their relation to the heat evolved or absorbed, and from this the change of temperature, and conversely. From certain experiments of MM. Delaroche and Berard, the Marquis de Laplace instituted some calculations †, which happened to come nearer the point than could have been expected; for these experiments were not at all suited to the purpose; and it is the more remarkable, that they should

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* According to the experiments of this last author, tinder or amadou is inflamed by the sudden compression of air into one-fifth of its bulk. Some have even questioned the fact, and others conjecture, that combustion commences at lower temperatures, as the air is denser. But may we not suppose, with more probability, that the pressure on the tinder, being suddenly augmented in an almost nine-fold ratio, should elicit much heat from this compressible substance itself? So that, till something else be known on the subject, we need neither doubt the fact, nor believe that a fivefold compression of air would of itself generate an inflammatory temperature. The melting of fine wires, or thin metallic leaves, would afford a surer test of the temperature in compressed air, than the kindling of soft spongy bodies.

† Annales de Chimie et de Phys. iii. 238.

have been used as the basis of such calculations, considering that, at as early a period (1812), MM. Desormes and Clement, had, with a very different view, made some better-contrived experiments, from which an approach to the true quantity could have been made with more certainty. Their method was very simple, and required no thermometer to shew the variations of temperature,—a contrivance which is said to have been first suggested by Lambert. No notice, however, seems to have been taken of these latter experiments,—probably because they were associated with a most fanciful inquiry after the absolute zero, till MM. Gay Lussac and Welter undertook a similar and more extensive series of experiments, giving nearly the same results. Of both of these and the inconsistent conclusions deduced from them by MM. Laplace and Poisson, I have had occasion to speak in the first volume of this Journal, where I have shewn that, whatever be the ratio of the specific heat of air under a constant pressure, to its specific heat under a constant volume; if that ratio only be constant, the variations of the quantity of heat in a mass of air must be uniform, while those of its volume, under a constant pressure, form a geometrical progression; and it is remarkable, that our first-rate authorities on the subject, who admit the *constancy* of this ratio, did not see that it was directly at variance with the commonly received theory of the air-thermometer.

But, although the value of the ratio referred to have nothing to do with the true law of temperature, yet its exact determination would be of great moment in various researches. Considerable deference is due to the experiments of the illustrious philosophers above mentioned. They were well calculated for shewing that the ratio of the specific heats is constant; because, supposing any inaccuracy to attach to them, it would be common to all the cases. But I had always some doubt whether their apparatus was the most eligible for determining the exact value of that ratio. The apparatus mostly employed consisted principally of a glass balloon, to the neck of which was fitted a brass cap and stop-cock. From the side of the cap, proceeded a horizontal pipe, communicating with a vertical glass tube, terminating in some light liquid to act the part of a very sensible gauge or measure of the variations of pressure. The same horizontal tube could be connected with a pump or condenser, for the purpose of rarifying or condensing the included air at pleasure.

Things being thus prepared, a slight change was effected in the density of the included air; and, after waiting a little till the former temperature was regained, the stop-cock was opened, and great care taken just to have it shut again by the very nick of time that the liquid within the gauge-tube had acquired the level of the outside, it being supposed that this was a proof that, at that instant, the included air had exactly regained the atmospheric pressure. A small interval being again allowed to restore the former temperature, the column of liquid in the gauge now shewed the change of pressure due to the last variation of temperature.

In this mode of operating, there is some ground for suspecting two sources of error, but which fortunately would be opposed to each other. In the first place, the air would take a sensible time to pass through a moderately sized stop-cock; and, during that interval, a considerable portion of the change of heat due to the change of density, would be lost on the sides of the vessel; especially considering how quickly heat might be communicated between air in its then agitated state, and a vitreous surface. On the other hand, the liquid in the gauge-tube might have acquired a force from its motion capable of carrying it to the common level of the cistern, before the spring of the air within had come into equilibrio with the atmosphere. If so, it is evident that, in the above arrangement, the stop-cock has been shut before that equilibrium was attained; and which shutting would, therefore, have been too soon, were it not that it happens nearly to be balanced by the other source of fallacy. To illustrate the second case, let one end of a glass-tube be stopped with the finger, and then let the other be immersed vertically in a jar of water. On removing the finger, the water, which had been depressed by the included air, will start considerably above the common level; so that, were the finger only partially removed, and suddenly re-applied to shut the tube again, at such a nick of time that the water within did not spring higher than the common level, it is clear that the force of the included air must still have exceeded the atmospheric pressure; and that it was this excess which prevented the liquor from rising to the same height as before.

With the view of making similar experiments, which should be in a great measure free from such objections, I had an apparatus fitted up on purpose. It consists of a large flask, made of strong tinned iron, and capable of containing 2300 cubic inches of air. The neck is of brass, about two inches wide; and into this was fitted by grinding a brass stopper, hollow and open inward. At equal distances from each other, four apertures were cut through the sides of the neck and of the stopper. Each is 1.2 inch long and 0.6 broad; so that these together can form a communication between the atmosphere and included air, equal to 2.88 square inches, or the opening of fourteen half inch stop-cocks, and which communication can be both opened and shut by simply turning the stopper one-fourth round,—an operation which requires but a very small moment of time.

Near the neck, a tube branches out, and joins a vertical glass tube, which, terminating in some light liquid, forms the same sort of gauge as in the apparatus first alluded to; and, on the opposite side, is an aperture for attaching a pump or condenser to change the density of the included air. The air-vessel is inclosed in another, both for the purpose of keeping the temperature steady, and also for applying a bath to maintain any temperature required. But, during tempestuous weather, or when the barometer is very unsteady, no experiments can be made with such apparatus.

As a preliminary step in the use of this instrument, it is necessary to ascertain at what rate we should turn the stopper, in order that the included air, when its pressure has been previously changed from that of the atmosphere by about 0.4 inch of mercury, may have a sufficient opportunity of regaining the external pressure. To determine this, the following method was employed: Having injected air till the increase of pressure, when the temperature had settled, was indicated by a depressed column of water of about six inches, I turned the stopper one-fourth round, by which it was both opened and shut. During this operation, I noted how far the previously depressed water in the gauge tube started above the common level. The same operation was repeated, with the difference of only turning the stopper one-eighth round, so as to leave its apertures completely open; and, on observing the gauge, it just sprung to the same height as before. Repeated trials satisfied me, that, with such small variations of density, it would require considerable haste to turn the stopper too quickly. In both of the cases just mentioned, the range through which the stopper turned was limited by a catch. But in the experiments to be afterwards noticed, I generally used a lighter fluid than water.

It is evident, that, instead of injecting air, as I usually did, to increase the pressure above that of the atmosphere, it would come to the same thing, if we first close the large vessel at a temperature a few degrees below that at which we wish to operate, and then raise it to the temperature which is to remain constant during the experiment. This consideration affords, perhaps, the simplest means of explaining the rationale, or use of this sort of experiments. For, let the pressure of the air when just shut in, be in equilibrio with the atmosphere, but suppose that the temperature of the apparatus is next raised, so as to increase the pressure and depress the liquor in the gauge b inches, which we may call b degrees; then, if, whilst this augmented temperature of the apparatus remains constant, the stopper be turned one-fourth round, as above described, the equilibrium with the atmosphere will be for a moment restored, the communication with it again cut off, and the included air cooled by the dilatation, but it will soon absorb heat, and recover the former temperature, as will be indicated by a second depression of c inches or degrees. This is obviously the change of temperature due to the excess of the quantity of heat, which would raise the temperature b degrees, under a constant pressure, above what raises it b degrees under a constant volume.

From this it would follow, that the quantity of heat which raises the temperature b degrees under a constant volume, would only raise it $b—c$ degrees under a constant pressure; or, that the specific heat in the first case is to that in the second as $b—c$ to b.

Strictly speaking, neither the volume during the first increase of temperature nor that during the second is constant, because the depression of the liquor in the gauge tube makes a little more room for the air. This, to be sure, could be obviated by using a tall jar, and pouring in more liquor till that in the gauge reached its former level. However, it is easier and more accurate in practice, to overlook those increments of volume, because they will be proportional to the depressions themselves, and therefore, the ratio of these depressions, which gives the thing wanted, is not altered by this circumstance. For the same reason, it is better to neglect any change in the height of the liquid in the cistern, and only to observe its height when the air-vessel is open.

As an error might have been introduced by allowing the liquid in the tube to spring up and displace a portion of the air it contained, or at least to render the volume uncertain by its undulations, a cork was struck in it, immediately above the common level. It was not so tight as to prevent the passage of air, but it operated as a sufficient check to the rise of the denser fluid. Every other precaution I could think of was attended to, and the mean of many experiments with this apparatus gave the ratio of the specific heat of air under a constant volume, to that under a constant pressure, as 1 to 1.334, which is so nearly as 3 to 4, that I am inclined to consider this the true value. However, I intend to repeat these experiments, and to prove them by a different process.

The ratio of 3 to 4 does not completely bear out the amendment proposed on the Newtonian theory of sound, by the Marquis La Place. But a complete theory ought to account for the almost absolute control which wind exercises over the *intensity* of sound. I have often thought that both the intensity and the excess in the experimental over the theoretical velocity, are connected with the reaction of the earth's surface. As an illustration of this, sound is well known to be rendered more intense, by passing along the face of a wall or precipice; and very likely it is at same time accelerated.

From the experiments of MM. Desormes and Clement, the ratio of the specific heat of air under a constant volume, is to that under a constant pressure, as 1 to 1.354; and from those of MM. Gay Lussac and Welter as 1 to 1.375. The fractional part of both approaches to $\frac{1}{3}$, and Mr Ivory has adopted this, and suggested a reason why it should be the true value *. By

* Phil. Mag. lxvi. 9.

adopting the fraction $\frac{1}{3}$, Mr Ivory obtains the following equation,

$$\frac{1+a\tau+ai}{1+a\tau}=\varrho^{\frac{1}{3}}\text{; or, } i=\frac{1+a\tau}{a}\left(\varrho^{\frac{1}{3}}-1\right).$$

Where τ is the initial temperature, a a constant, and i the change of temperature, produced by changing the density from unit to ϱ. That this is the true value of i, considered as proportional to the change in the quantity of heat, Mr Ivory thinks pretty certain; because he supposes a consequence of it to be, "that, when air contracts or enlarges its dimensions, the heat disengaged or absorbed follows the proportion in which the linear distance of the particles is lessened or augmented,"—an opinion which he thinks so probable, that it should not be rejected till the contrary be placed beyond all doubt.

Now, although my experiments are favourable to Mr Ivory's conjecture regarding the value of this ratio, yet I cannot acquiesce in the *reason* which that able mathematician has given for fixing on that quantity. I shall not enlarge on its incompatibility with the law of temperature which I formerly laid down; but that it may not be urged as an argument against that law, I shall, with every deference to Mr Ivory, shew that his view of this part of the subject is otherwise untenable; because it involves a mistake, in that he has inadvertently taken the linear distance of the particles of a mass of air as proportional to the cube root of the *density*, in place of the cube root of the *volume*. For it is obvious, that $\varrho^{\frac{1}{3}}$ is not proportional to the linear distance of the particles, but to its reciprocal; and whilst τ is the same, i varies as $\varrho^{\frac{1}{3}}-1$, that is, as the difference of the *reciprocals* of the linear distances at the beginning and end of the change of density; so that neither the heat of combination nor the quantity i follows the variation of the linear distance of the particles. For, as we formerly saw, the first follows the variation of the logarithm of the volume or cube of the linear distance.

The following is a different mode of estimating the ratio of the specific heats, by using great changes of density.

Let the density of the external air $= e$, and suppose the air in a close vessel to be rarified till its mass or density $= r$; and that when it has acquired the common temperature, a communication with the atmosphere is opened, restoring the external pressure, whereby the density within is increased from r to m. The density of the air which has re-entered will thus be diminished from e to m, and its mass will be $m - r$.

Now, from what was formerly shewn of the air-thermometer, the heat evolved by the compression of the rarified mass r, will be to that absorbed by the dilatation of the re-entered mass $m - r$, as $r \log \frac{m}{r}$ to $-(m - r) \log \frac{m}{e}$. Their difference or $\log \left\{ \left(\frac{m}{e}\right)^m \left(\frac{e}{r}\right)^r \right\}$ may therefore represent the change of temperature by the true scale, or the heat evolved by a mass of air $= 1$, when its density is increased from unit to $\left(\frac{m}{e}\right)^m \left(\frac{e}{r}\right)^r$. But the mixed mass is m, and, therefore, the rise in its temperature on the same scale, is $\frac{1}{m} \log \left\{ \left(\frac{m}{e}\right)^m \left(\frac{e}{r}\right)^r \right\} = \log \left\{ \frac{m}{e} \left(\frac{e}{r}\right)^{\frac{r}{m}} \right\}$.

Hence, i the rise of temperature in the mass m, reckoned on the common scale, is equal to what any mass of air at the temperature τ would undergo by increasing its density from unit to $\frac{m}{e} \left(\frac{e}{r}\right)^{\frac{r}{m}} = \varrho$. Wherefore, if the specific heat of air under a constant volume, be to that under a constant pressure, in the constant ratio of 1 to $1 + x$, we have $i = \frac{1 + a\tau}{a} \left(\varrho^x - 1\right) = \frac{1 + a\tau}{a} \left(\frac{e}{m} - 1\right)$, from the law of Boyle. Hence, $\varrho^x = \frac{e}{m}$, and

$$x = \frac{\log \frac{e}{m}}{\log \varrho}.$$

To find the value of r when the surplus heat, or $\log \left\{ \frac{m}{e} \left(\frac{e}{r}\right)^{\frac{r}{m}} \right\} = \frac{1}{x} \log \frac{e}{m}$, is a maximum, we have

$d \log \left\{ \frac{m}{e} \left(\frac{e}{r} \right)^{\frac{r}{m}} \right\} = - \frac{d\,m}{x\,m} = o.$ Hence, $d\,m = o$, and, therefore, $\log \frac{e}{r}\,d\,r - d\,r = o$; or hyp-log $\frac{e}{r} = 1$, and $r = \frac{e}{2.71828}$. This value of r is independent of x. When r and x are given, m may in every case be found, from the above formulæ, or from

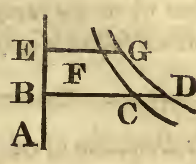
$$m \log \frac{m}{e} = \frac{x\,r}{1 + x} \log \frac{r}{e}.$$

If $x = \frac{1}{3}$, and $r = \frac{e}{2.71828}$, then $m = .903184\ e$. Every value of m, but its minimum, answers to two different values of r. For instance, $r = \frac{1}{2}\,e$ should give the same value to m as $r = \frac{1}{4}\,e$. If three-fourths of the air be extracted from a close vessel, and, after the temperature has settled, one-fourth be instantly restored, no change of temperature should ensue.

The law of temperature admits of a somewhat simpler investigation than was formerly given. Let t be the temperature, or rather the indication on the common scale of an air-thermometer, p the pressure, and ϱ the density of the mass of air; then a and b being constants, we have, as before, from the law of Boyle, $p = b\,\varrho\,(1 + a\,t)$. Now, the specific heat under a constant pressure being to that under a constant volume, in the inverse ratio of the variations of temperature produced in these two different cases by equal variations in the quantities of heat, the following expressions respectively contain all the variables which enter into these specific heats, relatively to the ordinary graduation.

$$\frac{1}{d\,t} = - \frac{1}{d\,\varrho} \cdot \frac{a\,\varrho}{1 + a\,t}, \text{ and } \frac{1}{d'\,t} = \frac{1}{d\,p} \cdot \frac{a\,p}{1 + a\,t}$$

which are obtained from the above equation, by making p and ϱ respectively to vary with t, whilst the other is constant. The variations of the quantities of heat being constant, and, as mentioned above, the same in both terms, are omitted, as also the constant linear degree of the common scale.



Let the temperature be reckoned on AB, as on the common scale of an air-thermometer commencing at A or — 448° F; and let CF be a line of such a nature, that every ordinate as BC, EF, &c. may be proportional to the specific heat of air under a constant volume, at the respective temperatures B, E, &c. So that the intercepted areas will denote the corresponding variations in the quantity of heat under a constant volume. But if the specific heat of air under a constant pressure exceed that under a constant volume, in the constant ratio of K to 1, and if these ordinates be every where increased in that ratio, another line GD, passing through their extremities, must be of the same nature with CF, and the intercepted areas to the former as K to 1.

Again, let the specific heat of a mass of air under a constant pressure be BD × 1°; and let its temperature be raised from B to E under the same pressure; then the area BDGE will denote the increase of heat, and EG × 1 the specific heat under a constant pressure at the temperature E. Now EG : EF : : K : 1, wherefore EF × 1° is the specific heat of the dilated mass at the temperature E, under a constant volume. But EF × 1° would still have been the specific heat, had the air under its original volume been raised to the temperature E; and because EF : EG : : 1 : K, its specific heat at the temperature E under a constant pressure would have been EG × 1°, as before. Hence, the constant ratio of the specific heats renders them independent of the actual density or pressure, and, therefore $\frac{\varrho}{d\varrho}$ and $\frac{p}{dp}$ are constant quantities. It thus appears, that the above expressions for the specific heats answering to a degree on the common scale, vary inversely as $1 + a\,t$; or, that any ordinate BD, or BC is inversely as AB, which is the well known property of the hyperbola; and, therefore, CF and DG are both hyperbolas, having A for their centre, and AE for an asymptote. We have, then, without going through the process of integrating a partial differential equation, arrived at the same construction as was used on page 337, vol. i., and which represents the relation between the common and true scales of temperature, viz. that when the variations on the latter are uniform, those on the former follow a geometrical progression.

On the Detection of Arsenic in cases of Poisoning. By J. L. Berzelius.

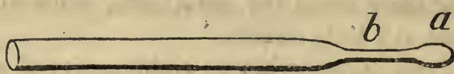
In cases of poisoning with arsenic, the individual may have taken the deadly poison either in the pulverulent form, or in a state of solution. In the first case, we can almost always detect visible particles of arsenic in the contents of the stomach, or on the inner coat of the stomach, where they are distinguished by dark red spots, on which they are to be looked for. The nature of these particles, although much under the one-tenth of a grain in weight, may be ascertained with great care and perfect certainty by the process or test of reduction. The following method I employ in the use of this test:—A glass tube, from one-tenth to one-seventh of an inch in diameter, is drawn out, at one extremity, into a fine point, from two to three inches in length, which ought not to be wider internally than the thickness of a coarse knitting needle, and is then hermetically closed at the extremity.

The particle of arsenic (even the one-hundredth part of a grain in weight is more than is necessary), is moved upwards to *a*, and covered with charcoal powder, which has been previously exposed to the flame of the blowpipe, to drive off any moisture it might contain, to *b*. The tube is then brought, in a horizontal position, into the flame of a spirit of wine lamp; and in such a way, that *a*, where the grain of arsenic lies, remains beyond the flame. As soon as the charcoal at *b* is heated to redness, *a* is brought into the flame, by which the arsenious acid is converted into gas; and, during its passage through the glowing charcoal, is reduced. The metallic arsenic is condensed in the small tube, at the line where it is beyond the flame, in the shape of a shining, dark metallic ring, which, by gentle heating, can be driven farther forward; and thus more is accumulated, by which it acquires a higher lustre. The small diameter of the tube prevents all circulation of air, so that no part of the metal is reduced. It only remains to determine the arsenic by its smell. This is effected, if we cut the tube between the charcoal and the metal, then heat it gently in the place where the metal rests, while we hold our nose over it but at a little distance.

The second case occurs, when no visible grains of arsenic are present, as in those instances where death has been caused either by solution of arsenic, or by finely pounded arsenious acid. When the poisoning has been caused by the solution of arsenic, it is often impossible to detect the arsenic, because the solution has been carried off before death. If, however, some portion of it still remains, it is discovered by heating the contents of the stomach, at a boiling heat, with caustic potash, and then with muriatic acid. The filtered fluid is reduced, by evaporation, to a smaller volume; and, if necessary, again filtered, and then a stream of sulphuretted hydrogen passed through it. The fluid is now heated, to cause the precipitate to collect, or evaporated, if it does not subside until it does, and then filtered *. If the quantity of precipitate is so small that it cannot be mechanically removed from the filter, it must be removed from the paper by means of caustic ammonia, and the fluid evaporated in a watch-glass. The sulphuret of arsenic can be oxidized in two ways: either it is dissolved in a little aqua regia, until all the arsenic is converted into arsenic acid, the fluid freed from sulphur, dried by a gentle heat, then the residuum dissolved in a drop of water, and supersaturated with lime-water: Or, better, we mix the sulphuret of arsenic with saltpetre and deflagrate the mixture at the end of a hermetically sealed glass-tube. We first melt a little saltpetre in the tube, and then gradually

* If the quantity of arsenic is very small, the fluid becomes yellow, without precipitation; but if it is then evaporated, the sulphuret of arsenic falls in proportion as the acid concentrates during evaporation. If the fluid becomes yellow, without any precipitation of sulphuret of arsenic, during the evaporation, it cannot be considered as a sign of the presence of arsenic. This colour almost always occurs when the fluid contains nitric acid, which reduced to the state of nitrous acid, colours the dissolved animal substances yellow.

drop into it small portions of the mixture, which burn without deflagrating, when too little saltpetre is not used. The mass is dissolved in some drops, or in as small a quantity of water as possible, then lime-water added in excess, and heated to boiling, by which the arseniate of lime is more easily collected and washed. The precipitate is collected, mixed with fresh burned charcoal powder, and put into a glass tube of the following form;



so that the mixture comes to lie at *a*. The tube is first gently heated to drive off any moisture the mixture may have absorbed, and then the under part of *a* is kept in the flame of the blowpipe until the glass begins to melt. The arsenic is now reduced and collected in the neck *b*, where it is spread over so small a surface that the smallest quantity may be detected. One-tenth of a grain of sulphuret of arsenic is sufficient to afford a satisfactory and decisive reduction test. Even the arseniate of lime, which is obtained from one-sixth part of a grain of sulphuret of arsenic, can, if carefully collected, serve for three different reduction tests *.

In using these delicate tests, we must be sure that our reagents contain no arsenic. All the sulphuric acid which is not obtained from volcanic sulphur, but either from the sulphur from iron-pyrites, or immediately from iron-pyrites, contains arsenic, and affords, when it dissolves zinc or iron, an arseniuretted hydrogen gas. If the same acid is used in the preparation of sulphuretted hydrogen gas, we have to dread a mixture of arseniuretted hydrogen gas with the sulphuretted hydrogen gas, by

* The following more simple mode of obtaining metallic arsenic from sulphuret of arsenic has been lately proposed by Berzelius. A very small portion of sulphuret of arsenic is introduced into a tube, like that on page 338, and brought up to *a*. Then a piece of steel piano-forte wire (No. 11.), an inch in length, is inserted into the tube, so far as the surface of the sulphuret. The steel-wire is next to be heated in a spirit of wine lamp, and the heat gradually raised in such a manner that the sulphuret, in the state of vapour, passes along the surface of the glowing iron. In this way, sulphuret of iron, and sublimed metallic arsenic, are obtained. The operation ought to be conducted slowly. Shavings of iron will not answer, because the arsenic combines with them, without any sublimation.

which the precipitation of an arseniated sulphur may take place, because the hydrogen of both in the test-fluids becomes oxidized by means of the air. The muriatic acid obtained by means of such a sulphuric acid contains also arsenic. We must therefore use, in such experiments, distilled sulphuric acid, but not until we have previously tested it by means of sulphuretted hydrogen for arsenic. The same applies to the muriatic acid used in such experiments. In all cases of this kind we cannot use too much caution.

The reduction-test is the only certain one, and it renders all others superfluous. If this does not succeed, the result is always unsatisfactory. Even the garlick arsenical smell so much depended on, is not to be trusted without actual reduction, as such a smell is sometimes evolved from the animal matter from the stomach. We may conclude by remarking, that no chemist or medical man can conscientiously and legally appear in a public court, as an evidence in such a case, without he has actually himself taken the contents from the stomach, or has had them sent to him, under proper seals, by a trust-worthy medical man, who declares on oath that he has taken the same from the stomach *.

On a Chemical Composition of Zinkenite and Jamesonite. By H. Rose, Member of the Royal Academy of Berlin. And *Description and Analysis of Pyrochlore, a new Mineral.* By F. Wöhler.

I. *On the Chemical composition of Zinkenite and Jamesonite.*

The Zinkenite, in its chemical composition, approaches more nearly to Jamesonite and red silver, than to any other minerals. I found it to contain the following constituent parts : Sulphur

* From the great delicacy of the reduction-test, it is evident that extremely minute portions of arsenic may be detected. This being the case, the court is entitled to demand of the chemist or medical man, on examination, whether or not he can prove that the articles of food, used by the deceased, did not contain minute portions of arsenic. Bread, for instance, is sometimes adulterated with alum ; alum is prepared, at times, from aluminous rocks, containing iron-pyrites ; and iron-pyrites, as mentioned by Berzelius, contains arsenic. This view might be farther illustrated.—Ed.

† In the third analysis, the quantity of sulphur could not be determined.

22.58, lead 31.34, antimony 44.39, copper 0.42 = 99.23. The Jamesonite, like the zinkenite, consists principally of sulphate of antimony and sulphate of lead, but in different proportions. Three analyses of Jamesonite afforded the following results :

	First.	*Second.*	*Third.*
Sulphur, - -	22.15	22.53	
Lead, - -	40.75	38.71	40.35
Lead, with traces of iron and zinc,		0.74	
Copper, - -	0.13	0.19	0.21
Iron, - -	2.30	2.65	2.96
Antimony, - -	34.40	34.90	34.47†

34.40 parts of antimony in the first analysis, combined with 12.87 parts of sulphur, to form the sulphuret of antimony, and 40.75 parts of lead, with 6.33 parts of sulphur, to form sulphuret of lead. The excess of sulphur, 2.95 parts, is nearly sufficient to form, with the iron, sulphuret of iron. Although the quantity of sulphuret of iron in Jamesonite is considerable, I still consider it as accidental, because neither iron nor lead, in the oxidated or sulphuretted state, combine together; the crystallised Fahlerz, for example, in which sulphuret of iron occurs, never contains sulphuret of lead, even when the tetrahedrons of Fahlerz are imbedded in lead-glance. The true composition of Jamesonite may be expressed by the formula $3Pb\,S^a + 4Sb\,S^a$; the sulphuret of antimony in it containing double the quantity of sulphur, as the sulphuret of lead.

II. *On Pyrochlore, a new mineral species.*

Pyrochlore occurs in the neighbourhood of Friederichschwärn in Norway, in zircon-syenite, where it was first found by Dr Tank. Dr Wöhler, during his journey with Berzelius and Brongniart, met with this mineral near to Laurvig, in veins in zircon-syenite. Berzelius proposes to name it *Pyrochlore*, in order to distinguish it from *Polymignite*, which, before the blowpipe, retains its black colour, while the pyrochlore becomes yellow. Its colour is reddish-brown, like brown titanite, and on the fresh fracture appears almost black :—in thin splinters, is translucent; in thicker pieces opaque. It crystallises in regular octahedrons. It is generally imbedded in felspar, sometimes in Elaolite. Its specific gravity = 4.206 — 4.216,—*Rose.* It scratches fluor-spar, but is scratched by felspar. Its streak is brown. The fracture is conchoidal, without any trace of cleavage. The surface of the crystal is shining and smooth, but the fracture surface splendent; and lustre between vitreous and resinous. Its constituent parts are as follows: Titanic acid 62.75, lime 12.85, oxide of uranium 5.18, oxide of cerium 6.80, oxide of manganese 2.75, oxide of iron 2.16, oxide of zinc 0.61, water 4.20, fluoric acid, quantity not determined, magnesia a trace, = 97.30.

The Law of the Preservation of Species, illustrated by the Phenomena of the Seed of the Stipa pennata. By Mr John Macvicar, Lecturer on Natural History in St Andrew's. (With a Plate.) Communicated by the Author.

Although it cannot be said that the primary object of nature, in reference to a species, is to prevent its destruction, yet its existence is an essential condition to that end, whatever it may be, and accordingly, nowhere do we observe a more admirable mechanism, than in those organs which are most eminently conservative or reproductive. The general law by which their developement and efficiency are regulated, may perhaps be thus stated, that, *in proportion as the causes operating to destroy a species increase, so also do the organs or functions operating to preserve it.*

Thus, as we descend the scale of animated beings, the successive species become more and more restricted in their faculties, their cunning, or swiftness, or force, by which they may meet their enemies, the number of which is also increased, or in those resources by which they may survive the violent action of the elements, which beat upon their more minute and simple structures, as rudely, and as boisterously, as upon the more perfect animals. Their liability to destruction, then, becomes greater as we descend. But to counterbalance this, we find that, in obedience to the law which has been stated, the very degradation of their structures becomes subservient to their existence. For, by a collateral diminution of sympathies, the life of the individual becomes more independent of partial injuries, and a tenacity is imparted to it, which would even be ridiculous in the higher animals. Thus, it is very absurd to think of a man continuing to live after his head had been cut off; yet low in the scale, we find many species which, when decapitated, can serve themselves with new heads, as efficient as those of which they had been deprived, and scarcely differing from them, but in their paler complexion. Of this circumstance Mr Dalyel availed himself, in his very interesting investigation of the Planariæ. For when he wished to know how many eyes the Planaria nigra possessed, not being able to distinguish them on account of the black colour of the animal, he decapitated several, and was then able to count the eyes in the pale reproduced heads. As to legs, the amputation of one of which without surgical aid, would prove inevitably fatal to a man, there are many animals which seem to part with them without much inconvenience; while there are others (as the crabs), which, according to recent observations, seem to scorn the possession of a leg when injured, casting it triumphantly from them.

If we descend still farther among animals still more beset by enemies and accidents, we find species which really seem to be "immortal under the edge of the knife," which to cut in pieces, is only to give being to so many individuals as perfect as that which was attacked.

The action of the same admirable law is illustrated in the reproduction of the race. Thus in the most perfect animals, the species is divided into two groups, only one of which is capable of producing offspring. As we descend, this bisexual character is obliterated, and every individual, often without the presence of another, acquires this power. Still lower, not only do we find each animal provided with a specific apparatus for this purpose, but the same end accomplished in other ways also, as by gems and spontaneous division.

In the vegetable economy, which runs parallel to that of animals, we observe the same law to operate. Thus the oak, which cannot easily be destroyed, the individual life of which survives the sweep of many ages, can only be reared from an acorn; while the tender moss, which springs up among the turf beneath which its roots are spread, or the parasitic lichen on its trunk and branches, the lives of which are subject to a multitude of accidents; may be propagated both by sporules produced in proper seedvessels, by germs and otherwise.

But besides this beautiful law, the action of which may be distinctly recognised, preserving the species of organised beings in existence, notwithstanding the perpetual destruction which they wage against each other ; we are able to observe the traces of another no less beautiful, that, *in proportion as a species is useful in the economy of nature, so are the developement and efficiency of the organs and functions that effect its diffusion.*

This might be inferred *a priori*, from what we know of the attributes of the Creator, and the analogy of his works. This, however, is a mode of reasoning not admitted in Natural History, in which a law must only be framed, as a generalised statement of a number of observed phenomena, tending to a common purpose. But that such a law exists we observe many traces of evidence. Thus there is no tribe of plants more eminently useful in the economy of nature than the grasses, the foliage and seeds of which supply the first necessaries of life, not only to man but to a multitude of the inferior animals. And, perhaps, in no tribe equally highly organised, do we observe the same tenacity of life, or the same economy and care in the reproductive organs, to avoid the introduction of parts that might be easily injured, and so prevent a successful fructification.

In the grasses, the delicate coloured flower that gives so much beauty to most other tribes, is replaced by concave husks, which are not only most hardy, but so situated that the weather can scarcely penetrate to injure the essential organs within. Besides this, the peculiar structure of the embryo, which admits of a number of stems from one seed, might be mentioned, the copious albumen, &c. But I proceed to describe, and a few words will suffice, the beautiful structure of the awn exhibited in a species of this family, which effects the introduction of the seed into the soil so wonderfully, that I cannot satisfy myself with admiration.

The Stipa pennata is a most elegant species of grass, which, though not a native of Scotland, thrives luxuriantly in the open border. Its seed is closely invested by the glumaceous perianth, which consists of two husks, a larger and a smaller, the former of which overlaps the edges of the latter, and almost entirely envelopes it. Thus the strong outer covering of the seed is produced below into a very sharp rigid spine ; and terminated above by a long awn, which is articulated to its summit. Originating near the base, and proceeding up certain ridges on this the investing valve chiefly, are lines of stiff hairs pointing upwards. The awn, when fully developed, is about thirty times the length of the seed, or about fourteen inches. It is round, tapering and plumose, with the exception of about three inches at the base, which are compressed, longitudinally sulcated, and without hairs.

The seed, therefore, and its appendages, possess a structure such as is imitated in a barbed and feathered arrow, which is so well calculated to find its way into the ground in a vertical direction. Many seeds, however, possess a similar structure, and it is not this which gives to the awn of the stipa its most striking peculiarity. It is a change which takes place upon the awn, after it has left the plant that produced it. When it has fallen from the parent plant, it enters the soil vertically, and in a few hours the base and sulcated part of the awn becomes twisted, and the feathered portion becomes horizontal. In consequence of which, it is blown round by the autumn winds like a vane, and every turn screws it farther down into the earth ; for the hollows and ridges which, when it remained upon the plant, were only longitudinal sulci, have now given rise to the hollows and elevations, in a word, to the threads of a screw. Thus it is moved down, and whatever is gained, is prevented from being undone by a reverse motion of the vane, in consequence of the stiff hairs upon the glume which act as barbs.

When it has been thus worked down into the moist soil, into the situation most favourable for germinating, the attachment between the awn and seed is dissolved ; for having drawn up many when they were in this condition, I have invariably procured the awn only, and never, by any chance, the seed. Such appears to be the function of the "spiral articulated deciduous awn" of this interesting species *.

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* The seeds of the Stipæ often occasion great inconvenience and trouble to travellers, and even to the domestic cattle of the districts where they grow. This fact is well stated in the following notice by Mr Raspail.—Ed.

" *On the morbid accidents to which animals are exposed by the seeds of Stipa pennata and capillata.*—It is known that the husks of the genus Stipa terminate

The accompanying drawing represents the seed and its appendages, more or less magnified.

Explanation of the Figures in Plate I.

Fig. 6. The two valves of the glumaceous perianth, with the stiff hairs, the spine and articulated awn.

7. The grain, with part of the skin torn at the base, to shew the albumen, of which nearly the whole is composed, the cotyledon and the embryo.

8. The seed, with a fourth part of the awn, to shew its form when ready to separate from the spike.

9. The same, as it appears some hours after separation.

Account of the Observations and Experiments made on the Diurnal Variation and Intensity of the Magnetic Needle, by Captain Parry, Lieutenant Foster, and Lieutenant Ross, in Captain Parry's Third Voyage, with Remarks and Illustrations. By PETER BARLOW, F. R. S. Mem. of the Imperial Academy of St Petersburgh, &c. (With a Plate.) Communicated by the Author.

As the experiments referred to in the head of this article were performed under such extraordinary advantages of locality, of

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at the base in a reversed cone, which is very sharp, and covered with stiff hairs directed upwards, so that when the point penetrates into any substance, the hairs not only prevent it from coming out, but contribute to make it go deeper. M. Desfontaines, in his Flora Atlantica, and M. Lamarck in the Encyclopedie, have pointed out the inconveniences to which a seed so organised subjects travellers passing over the fields of Barbary, Greece, and Portugal, at the time of ripening of the stipas. The seed penetrates into their clothes, and sooner or latter disconveniences them in a high degree, by producing scratches of various depths upon the skin. A great mortality of the cattle, which took place in 1823, in the neighbourhood of the village of Berczel in Hungary, afforded an opportunity to the Professors of the Royal University of Pesth, of making known a still more singular effect produced by these seeds. It was found that the seeds of the stipas, which abound in the pasture grounds of Berczel, stuck to the wool of the sheep, penetrated into the skin, and even made their way to the internal organs. On dissecting a great number of these sheep, seeds were found in the vicinity of the liver and in the peritonæum, and the skin, examined between the eye and the light, had the appearance of a sort of riddle. As these grasses occur in all the south-instruments, and of observers, they cannot fail to be highly interesting to every one who has paid attention to this curious and important branch of natural philosophy. With regard to locality, no place could have been more admirably situated than Port Bowen, in latitude 73° 14′ N., longitude 88° 54′ W., with a dip of 88° 1′, and consequently within a very short distance of the magnetic pole, and yet sufficiently remote to leave to the needles a natural directive power, which they would in all probability have lost, had the approximation to the Pole been much greater. With regard to instruments, every thing that could be effected by the skill of the most distinguished artists in London, was liberally supplied to the expedition by the Government; and as observers, it is sufficient to mention only the names of Parry and Foster, as they cannot fail to inspire us with every possible confidence, both with respect to the accuracy of the observations, and to the most careful and unbiassed registry of the results. It is but fair, however, to state, that these two distinguished individuals alone, would not have been able, with all the zeal they are known to possess, to have obtained such a series of results as those to which we are now referring. It was necessary for this that they should be seconded by the cordial assistance and co-operation of the other officers of the expedition. This assistance was cheerfully given; and it is acknowledged in the most handsome and liberal terms by the authors of the memoir in which these experiments are recorded, and which has been recently published as a separate part of the Transactions of the Royal Society for 1826.

The experiments commenced about the 10th of December 1824, and were continued to the end of May 1825; and, when we consider that, for a considerable part of this time, the sun was below the horizon,—that the thermometer was sometimes 40° below zero,—that the place of observation, *a snow house*,

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ern parts of Europe, the above fact ought to fix the attention of the agriculturists of those countries. The stipæ do not furnish good fodder, and the meadows would lose nothing by their absence. If they could not be extirpated all at once, the flowers are surmounted by an awn upwards of a foot long, by which they might easily be plucked off, before detaching themselves spontaneously. Should a seed happen to have buried itself in the substance of the skin, it would require to be extracted by the ordinary means, for accidents of this kind are not to be remedied by a more complicated treatment."

was at a distance from the ships, in order that the needles should be out of the influence of the iron on board; and that, notwithstanding these obstacles, the needles were carefully watched, the experiments performed, and the results carefully registered every hour, and frequently oftener, during this whole period; we shall feel convinced, that more than common exertions were made, and more than usual interest must have been excited, in the pursuit of these curious and valuable experiments; and, if we add to this, that these energies and these means were employed in a situation where Nature has placed her great depot of magnetic powers, and where every phenomenon of this kind is exhibited on the grandest scale, we shall then, and not till then, sufficiently appreciate the value of these interesting and important results.

With this feeling, I have thought that a brief abstract of these experiments would be acceptable to many of the readers of the Edinburgh Journal, particularly to those who have not the opportunity of consulting the original memoir; and I have accordingly, in the following pages, endeavoured to convey within the least compass, a general view of the subject, and have ventured also upon one or two illustrations of some of the theoretical points touched upon by the authors of the papers in question.

The first of the magnetic articles is by Lieutenant Foster, from which it appears, that, previous to his leaving England, he had determined upon making a series of observations on the daily variation of the magnetic needle, when any opportunity offered of so doing; and the first occurred at Whale Fish Islands, during the time of trans-shipping the stores from the transport which had accompanied the expedition to that place. The time employed in these experiments was only three days, consequently the results are not so certain as we could wish; but it is satisfactory to find, that the few facts which were obtained agree remarkably well with each other, both as to quantity and to the time of the day when the variation was the greatest westerly,—the least westerly variation, or the maximum of easterly variation, occurred during the night, and was not observed. The greatest daily variation westerly was 23′, and this occurred at 1^h 10′ P. M., at which time the *sun was west by compass*, the mean variation being 70° 2′ W., and dip 82° 53′ W. The important remark, distinguished above by italics, seems to have been a strong incitement to Lieutenant Foster to prosecute the subject again on a larger scale the next favourable opportunity, which did not occur till the ships were laid up for the winter at Port Bowen. At this place, as we have already stated, the experiments were begun on the 10th of December 1824, on one needle only. In the course of this month, however, the varied phenomena which this one exhibited, while every thing besides appeared to partake of the stillness and monotony of this dreary region where it was posited, excited that degree of interest amongst the officers of the expedition which we have endeavoured to describe; and with the new year commenced a much more extended series of experiments on the daily variation, the variation of intensity, and, in fact, of the whole series of which it is intended to give a general outline in the subsequent pages.

The detail of the daily variation experiments forms the second of these articles. After describing the needles employed, marked No. 1. and 2., and a third, employed exclusively for determining the changes of intensity; and also acknowledging the assistance of Lieutenants Sherer, Ross, Messrs Crozier, Richards, and Head, as also that of Mr Hooper for the delineation of a very accurate diagram*, offering a graphical exhibition of the several changes; the authors proceed to take a sort of general review of their results, as follows:

"Soon after the observations were commenced, it was ascertained that, twice in every four and twenty hours, the needles moved past a certain point, which may be denominated the zero, or mean magnetic meridian; a fact which was first rendered clearly apparent from the accompanying diagrams, already mentioned, by which it appears, that, in every instance except one, both needles every day passed the line in question. On a single day, February 24., the needle No. 2. did not arrive at it during its eastern motion.

"The means of the times of the needle passing this zero, as deduced from four months' continued observations, is 6 hours 15 minutes A. M., and 4 hours 37 minutes P. M., the mean time in each month being as follows:

1825.		A. M.		P. M.	
January,	-	6 hours	00 min.	4 hours	00 min.
February,	-	6	30	4	00
March,	-	5	30	5	00
April,	-	7	00	5	30
		—	—	—	—
		6	15	4	37

To avoid the insertion of many useless figures in the tables, the resulting *amount of easterly or westerly deflection on each side of the zero has been computed.*

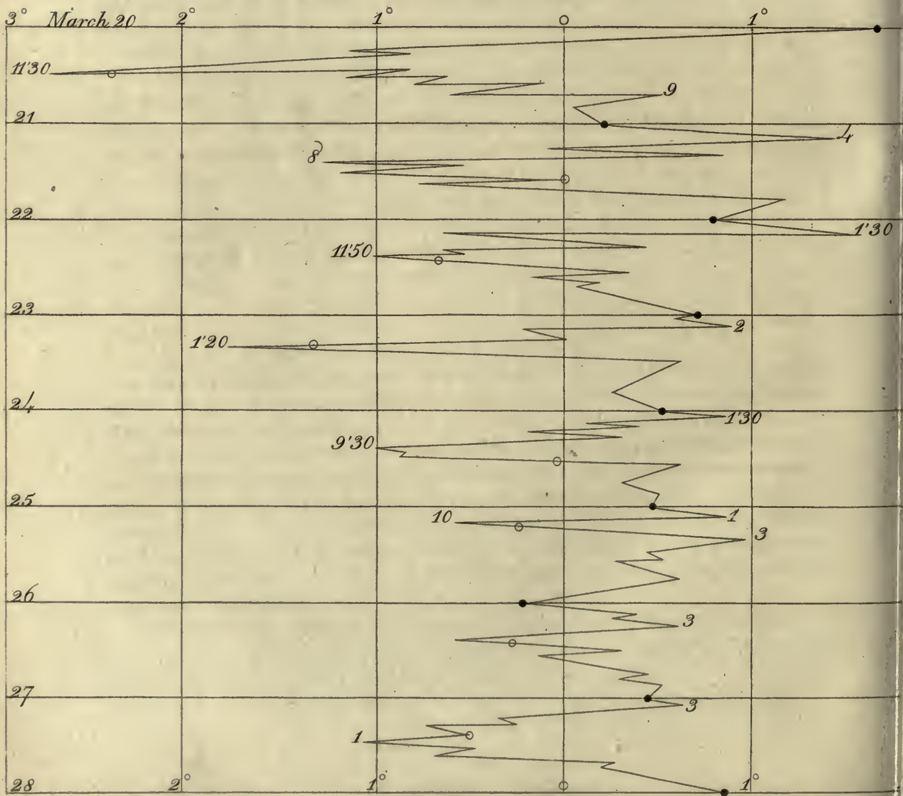
The maximum westerly variation at Port Bowen, appears from these observations generally to have occurred between the hours of 10^h A. M. and 1^m P. M., the mean result of 120 days' observations being 11^h 49^m A. M. The minimum westerly variation, or the greatest deflection of the north end of the needle to the eastward, took place between 8^h P. M. and 2^h A. M., the mean time deduced as above being 10^h 1^m P. M.

* In order to give an idea of this diagram, we have given a sketch of it in Plate V., for six days, viz. from the 20th to the 26th of March.

Fig. 1.

Drawn by W. H. Barlow.

Graphical representation of the daily variation of the needle at Port Bowen



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In a few instances the maximum deflection of the needle to the westward occurred as early as 8^h A. M., and as late as 3^h P. M.; and, in the like manner, the greatest deflection eastward took place at 2^h and 3^h P. M., on some few occasions. In all these anomalous cases, however, it was remarked, from simultaneous observations on the times of vibration of a suspended horizontal needle, that these irregularities were evidently due to an extraordinary alteration in its intensity, which produced a deflection contrary to the regular order of the motion of the needle.

The diurnal change of direction appears, by these observations, to have been seldom less than one degree, and sometimes to have amounted to five, six, and even seven degrees; and there can be no doubt, that the changes in this amount were more or less due to the position or influence of the sun, and probably of the moon, on the terrestrial magnetic sphere; but the particular law of this influence is a question of great delicacy, and of intricate research, and will be best left to the investigations of those who are theoretically conversant with these subjects.

After these general observations, the tables to which they allude follow; these, however, occupy forty quarto pages, and, of course, we can only attempt a general explanation of them; they are given under the following title.

"Tables, shewing the observed daily variations of the horizontal needle, from 10th December to 31st December 1824; and from 1st January to 31st May 1825, at Port Bowen. Lat. 73° 14′ N., long. 88° 54′ W. Mean dip 88° 1′.4 N., and mean variation 124° W."

After 1st January, when the general series commenced, these tables exhibit the deflection of the two needles No. 1. and No. 2. for every hour, and frequently intermediate observations, to the end of the series, with the registered temperature at the moment of observation; but, as I have already observed, they are too extensive to allow us to attempt a regular detail of them.

Lieutenant Foster has, however, in a subsequent article, given a general abstract of the five months' observations, and this, by a little farther abridgment, will reduce them to such a compass, as to allow of their being inserted in the pages of the Journal. Here we have given only the greatest amount of the daily variations for every day, and the hours and minute when the needle had its greatest and least westerly bearing; or the time of maximum westerly and easterly variations; the temperature at those times; the state of the winds and weather, with a column, also indicating whether the auroræ boreales were, or were not, visible. These tables will be sufficiently intelligible, with one remark, namely, that, in the column marked A. M., the hours sometimes exceed twelve, and ought, therefore, to have fallen in a column marked P. M.; but, to save room, we have preferred the above notation, which will be understood to indicate the hours since midnight. The same occurs in the column of maximum easterly bearings, marked P. M. Here the time indicates the hour, &c. past noon.

ABSTRACT of the Daily Variation Experiments on Magnetic Needle No. 2. *from January* 1. *to May* 31. 1825.

JANUARY 1825.

Days.	Times of Maximum. Westerly daily variation. A. M.	Times of Maximum. Easterly daily variation. P. M.	Amount of daily variation.	Temp. at Maximum. Westerly daily variation. AIR.	Temp. at Maximum. Easterly daily variation. AIR.	Aurora.	Prevailing Winds, and Weather.
	H. ′	H. ′	° ′	°	°		
1	13 0	12 0	1 20½	—26	—26¼	Not vis.	E.; clear and fine.
2	11 50	19 10	0 53	27	29½	...	... do. do.
3	10 0	12 0	0 50	28	34	...	... thin cl. with haze.
4	10 10	3 0	0 56½	26	33	...	... hazy.
5	11 10	12 0	2 33	32½	36	...	NE.; a partial haze.
6	9 45	11 5	2 50	29½	34	...	E.; ditto.
7	9 20	12 0	2 3	36	32	...	... fine and clear.
8	...	...	...	...	...	...	... hazy, with drift.
9	...	...	...	...	...	...	... ditto.
10	13 0	9 3	1 23	33	37	...	... clear.
11	12 0	13 7	2 1½	35	38	...	NE.; ditto.
12	10 10	13 10	0 51	16	38½	Visible.	... ditto.
13	13 0	11 10	1 0½	18	16½	Not vis.	SE.; small snow.
14	13 20	11 10	1 22	25	20	...	SSE.; snow and drift.
15	12 15	14 17	4 13	31	27	Visible.	E.; fine and clear.
16	12 10	11 10	2 25½	26½	35	...	... a thin haze.
17	8 10	10 15	2 29	24	27	...	... fine and clear.
18	12 10	6 15	2 56	23	22½	...	... overcast, cloudy.
19	14 10	14 10	1 56	28	23	Not vis.	NE.; very hazy.
20	13 55	5 10	1 8	30	28	Visible.	... clear and fine.
21	13 40	6 5	1 17½	27	31½	...	N.; very hazy.
22	12 55	12 5	1 20½	32	29	...	... cloudy.
23	12 20	8 5	1 16	34½	33½	Not vis.	NNE.; hazy.
24	11 11	13 10	1 3½	40	36	Visible.	NE.; clear and fine.
25	15 10	10 5	1 12½	29	44	Not vis.	E.; fine and clear.
26	10 7	14 5	2 0	31	26½	Visible.	... do. do.
27	13 10	15 5	1 55	25½	33	...	NW.; hazy with drift.
28	12 0	6 10	0 44	29	27	...	... do. do.
29	11 3	2 2	1 5	27	28½	...	NNW.; cl. dense haze.
30	12 0	10 5	1 31½	29	31	...	E.; overcast.
31	8 5	6 10	0 26	32½	36	Not vis.	... thick, cloudy.
Mean,	11 46	10 50	1 37¼	28½	30		

Abstract of Experiments,—continued.

FEBRUARY 1825.							
Days.	Times of Maximum.		Amount of daily variation.	Temp. at Maximum.		Aurora.	Prevailing Winds, and Weather.
	Westerly daily variation.	Easterly daily variation.		Westerly daily variation.	Easterly daily variation.		
	A. M.	P. M.		AIR.	AIR.		
	H. ′	H. ′	° ′	°	°		
1	12 0	11 57	0 39	—33	—36	Not vis.	E.; fine and clear.
2	12 3	4 0	0 52½	40	41½	...	... do. do.
3	11 4	3 4	0 17½	32	26½	...	... hazy low down.
4	14 0	13 0	0 54	24½	26	...	... do. do.
5	11 4	2 0	1 14¼	25	26	...	NE.; cloudy.
6	12 4	6 0	1 27	16	19	Visible.	N.; hazy, with drift.
7	14 0	10 0	0 46½	22½	29	Not vis.	E.; fine and clear.
8	7 58	13 57	1 10½	32	39½	...	Calm; do. do.
9	10 58	12 6	0 51½	39	39½	...	... do. do.
10	6 57	10 58	0 47	38	31½	...	... not a cloud vis.
11	14 10	13 32	3 53	31½	20	Visible.	NW.; a few light cls.
12	13 25	12 0	2 46	11½	9	...	ESE.; hazy, with drift.
13	14 15	13 3	2 25	14	24	...	... very hazy.
14	12 33	10 43	5 0	21½	33	...	NE.; thick and hazy.
15	12 28	13 8	4 25	30½	33	...	N.; thick and hazy.
16	13 58	13 0	1 41	34	29½	...	NNW.; hazy at horiz.
17	14 12	13 0	2 46	16½	25	Not vis.	N.; fine thin clouds.
18	12 0	17 3	0 48½	26	32	...	ESE.; clear, fine.
19	10 58	14 4	1 55	29	37	Visible.	NE.; fine and clear.
20	12 18	10 0	1 41	34½	40½	...	... do. do.
21	7 0	14 10	1 53½	42	33	...	N.; hazy near horizon.
22	10 56	13 58	2 10½	31	29	...	Calm; fine and clear.
23	10 48	13 8	1 46½	25	27	...	ESE.; hazy.
24	10 4	12 58	0 19½	29	29	...	E.; overcast.
25	10 5	13 6	0 45	31½	27	...	... fine and clear.
26	13 5	11 0	1 24½	17	8½	Not vis.	... fine, with drift.
27	13 9	9 50	0 44	8½	13	...	... thick and hazy.
28	12 2	14 2	0 19½	22	22½	...	N.; fine and clear.
Mean,	11 46	11 23	1 38	—26.9	—28.0		

Abstract of Experiments,—continued.

MARCH 1825.							
Days.	Times of Maximum.		Amount of daily variation.	Temp. at Maximum.		Aurora.	Prevailing Winds, and Weather.
	Westerly daily variation. A. M.	Easterly daily variation. A. M.		Westerly daily variation. AIR.	Easterly daily variation. AIR.		
	H. ′	H. ′	° ′				
1	11 2	4 58	1 56½	—33°	—38°	Not vis.	Var.; hazy, with drift.
2	10 5	10 50	1 2½	45	41	...	E.; cloudy. [hazy.
3	11 22	11 58	2 29½	26	26	...	... A. M. fine; P. M.
4	12 4	9 35	2 0	30	34	...	... cloudy. [fine.
5	10 33	3 2	1 10½	29	30	...	... A. M. hazy; P. M.
6	7 3	10 58	1 26½	23	39	...	S.; hazy, with drift.
7	10 25	12 50	1 12	26	31	...	W.; A. M. hazy; P. M.
8	11 58	10 40	1 31½	26	32	...	E.; cloudy. [clear.
9	10 0	3 0	1 7½	27	26	Visible.	... fine and clear.
10	10 7	7 3	1 17½	28	33	...	... do. do.
11	11 35	11 0	3 39½	31	37	Not vis.	... do. do.
12	11 6	12 3	2 13½	31	33	Visible.	Calm do. do.
13	12 23	13 3	3 18½	32	35	Not vis.	... do. do.
14	12 33	17 8	3 20	30	33	...	E.; do. do.
15	16 30	7 10	1 15½	24	25	...	... do. do.
16	14 8	13 33	1 51½	25	27	...	NW.; hazy with drift.
17	10 3	9 24	1 4½	24	27	...	... do. do.
18	12 38	13 5	3 7	20	22	...	... do. do.
19	13 9	10 18	5 26	21	22	...	... overcast.
20	11 48	16 0	4 11	20	26	...	... do.
21	7 55	13 3	2 54	25	35	...	W.; do.
22	11 46	14 5	1 50	16	34	...	E.; fine and clear.
23	13 18	13 32	2 40	26	37	...	... extremely clear.
24	9 28	13 8	1 52	32	39	...	Calm; do.
25	10 4	3 3	1 32	32	30	...	Var.; fine, horiz. hazy.
26	10 33	15 4	1 6	24	24	...	N.; do. do.
27	13 0	13 5	1 59	15	25	...	NE.; hazy.
28	13 12	10 30	0 56½	18	23	...	NW.; overcast.
29	10 3	1 28	2 37½	22	19	...	E.; cloudy.
30	9 58	13 3	2 21½	25	35	...	... fine and clear.
31	12 2	3 38	3 42	26	36	...	... do. do.
Mean,	11 25	10 43	2 14¼	—26.2	—30.7		

Abstract of Experiments,—continued.

APRIL 1825.							
	Times of Maximum.			Temp. at Maximum.			
Days.	Westerly daily variation.	Easterly daily variation.	Amount of daily variation.	Westerly daily variation.	Easterly daily variation.	Aurora.	Prevailing Winds, and Weather.
	A. M.	P. M.		AIR.	AIR.		
	H. ′	H. ′	° ′	°	°		
1	12 58	11 5	4 4	—25	—35	Not vis.	E.; fine and clear.
2	10 55	13 0	2 0½	25	29	...	... A.M. fine, P.M. hazy
3	10 0	17 7	2 24½	23	28	...	... hazy, small snow.
4	12 3	2 0	2 48½	19	20	...	Calm; fine and clear.
5	9 35	12 0	2 28½	26	25	...	E. do. do.
6	10 0	3 0	2 39½	26	28	...	... do. do.
7	14 2	13 3	3 16½	20	29	...	... do. do.
8	13 2	11 12	4 39½	17	25	...	... do. do.
9	13 2	14 57	5 58	14	18	...	... do. do.
10	...	...	...	...	...	...	... do. do.
11	13 0	12 3	4 3	4	+ 2	...	NNE. do. do.
12	13 8	18 1	2 9½	+15	— 3	...	... hazy, with drift.
13	13 30	15 7	2 2½	3	—16	...	... cloudy.
14	12 30	11 0	4 34	+ 5	—14	...	Calm; hazy.
15	11 0	3 0	1 21½	— 8	— 6	...	... do.
16	2 0	11 7	3 4½	+15	5	...	E.; fine and clear.
17	12 0	12 4	4 17½	26	+ 8	...	... do. do.
18	6 0	2 32	2 39½	— 8	2	...	... A.M. fine, P.M. hazy
19	13 0	14 2	1 51½	+ 2	2	...	... hazy.
20	11 52	9 35	2 13½	14	8	...	... do.
21	12 60	17 0	2 30½	17	1	...	... cloudy.
22	12 42	3 0	3 4	19	15	...	S. do.
23	14 4	13 5	2 43½	11	7	...	... hazy, with snow.
24	9 30	15 4	1 19	3	1	...	NW.; hazy.
25	12 50	13 5	3 41½	15	1	...	... cloudy.
26	10 4	10 3	2 6	6	2	...	Var.; do.
27	11 2	12 4	2 15	12	zero	...	S.; hazy, with snow.
28	11 2	11 58	1 52½	11	— 4	...	E.; do.
29	6 3	2 12	2 8½	zero	+ 17	...	... A.M. fine, P.M. hazy
30	13 28	12 0	2 38½	+ 2½	— 5	...	N.; cloudy.
Mean,	11 13	11 13	2.52.44	—10.8	—10.8		

Abstract of Experiments—continued.

MAY 1825.							
Days.	Times of Maximum.		Amount of daily variation.	Temp. at Maximum.		Aurora.	Prevailing Winds and Weather.
	Westerly daily variation.	Easterly daily variation.		Westerly daily variation.	Easterly daily variation.		
	A. M.	P. M.		AIR.	AIR.		
	H. ′	H. ′	° ′				
1	12 3	10 3	1 55	+11°	+3°	Not vis.	W.; hazy, small snow.
2	14 4	11 53	1 24½	9	3	...	E.; squally.
3	9 33	14 10	1 43	9	3	...	SW.; much drift.
4	13 10	5 33	5 10	13	12	...	... cloudy, with drift.
5	13 3	12 3	4 58	9	1	...	E.; fine and clear.
6	13 2	10 30	5 43½	20	10	...	W.; hazy.
7	13 29	14 11	5 25	20	12	...	E.; cloudy.
8	13 28	14 0	4 45½	21	12	...	... hazy. [snow.
9	13 2	14 30	4 23	25	14	...	W.; hazy, constant
10	13 2	14 6	2 43½	11	4	...	... do. do.
11	9 28	12 2	1 59½	9	3	...	... do. do.
12	13 30	13 0	3 18½	15	7	...	... do. do.
13	13 33	2 59	4 59	21	21	...	... do. do.
14	6 2	12 2	2 36	9	18	...	... do. do.
15	15 2	13 15	1 34½	33	14	...	... do. do.
16	14 20	9 3	3 41½	22	16	...	N.; do. do.
17	15 4	14 0	3 42	27	18	...	NE.; do. do.
18	6 0	3 3	3 33	27	21	...	N.; do. do.
19	14 32	14 4	4 52½	22	14	...	E.; do. do.
20	14 0	9 6	4 46½	31	17	...	... cloudy.
21	15 0	17 0	4 50½	29	19	...	... do.
22	10 32	2 4	3 58½	26	27	...	... light clouds.
23	13 35	14 2	4 26½	18	10	...	N.; small snow.
24	9 38	18 2	4 10½	19	19	...	Calm; very fine and
25	11 3	14 33	3 55	25	21	...	N.; overcast. [clear.
26	12 2	14 3	3 59½	32	21	...	... cloudy.
27	12 0	...	...	...	...	...	Hazy, with drift.
28	12 4	10 0	3 41	33	26	...	W.; do. do.
29	12 3	1 0	1 11	27	25	...	SE.; cloudy.
30	13 13	14 33	5 13	38	27	...	ESE.; do.
31	14 2	14 34	3 40	35	25	...	... fine.
Mean,	12 25	11 19	3 44	18.2	14.8		

It may be well to draw the general monthly mean results from the preceding Table under one head, as follows;

	Mean Time of Maximum Westerly Variation.	Mean Time of Minimum Westerly Variation.	Mean Daily Variation.	Mean Temperature.
	A. M.	P. M.		
	H. ′	H. ′	° ′	°
January,	11 46	10 50	1 37	— 29¼
February,	11 46	11 23	1 38	— 27½
March,	11 25	10 43	2 14	— 28½
April,	11 13	11 13	2 52	— 10⅘
May,	12 25	11 15	3 44	+ 16½

The above is a general mean view of these curious observations, and the following Table contains the mean results of the experiments on intensity. A needle, as we have stated, was kept specifically for the intensity experiments. These were made and registered every hour, by noting the time the needle required to make 60 vibrations; and the following Table is a general mean for the same hour for all the days in each month. It should be observed, however, that, on the 1st of May, for some reason not stated, the needle was magnetized. The general mean is therefore exclusive of May.

Monthly and General Mean Intensities of the Horizontal Magnetic Needle for every Hour for Four Months. *

Hour.	February.	March.	April.	May.	General Mean independent of May.
	Mean Time in performing 60 vibrations.	Mean Time in performing 60 vibrations.	Mean Time in performing 60 vibrations.	Mean Time in performing 60 vibrations.	
	"	"	"	"	"
A. M. 1	1076.8	1079.1	1098.9	916.4	1086.6
2	1073.5	1083.1	1100.7		1089.4
3	1075.7	1082.1	1102.7	930.7	1089.1
4	1080.7	1084.8	1102.7		1081.1
5	1082.5	1082.8	1101.7	923.2	1090.3
6	1082.1	1082.4	1105.4		1090.6
7	1082.8	1082.9	1108.2	922.6	1092.6
8	1082.9	1083.1	1109.1		1093.4
9	1080.9	1084.7	1108.1	927.5	1094.2
10	1079.5	1081.7	1107.1		1091.4
11	1077.9	1081.9	1101.9	923.0	1089.0
Noon 12	1077.1	1077.4	1093.3		1084.6
P. M. 1	1075.1	1074.0	1092.5	914.4	1080.5
2	1072.7	1072.9	1106.6		1084.1
3	1077.9	1076.4	1110.2	905.2	1087.6
4	1077.4	1073.6	1090.9		1080.6
5	1073.6	1073.4	1094.0	905.4	1081.7
6	1073.5	1072.1	1090.7		1078.8
7	1074.2	1072.0	1089.2	904.4	1079.1
8	1073.8	1074.0	1088.7		1079.7
9	1075.1	1074.5	1091.2	906.0	1080.8
10	1073.8	1074.8	1092.1		1081.3
11	1075.1	1075.9	1093.3	911.6	1082.3
Midn. 12	1076.3	1077.1	1096.1		1083.9

We come now to a highly important part of these experiments, and which we owe to a very happy thought of Lieutenant Foster's, while pursuing the two series we have endeavoured to describe; and which cannot be better illustrated than by using the author's own words. The article here referred to is the seventh in the volume, and is entitled " A Comparison of the Diurnal Changes of Intensity in the Dipping and Horizontal Needles at Port Bowen." These are introduced by the author in the following terms:

* In the above Table a few errors have been detected in obtaining the means, and are corrected.

"These comparative observations on the intensity of the dipping and horizontal needles, were made with a particular object in view, which it will be proper to explain before giving the details.

"It was found by observation, that the intensity of the horizontal needle was hourly varying. This appeared by the results already given; but it was doubtful whether this variation of horizontal intensity of a needle, proceeded from an actual variation in the intensity of the terrestrial magnetism, or from a variation in the amount of its direction, as indicated by the dip itself.

"The power of the horizontal needle varying as the cosine of the dip, a change to the amount of a few minutes in the dip, at places where it is very great, would be sufficient to explain all the variations of intensity observed in the horizontal needle, without supposing any change to have taken place in the intensity of the terrestrial magnetic force.

"The variation in dip, however, if it did occur, was too small to be detected by direct observation; and I failed also to render it sensible by the application of magnets, as stated in a former communication.

"My object, therefore, in making the experiments contained in the following table, was to ascertain, by several series of vibrations made with the same needle, mounted alternately as a dipping needle, and as a horizontal one, whether or not a corresponding variation of intensity would manifest itself in these two positions respectively, as ought to be the case, if the diurnal changes of intensity in the horizontal needle proceeded from a general change of intensity in the terrestrial magnetic power. But, on the other hand, if the force indicated by the dipping needle should be found to remain constant, then it would be equally clear, that the variations of intensity in the horizontal needle proceeded from an actual change of dip only.

"As this question is of considerable importance in the theory of terrestrial magnetism, I regret that I had not an opportunity of making a more extended series of experiments of this kind; but, as far as they go, they certainly appear to indicate, that the alterations of intensity in the horizontal needle, are due rather to a daily change in the amount of the dip, than to any variation in the general intensity of the earth's magnetic force, although some change in this also is observable by vibrations of the dipping needle. This explanation of the cause of the change of horizontal intensity, it may be remarked, is consistent with the observations made in Europe, which likewise shew an alteration of intensity in the horizontal needle during the day, but in a much less degree than at Port Bowen. Now, if the variation in question really proceed from a change of dip, to the amount of three, four or five minutes of a degree, the change of intensity in the horizontal needle will be less and less obvious, as the dip decreases; but if it proceed from a change in the actual intensity of the earth's magnetism, it ought to be constant in all parts of the world, which is contrary to observation.

"The following are the results of these experiments. The table is divided into two parts; the first contains the observations on the times of vibration of the needle in its horizontal position; and the second, those on it when used as a dipping needle. In the first column of each part, is inserted the day of the month; in the second, the hour and minute at which the observations were commenced; the third column of each part contains the mean time in seconds taken by the needle in its different positions, to perform one hundred vibrations; and, in the fourth, is inserted the temperature of the needle at the time of observation.

First Part, Horizontal Needle.				Second Part, Horizontal Needle.			
1825.	Time of commencement.	Mean time in seconds of performing 100 vib.	Temp. Fahr.	1825.	Time of comment.	Mean time in seconds of performing 100 vib.	Temp. Fahr.
Feb.	H. M.	″	°	Feb.	H. M.	″	°
12.	A. M. 6 35	2128.6	—17	12.	A. M. 11 58	405.4	—17½
	10 54	2127.6	—17°		P. M. 0 30	405.7	—17½
	P. M. 1 32	2079.9	—17	13.	P. M. 3 41	410.0	—17½
13.	P. M. 1 42	2103.1	—17	14.	A. M. 10 34	408.0	—19½
	2 54	2152.5	—17½		P. M. 0 12	406.5	—20
14.	A. M. 11 21	2088.2	—20		8 33	408.4	—22
	P. M. 1 14	2067.7	—20		10 00	409.0	—21½
	9 00	2086.0	—22		11 12	408.7	—21½
15.	A. M. 0 41	2107.0	—22	15.	A. M. 1 34	411.1	—22
	10 48	2115.5	—21		10 32	410.0	—21
	P. M. 8 44	2064.2	—23		11 35	409.6	—21
	10 29	2071.0	—23		P. M. 8 9	409.2	—23
16.	A. M. 11 4	2077.4	—27		9 43	408.7	—23
17.	A. M. 10 18	2071.0	—22		11 15	409.2	—22
	11 12	2058.2	—21	16.	A. M. 10 38	409.9	—28
	P. M. 0 29	2079.5	—20		11 46	409.1	—27
19.	A. M. 10 18	2092.2	—22½	17.	A. M. 9 42	409.0	—22
					11 54	408.5	—20
					P. M. 1 10	409.0	—20½
				19.	A. M. 10 00	408.5	—23
					10 58	408.1	—22
	Mean *,	2092.33	—20½		Mean *,	408.65	—21½

"The above results show, that the mean of all the observed times which the horizontal needle required to make 100 vibrations, was 2092.33 seconds, but that differences appear in these times amounting to 94.3 seconds, or $\frac{1}{22}$d part of the interval; whereas, in the dipping needle, in which the mean of the times required to perform 100 vibrations was 408.65 seconds, the greatest difference is only 57 seconds, or $\frac{1}{72}$d part of the interval, which is a much less proportional change than the former.

"Therefore, as has been stated, the change of intensity in the horizontal needle is due, principally, to a daily variation in the amount of the dip, not to a real change of intensity in the terrestrial magnetic force. This, at least, appears to be a legitimate deduction from the preceding observations; from which circumstance, and that of the daily variation in the direction of the horizontal needle, we are naturally led to the conception of a small variation in position of the magnetic axis, corresponding to a revolution of the polar point round its mean position as a centre, produced by the action of the sun, on the magnetism

* The dip of the needle resulting from these elements is 87° 48′ 8 N.

of the parts of the earth successively exposed to its influence. And, moreover, it seems by no means improbable that the annual variation of the position of the magnetic pole, may ultimately be traced to the same universal cause.

"I have not attempted to enter into any minute calculations on this subject, but I believe it will be found, that, if the radius of the circle, described by the pole of the general magnetic axis of the earth during the day, be supposed to subtend at the centre an angle of 2 or $2\frac{1}{2}$ minutes, it will reconcile, to a considerable degree of precision, nearly all the observations on the daily variation of the direction, and daily change of intensity of the horizontal needle, made both in Europe and within the Arctic Circle."

In order to illustrate the very ingenious hypotheses which Lieutenant Foster has thus deduced from the experiments last reported, it will be best to refer to Fig. 1. In this, P represents the terrestrial pole, M the magnetic pole of any place L, of which the dip and variation are given; join M L, which is the magnetic meridian of the place L, and produce M L to l, m Q L representing the equator; as also, P L be produced to meet the equator in Q, then MLQ will be the meridian of the place L; and from M draw Mm, perpendicular to ML l. Then, confining our illustrations to the time when the sun is in the equator, the arc Q l, converted into time, will give the time when the sun is on the magnetic meridian of the place L; Q m, converted into time, will give the time when the sun is perpendicular to that meridian, and, of course, from these may be readily determined the time when the sun is again on the magnetic meridian, and when again he is perpendicular to the same; let us, therefore, go through the necessary calculations, and see how nearly the several phenomena which have been recorded, agree with the hypotheses in question.

First, let L represent London, Lat. 51°31′, dip 70°34′, Long 0°0′. Here, since tan dip $=$ 2 tan mag. lat. we have $\frac{\tan 70°34'}{2} = 54°48'$ mag. lat. conseq. ML $=$ 35°12′ PL $=$ 38°29′, and PLM $=$ 24°30′ variation.

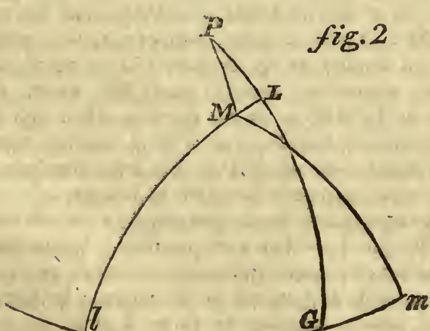
From these we readily find MP $=$ 14°58′ colat. of magnetic pole, and angle LPM $=$ 67°41′ $=$ long. west of magnetic pole. In the triangle LQl, right angled at Q, we have LQ $=$ 51°31′, and the angles QLl $=$ 24°30′, whence we find lQ $=$ 19°38′, which, converted into time, gives about $10^h\ 40^m$ A. M. for the time when the sun is on the magnetic meridian of London; and, in a similar manner, we find Qm $=$ 55°24′ equal to about $3^h\ 40^m$ P. M., the time when the sun is perpendicular to the magnetic meridian of London.

These being determined, let us proceed to a comparison of recorded phenomena with the hypotheses in question. Lieutenant Foster conceives, that the sun, by some influence or other, causes the magnetic pole M to describe, in the course of 24 hours, a little circle about the mean point M, whose diameter is about 5′ or 6′, the pole being constantly deflected towards the sun. Now, first, according to this supposition, at $10^h\ 40^m$ A. M. M will be deflected towards L, the magnetic colat. will be diminished, and, consequently, the dip increased; and this increase of dip will induce a less magnetic intensity on the horizontal needle, and the least that ought to take place in the 24 hours, and this is precisely the time that the minimum intensity is recorded to take place. At $10^h\,40^m$ P. M. we ought, in like manner, to have the greatest intensity, because then the sun will be again on the meridian, but its tendency will be to increase the magnetic colat., and, consequently, to diminish the dip. We have no distinct account of the intensity at this hour, but at $9^h\,30^m$ P. M.* it is greater than at any other hour recorded; we may, therefore, I conceive, fairly state this as a confirmation of the agreement of the hypotheses with observations on these cases of intensity.

Again, at about $3^h\,40^m$ P. M., we have seen that the sun is to the west of the magnetic meridian, the needle ought, therefore, at this hour to have its greatest westerly bearing. This hour agrees very well with a number of recorded observations, but, in the recent observations by Colonel Beaufoy, the maximum is said to happen at $1^h\,30^m$, at least this was the time at which he always recorded his noon observations. Here, therefore, is some discrepance in time; but the motion of the needle is nearly suspended for some considerable time about this part of the day, and the whole amount is so very small, that I can by no means admit this as an objection to the hypotheses. It is only by a very great number of hourly observations that the exact time of the maximum can be deduced; and where these are most numerous, the time is variously stated from 2^h to 4^h P. M. We have no good recorded experiments during the night in London; it is only generally said, that the motion of the needle is less to the eastward in the night than to the westward in the day, and this ought to be expected from the hypotheses, for the sun will pass during the night 30° farther from the pole than in the day, and its effects, of course, ought to be proportionally less. Upon the whole, therefore, Lieutenant Foster's hypothesis is by no means at variance with our recorded observations in London.

Let us now submit it to a similar test with the Port Bowen observations.

fig. 2



* See Mr Christie's Paper on the Effect of Temperature, &c.—*Phil. Trans.* for 1824.

Here, referring to fig. 2. and repeating the calculations already indicated, we find,

$$\begin{array}{llll} PL = 16°46' & \text{angle } PLM = 124° & lQ = 54°51' \\ PM = \ \ 4 \ \ 0 & \text{angle } LPM = \ \ 10\ 23' & Qm = 25\ 49 \end{array}$$

The two latter, converted into time, give $3^h\,40^m$ P. M. for the time the sun is on the magnetic meridian of Port Bowen, and $10^h\,40^m$ A. M. for the time when he is perpendicular to the same.

It is remarkable, that these times are nearly the reverse of those in London, and cannot, therefore, but furnish an excellent test of the hypothesis in question. According to these the needle ought to have its greatest westerly variation, which is, however, due to an actually eastward motion at $10^h\ 40^m$ A. M., and its least westerly at $10^h\,40^m$ P. M., whereas the times stated from a mean of all the observations is $11^h\,49^m$ A. M. and $10^h\ 1^m$ P. M., which is as close an approximation as can be expected. Again, according to this calculation, the time of the sun traversing the magnetic meridian, when the needle ought to be found in its natural meridian, is $3^h\,40$ P. M. and $3^h\,40^m$ A. M. And the time stated of the needle passing what is called the mean daily zero is $6^h\ 15^m$ A. M. and $4^h\ 37^m$ P. M., and as this time was merely an approximate assumption of the mean meridian by taking it at half the extreme range for the day, it is far from being unsatisfactory.

The times of greatest and least intensity of the horizontal needle are not so well defined as some of the other points. By referring to the table we have given, it will, however, be found to be greatest from about three or four o'clock afternoon to about six or seven ; and least at about the same hours in the morning ; and, according to what we have computed, these effects should have taken place at $3^h\,40^m$ P. M. and A. M. precisely.

Upon the whole, therefore, I conceive that the experiments, observations, and computations, are very consistent with each other, and afford a strong presumption in favour of the hypothesis, particularly when it is observed, that the illustration has been given wholly with reference to the sun being in the equator ; and that all the circumstances of time, &c., will be different when the sun has either north or south declination, and thereby produce that kind of uncertain and variable results, which are so strongly marked in the general table. There can, moreover, be no doubt, that all the phenomena are modified by other circumstances, besides those of the sun's motion ; and that, although the latter is the great primary cause, it is not the only one which is influential in producing the changes we have been endeavouring to explain. It may be proper also to add a few words with regard to the amount of daily variation in different latitudes.

Lieutenant Foster says, that he conceives a mean radius of about $2'$ or $2\frac{1}{2}'$ for the orbit of the daily motion of the pole, will agree very well with the quantity of daily variation observed in different latitudes. We would, however, rather say $2\frac{1}{2}'$ or $3'$; and assuming this, let us examine how nearly the observed and computed quantities agree with each other. According to this, the daily variations at the magnetic equator, will be 5′ or 6′. In London, the magnetic colatitude being 35° 12′, it ought to be about 13′ or 15′; at Port Bowen, 1° 52′, or 2° 15′, all which quantities are very consistent with observations at those places.

Again, it follows from the hypothesis, that the daily variation ought to be much greater, and the change of daily intensity also greater in our hemisphere, while the sun has northern declination, than when his declination is south, or than when he is in the equator; because he will then approach so much nearer the magnetic pole than in the latter cases; and, in whatever way the influence takes place, we may expect it to be greatest when its action is most direct: this circumstance is also fully confirmed by observation.

There is, however, one point, and only one that I am aware of, that has the appearance of being opposed to the theory we are examining, and this in candour ought to be stated. It is this, that although we ought to find, as we really do, a greater change in the daily intensities, as the sun advances to the north, yet the mean daily intensity ought to be nearly the same; whereas, by referring to our tables, it will be found to be constantly decreasing, from the 1st of January, when the experiments began, to the end of April, when the needle was magnetized, without any such change of temperature, as is sufficient to account for the circumstance. This anomaly, as it is the only one we have met with, leads us to suspect some other cause, and I think it by no means an improbable one, that the daily and hourly use of this needle for four months, might lead to a deterioration of its own magnetic power; and that some such effect was noticed, seems probable, by the needle being re-magnetised on the 1st of May, particularly as its intensity was so much increased by this operation, which could not have happened, had the needle maintained itself in a state of saturation.

If this was the case, it necessarily prevents us from comparing the intensity of one month with that of another, although the hourly changes will be too small to be affected by this cause. I have not at present made any reference to the experiments performed at the Whale Fish Islands, because their number is inconsiderable, and they cannot, therefore, be supposed to have the same weight as the preceding, in a case of this kind. It is, however, satisfactory to find, that they still agree with the hypothesis which has been advanced. If we go through the same calculation here as in the other examples, we find the magnetic polar distance $ML = 14°$; the one of the equator $Q\,l = 68° 43'$, answering to $4^h 32^m$, or $7^h 28^m$ A. M., the time when the sun was on the magnetic meridian of Whale Fish Island; and $1^h 32^m$ P. M., for the time when the sun was at right angles to the same, and when, as we have seen, the daily variation ought to be the greatest westerly. The time of maximum is registered from $1^h 10^m$ to $1^h 30^m$. Again, the amount here (the magnetic polar distance being 14°) ought to be 32′ or 38′, according to our preceding determination, and the quantity actually observed on one side of the meridian only as 23′; which, if the night easterly variation had been taken, would certainly have brought the total somewhere about these limits.

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After such close accordances as those we have shewn, between theory and observation, in so many, and in such distant and peculiar situations on the globe, no one can, I think, hesitate in pronouncing, that that theory, in its general character, must be correct, although there may be variations due to different causes, which modify the results, as the wind and other circumstances influence the tides, without, however, in any way throwing a doubt upon the theory, which makes the moon the great primary agent, productive of those daily changes. These influencing or disturbing causes may furnish the subject of another communication. This I shall conclude by examining what is the present state of our knowledge, and what are our future hopes of arriving at a more perfect knowledge of the laws, which govern the phenomena of the magnetic needle in different parts of the earth. With reference to the former, I think we may venture to say, 1*st*, We know, that, from whatever source the earth derives its magnetism, it is by some inductive principle, the phenomena which it exhibit being wholly inconsistent with a state of determinate magnetic polarization,—"*Essay on Magnetic Attraction*," p. 208.; 2*dly*, I have shewn, by an incontestible experiment, that such a power may be induced in a globe of any matter, and all the phenomena of terrestrial magnetism exhibited by the agency of electricity or galvanism, independently of any magnetic body whatever; 3*dly*, Professor Leibech has shewn, that such an electric motion may be induced in a body composed of different metals, by merely destroying the equilibrium of caloric within them; and, 4*thly*, It is shewn, by the highly valuable experiments of Captain Parry and Lieutenant Foster, that a magnetic disturbance is actually produced on the needle, and on the general magnetism of the earth, through the medium of the solar influence.

We have thus at least a glimpse of the probable cause of that hitherto mysterious, but invaluable property, of a magnetized needle, which disposes it to take up a determinate position; and, as we owe this conclusion, in a great measure, to the happy thought of Lieutenant Foster, which led him to make a series of simultaneous observations on the intensity of the horizontal and dipping needles, we do sincerely hope he may be enabled to complete a comparison he has so happily begun, by being allowed to pursue his experiments in the southern hemisphere.

If, as has been said, all knowledge is valuable, that must be more especially so which contributes to the comforts, necessities, and preservation of human existence; and that a correct knowledge of the theory of terrestrial magnetism is entitled to rank in this class, cannot be doubted, when we reflect, that it would enable us to add to the facilities of commerce, to the security of navigation, and tend materially to the preservation from shipwreck and death, of those brave men to whom England is so much indebted for her pre-eminence amongst nations.

It is a subject, however, which cannot be pursued with advantage in the closet; at least the data must be drawn from accurate observations made in various and remote situations on the globe, which can only be obtained through the assistance and support of governments,—and no government can be so much interested in the inquiry, as that which directs the efforts of a nation, whose pride and boast is to be the first maritime power on the globe. The British Admiralty, then, is the rock on which we build our hope for a more complete knowledge of the laws of terrestrial magnetism; and, after the liberal support it has already given to these inquiries, we feel confident that our hope is not ill founded.

At some future time I propose to examine the magnetic experiments of Captain Sabine, and endeavour to show, that the theory in question will also serve to explain the anomalies he found in the deep intensity of the needle in the torid and temperate zones, and which led him to look for a pole of intensity distinct from that of direction,—not reflecting that the formula he employed was rendered inapplicable the moment he assumed the separation.

On the Use of a Simple Syphon as a Hydrometer. By Mr HENRY MEIKLE. Communicated by the Author.

AMONG the numerous instruments for comparing or ascertaining the specific gravities of liquids, the "pump areometer" has been for a considerable time known. This consists of a syphon, having its extremities immersed in two different liquids, whose specific gravities are to be compared, and having a pump or syringe communicating with the upper or bent part; so that on exhausting a portion of the included air, the atmospheric pressure raises the liquids through heights, which are inversely as their specific gravities. The reason of this is obvious, and was long ago particularly noticed by Boyle. In the last volume of the *Philosophical Magazine*, is a description of a different instrument, consisting of a double syphon, with four parallel legs; into each pair of which, a different liquid being put, with a portion of air between, the effective columns compressing that air will be inversely as their specific gravities. This instrument possesses the remarkable property, that if the bore of the tube, however narrow, be uniform, its indications will be entirely free from capillary action; because both extremities of the same liquid being equally affected by capillary attraction, the difference of their heights, or the effective column, is not altered thereby.

It appears, however, that, when the liquids are transparent, the syphon may be applied in a still more convenient form than either of those just mentioned, though, to avoid capillary action, the tube in this, as well as in the pump areometer, must not be narrow. Thus, if the legs of a simple glass syphon be immersed in different liquids, the lengths of the columns, depressed by the included air, will be inversely as their specific gravities. The vessels containing the liquids only require to be transparent, such as glass bottles or jars. Any scale of small equal parts may be attached to the tubes; but it will be still simpler, and more convenient, for corrosive liquors to graduate the tubes themselves; for, in proper hands, a glass tube is as easily divided into equal parts as any thing else.

But with the assistance of a little calculation, the simple syphon may be used for comparing the specific gravity of an opaque liquid with that of a transparent one, as for instance water.*

Let a be the volume which the air included in the syphon had under the external barometric pressure b, and c the increase of pressure occasioned by the immersion which will be proportional to c', the volume of air below the surface of the water; also let e be the volume of water in the bottom of the tube. Then the reduced volume of air is $\frac{a\,b}{b+c}$, and the volume of the other liquid within the tube, is $a - \frac{a\,b}{b+c} - e = \frac{a\,c}{b+c} - e$, which subtracted from g, the whole contents of the tube under the level of the opaque liquid, gives $g + e - \frac{a\,c}{b+c}$ for the column of air below the surface of the opaque liquid, and if by this we divide c', the quotient is the specific gravity sought.

In this case, it is supposed that the bore of the tube is uniform, and that both legs enter their respective liquids at the same instant. But when the two specific gravities are very different, unless care be taken not to immerse the syphon too far, some air may escape from the end which descends into the lighter fluid. This may also be avoided, by gradually lowering the vessel containing the heavier liquor, or raising the other whilst the syphon is descending; but that will seldom be necessary, and the escape of a little air will not affect the simpler method, to be used when both liquids are transparent.

On the Live Marine Cockles, said to have been found at a great distance from the Sea in Yorkshire. In a letter to Professor JAMESON. By W. C. TREVELYAN, Esq. M. W. S., &c.

[Nearly a year ago, my intelligent friend Mr Witham of Lartington, had sent to him in Edinburgh several specimens of live marine cockles, said to have been found in a bog, considerably above the level of the sea, and fully forty miles distant

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* In some opaque liquids, as for example mercury, the top of the column within the tube may be rendered visible by bringing the leg of the syphon close to the side of the jar; in such cases, no additional calculation is required.

from the sea coast. Since that time, Mr Witham visited Yorkshire, personally examined the spot, and actually found *live marine cockles,* in the situation already mentioned. We are still, however, of opinion that the live cockles are not natives of the bog; and in this view we are borne out by the following statement of Mr Trevelyan.—Ed.]

Having lately been on a visit in Yorkshire, in the neighbourhood of the place where the *marine cockles* sent to Mr Witham were said to have been found, I took advantage of the opportunity to examine the spot, and to make inquiries concerning the fact. The result is my thorough belief, that the *cardium edule* is *not* a native of the place, and that if specimens of it have been found there, they have been put there by some absurd person, for the purposing of hoaxing the individuals who sent the statement to Edinburgh.

The spot where they are said to have been is a peat-moss resting on sand, through which drains have been cut. The tenant (Pratt) on whose farm part of the moss is situated, and who has been there many years, when I questioned him, said that he had seen *cockles* at different times in clearing out the drains, and described them as being nearly the size of his thumb nail, of the colour, and about the same thickness as the *whelks,* which are common in the ditches there, some of which he shewed me, and which are fresh water helices (putris, &c.); that the stripes were across the shell, from side to side, not in the same direction as in the sea-cockle, which he said he knew well, but had never seen any, or heard of any being found there, excepting those sent to Mr Witham. From this description, I was convinced that Pratt's *cockles* were the *Tellina cornea;* the only cockles I expected to find there, and of them, after a little search in the ditches, I found some small specimens. They call them *cockles,* from their analogy to the marine shells of that name, in the same way as the *helices* are called *whelks.*

The farm house called Cocklesbury stands on an elevation, a short distance from the moss; and may perhaps be named from the cockles (Tellina) found there, though I think if it is from shells at all that it derives its name, it is from the shells abundant in the neighbouring limestone, some of which may perhaps have been dug up in sinking the foundations. We have in Northumberland a limestone abounding in Terebratula and Anomia, the local name of which is the Cockle-shell limestone.

In a moss much resembling this, at Kirby Ravenswath, in the same neighbourhood, now draining, I found the same shells below the peat, which is about four feet thick, resting on a sandy clay. Formerly it has evidently been covered with water, forming the principal defence of Kirby Ravenswath Castle, which it partly surrounds.

Notice of Fresh Water found in the Sea at a great distance from the land. By D. BUCHANAN, Esq. (In a Letter to Professor Jameson.)

I HAVE received your letter of the 15th, in which you request me to give you an account of my voyage to Chitagong, during which the singular circumstance of our finding fresh water so far from land occurred. Not having thought much of this at the time, I fear I may have forgotten some of the circumstances attending it, but all that I do recollect shall be communicated to you. In the beginning of September 1824, I embarked with the other officers of our regiment, in a country ship (having most of the officers of his Majesty's 54th Regiment on board), for Chittagong. We sailed out of the Madras Roads with a fair wind, which continued for four days; but, on the fifth, we were becalmed, and continued so for fourteen days, having had only once or twice a very slight breeze, which never lasted longer than a few hours. It was towards the end of this calm that I observed a very strange appearance on the surface of the glassy ocean. It seemed to be furrowed in several directions, and much agitated in these furrows, so that, when the ship was drifted into these parts, she was driven about in all directions. On the night of the 14th, a breeze sprang up. Owing to our unexpectedly tedious passage, we ran short of provisions, particularly of water. You may suppose what was our joy and astonishment the next morning, in taking up the water alongside to wash decks, to find that it was fresh, and much more palatable than that which remained in our casks, which were immediately replenished with it. By this day's observation we were 125 miles from Chittagong, and about 100 from the nearest part of the Junderbunds. The water was of a more yellow tinge than in most parts of the bay; and those who drank a great deal of it, suffered from it afterwards.

Description of Anatina villosiuscula, a new Species, and of Venerupis Nucleus, a Species new to the British Fauna. By Mr WILLIAM MACGILLIVRAY, M. W. S., &c. With Figures. Communicated by the Author.

I. ANATINA VILLOSIUSCULA. Pl. I. fig. 10, 11.

Spec. Char.—A. TESTA ovata ventricosa, inæquivalvi, antice subtruncata, rugosa, minutissime granulata.

Description.—Shell ovate, ventricose, inequivalve, with the umbones nearer the anterior extremity, the posterior extremity rounded, the anterior subtruncate, thin, fragile, diaphanous, transversely wrinkled, white, slightly tinged with yellow. Right valve larger, and much more convex, with a more prominent umbo; umbones directly opposite; ligament double, the external short. One transverse scarcely prominent tooth in each valve, resembling an incrassation of the margin, immediately behind which, and directly under the umbo, is a deep sulcus. Posterior extremity shut close, anterior hiant. External surface covered with very minute prominent points, which, to the naked eye, are not individually distinguishable, but aggregately produce a dull or lustreless appearance; internal surface smoothish, shining at the ends, glimmering about the middle.

It will be perceived that this shell is closely allied to *A. myalis* of Lamarck, which is *Mya pubescens* of Turton, as well as to several others, such as *Anatina truncata* of Lamarck. It would be tedious to enter into all the explanations necessary for the accurate distinction of species so intimately connected. Our British conchologists have sadly puzzled themselves with this genus, which they have most injudiciously stuck to the genus *Mya*, after Linnæus's example; so that, to clear up all difficulties, would require a monograph.

The individual figured is from the Island of Harris, and is the largest in my possession.

2. Venerupis nucleus. Lamarck Syst. v. p. 507. Pl. I. fig. 12, 13.

Spec. Char.—V. testa ovata, extremitatibus obtusa, ad umbones lævigata, transverse rugosa, longitudinaliter striis minutissimis decussata, latere antico lamelloso.

Description.—Shell broadly ovate, subrhomboideal, rounded at both ends, with the umbones close upon the posterior extremity, thick, transversely wrinkled, longitudinally very minutely striate, the umbones smooth and shining, the anterior extremity lamellar. Colour yellowish-white. Left valve with three, right with two teeth, much resembling those of *Venus pullastra*, but shorter. Anterior extremity a little hiant. Internal surface smooth, shining, white, with a purple spot at the anterior extremity.

It is allied to, but very distinct from, Montagu's *Venus perforans*.

The specimen figured is from the Island of Scalpay, in Harris; but I have seen one from the same place more than double the size.

Of the species here described, the first is supposed to be new; the second to be for the first time ascertained as British.

Account of the Capture of a colossal Orang-Outang in the Island of Sumatra, and Description of its Appearance. By Dr Clark Abel.

In the Hunterian Museum there was, and probably still is, the arm of an orang-outang, which many years ago excited the curiosity of naturalists, and induced them to infer that it belonged to an animal exceeding in height the human species. That arm, we doubt not, belonged to the species here noticed by Dr Abel, of which the following accounts, extracted from the fifteenth volume of the Asiatic Researches, cannot but be read with much interest.

The individual described by Dr Abel was captured in the woods of Sumatra.

Capture of the Animal.—The following short history of the circumstances under which the animal was found, and of the mode of taking him, is drawn up from accounts which were furnished to Dr Abel, either directly or indirectly, by persons concerned in his capture.

A boat party, under the command of Messrs Craygyman and Fish, officers of the brig Mary Anne Sophia, having landed to procure water at a place called Ramboom, near Touraman, on the north-west coast of Sumatra, on a spot where there was much cultivated ground, and but few trees, discovered on one of these a gigantic animal of the monkey tribe. On the approach of the party he came to the ground, and, when pursued, sought refuge in another tree at some distance, exhibiting as he moved, the appearance of a tall man-like figure, covered with shining brown hair, walking erect, with a waddling gait, but sometimes accelerating his motion with his hands, and occasionally impelling himself forward with the bough of a tree. His motion on the ground was plainly not his natural mode of progression, for even when assisted by his hands or a stick, it was slow and vacillating: it was necessary to see him amongst trees in order to estimate his agility and strength. On being driven to a small clump, he gained by one spring a very lofty branch, and bounded from one branch to another with the ease and alacrity of a common monkey. Had the country been covered with wood, it would have been almost impossible to prevent his escape, as his mode of travelling from one tree to another is described to be as rapid as the progress of a swift horse. Even amidst the few trees that were on the spot, his movements were so quick that it was very difficult to obtain a settled aim; and it was only by cutting down one tree after another, that his pursuers, by confining him within a very limited range, were enabled to destroy him by several successive shots, some of which penetrated his body and wounded his viscera. Having received five balls, his exertions relaxed, and reclining exhausted on one of the branches of a tree, he vomited a considerable quantity of blood. The ammunition of the hunters being by this time expended, they were obliged to fell the tree in order to obtain him, and did this in full confidence that his power was so far gone that they could secure him without trouble, but were astonished, as the tree was falling, to see him effect his retreat to another, with apparently undiminished vigour. In fact, they were obliged to cut down all the trees before they could drive him to combat his enemies on the ground, against whom he still exhibited surprising strength and agility, although he was at length overpowered by numbers, and destroyed by the thrusts of spears, and the blows of stones and other missiles. When nearly in a dying state, he seized a spear, made of a supple wood, which would have withstood the strength of the stoutest man, and shivered it in pieces; in the words of the narrator, he broke it as if it had been a carrot. It is stated by those who aided in his death, that the human-like expression of his countenance, and piteous manner of placing his hands over his wounds, distressed their feelings, and almost made them question the nature of the act they were committing. When dead, both natives and Europeans contemplated his figure with amazement. His stature, at the lowest computation, was upwards of six feet; at the highest, it was nearly eight; but it will afterwards be seen that it was probably about seven.

In the following description, which I give in the words of my informant, many of my readers will detect some of those external conformations which distinguish the young eastern orang outangs that have been seen in Europe. The only part of the description in which the imagination seems to have injured the fidelity of the portrait, regards the prominence of the nose and size of the eyes, neither of which are verified by the integuments of the animal's head. "The animal was nearly eight feet high, and had a well-proportioned body, with a fine broad expanded chest and narrow waist. His head also was in due proportion to his body; the eyes were large, the nose prominent, and the mouth much more capacious than the mouth of a man. His chin was fringed from the extremity of one ear to the other, with a beard that curled neatly on each side, and formed altogther an ornamental rather than a frightful appendage to his visage. His arms were very long, even in proportion to his height, and in relation to the arms of men; but his legs were in some respects much shorter. His organs of generation were not very conspicuous, and seemed to be small in proportion to his size. The hair of his coat was smooth and glossy when he was first killed, and his teeth and appearance altogether indicated that he was young, and in the full possession of his physical powers. Upon the whole," adds his biographer, "he was a wonderful beast to behold, and there was more in him to excite amazement than fear."

That this animal showed great tenacity of life, is evident from his surviving so many dreadful wounds; and his peculiarity in this respect seems to have been a subject of intense surprise to all his assailants. In reference to this point, it may be proper to remark, that, after he had been carried on board ship, and was hauled up for the purpose of being skinned, the first stroke of the knife on the skin of the arm produced an instantaneous vibration of its muscles, followed by a convulsive contraction of the whole member. A like quivering of the muscles occurred when the knife was applied to the skin of the back, and so impressed Captain Cornfoot with a persuasion that the animal retained his sensibility, that he ordered the process of skinning to stop till the head had been removed.

It seems probable that this animal had travelled from some distance to the place where he was found, as his legs were covered with mud up to the knees, and he was considered as great a prodigy by the natives as by the Europeans. They had never before met with an animal like him, although they lived within two days' journey of one of the vast and almost impenetrable forests of Sumatra. They seemed to think that his appearance accounted for many strange noises, resembling screams and shouts, and various sounds, which they could neither attribute to the roar of the tiger, nor to the voice of any other beast with which they were familiar. What capability the great orang-outang may possess of uttering such sounds does not appear, but this belief of the Malays may lead to the capture of other individuals of his species, and to the discovery of more interesting particulars of his conformation and habits.

The only material discrepancy which I can detect in the different accounts which have been given of this animal, regards his height, which in some of them is vaguely stated at from above six feet to nearly eight. Captain Cornfoot, however, who favoured me with a verbal description of the animal when brought on board his ship, stated that "he was a full head taller than any man on board, measuring seven feet in what might be called his ordinary standing posture, and eight feet, when suspended for the purpose of being skinned."

The following measurements, which I have carefully made of different parts of the animal in the Society's Museum, go far to determine this point, and are entirely in favour of Captain Cornfoot's accuracy. The skin of the body of the animal, dried and shrivelled as it is, measures in a straight line from the top of the shoulder to the part where the ancle has been removed, 5 feet 10 inches, the *perpendicular* length of the neck as it is in the preparation $3\frac{1}{2}$ inches, the length of the head from the top of the forehead to the end of the chin 9 inches, and the length of the skin still attached to the foot from its line of separation from the legs 8 inches;—we thus obtain 7 feet $6\frac{1}{2}$ inches as the approximated height of the animal. The natural bending posture of the ape tribe would obviously diminish the height of the standing posture in the living animal, and probably reduce it to Captain Cornfoot's measurement of 7 feet, whilst the stretching that would take place when the animal was extended for dissection, might as obviously increase his length to 8 feet.

(To be continued.)

On the Lead Mines in the South of Spain.

THE metalliferous limestone of the South of Spain is so rich in galena, as to furnish, even in the present imperfect state of mining in that country, about 20,000 tons of lead, a quantity nearly equal to half of the total produce of the lead mines of England (45,000 tons). It is worthy the attention of the lead-mine owners in England, that those of Spain consider themselves well paid if they get L. 19 sterling per ton, on delivery in London; and that the quantity actually made will go on increasing, as the population becomes more numerous, or as the power of machinery is substituted for manual labour. The introduction into this district of machinery from England, also deserves the most serious consideration, as it would not only give the greatest stimulus to the lead trade, but would also enable those who have lately discovered valuable iron mines near Marbella (25 miles south-west from Malaga, and not 4 miles from the sea), to ruin a branch of trade almost exclusively in our hands, namely, the construction of iron-hoops for barrels, &c. for which, in a wine-country, there is a great demand. It is certain that there are now in England agents employed for the purpose of purchasing machinery for the owners of these mines, who are only waiting for its arrival, and for that of an Englishman to superintend it, to commence their projected manufactory. Having stated this much, I may now ask, how far we might be justified in refusing the introduction of machinery to a country, which rigidly prohibits almost every article of British manufacture, and charges the few that are permitted with such exorbitant duties, that they can only be smuggled into it? Should the prohibition of machinery be deemed expedient under the above circumstances, it would be necessary to prevent any being sent, as it now is, when intended for Spain, to Gibraltar, under the idea of this being an English and a free port. Every one knows that there are neither mines nor manufactories on the rock of Gibraltar; it is therefore absurd to make use of such a pretext for the introduction of machinery into Spain, thereby enabling that country to rival us in interesting branches of our commerce. I am of opinion, that the captain of this port, who is now a Magistrate, and is empowered to visit every ship in the bay, ought to be directed to seize any machinery he may discover; for, as it cannot be intended for Gibraltar, nor for English interests, it is evident, that its being put into the bill of lading as destined for that port, is a mere stratagem; and it no sooner arrives there, than it is transferred to another vessel, to be landed at some place along the coast. Political economists will perhaps say, that if our machinery enriches Spaniards, they will purchase more of our articles. As a general principle, this I admit; but when we know that almost every British article of trade is strictly prohibited (even coals, although there is not a single coal-mine wrought in the Spanish Peninsula), I cannot help thinking, that such prohibitions on their part should be followed by similar prohibitions on ours, with respect to articles so likely to operate to our immediate disadvantage, and that they call for legislative interference, as being subversive of free trade in general. H. WITHAM, Esq. F. R. S. E. &c.

Letter of Professor BUCKLAND *to Professor* JAMESON, *and of Captain* SYKES *to Professor* BUCKLAND, *on the Interior of the Dens of living Hyænas.*

DEAR SIR, *Oxford*, *5th March* 1827.

IN the 4th volume of the Memoirs of the Wernerian Society of Edinburgh, a paper has been printed by Dr Knox, in which he expresses doubts as to a circumstance I have insisted on in my history of the Cave of Kirkdale, namely, that it is the habit of living hyænas to drag home their prey to the interior of their dens.

These doubts he allows are founded only on the two negative facts, that, during his residence at the Cape, he has never seen hyænas engaged in the act of dragging dead carcases into their den, nor ever examined, or caused to be examined, the interior of their habitation, to see what may be its contents. He at the same time candidly admits, that negative evidence is never reckoned so good as positive; and that, after all, my theory is perhaps the best hitherto offered.

In No. 28, also, of the Edinburgh Philosophical Journal, Dr Fleming contends, it is more probable that the bones discovered in the cave of Kirkdale have been drifted in by water, than gradually accumulated by the agency of hyænas that once inhabited it; and adds, that "the evidence proving the Kirkdale Cave to have been an Antediluvian Den, seems in all its parts so deficient in precision, as to warrant the rejection of that hypothesis it had been produced to support."

As in cases of this nature, where the question is concerning facts, the evidence of accurate and independent observers is most competent to decide the point at issue, I subjoin a copy of a letter I have lately received from Captain Sykes, a friend of Dr Somerville, now on service near Bombay, who has recently been investigating this subject. From his observations, it appears that the interior of a living hyæna's den, presents an exact fac-simile of the mangled antediluvian remains that occur in the caves of Kirkdale and Torquay.

My Dear Sir, *Poona*, 11*th June* 1826.

Your commission with respect to the hyæna has not been executed probably with the promptitude you anticipated, but, in truth, it was only in my last campaign I was enabled to meet with a hyæna, to satisfy myself fully with respect to the habits of this beast. At the present moment, from having examined the dens of hyænas in three different districts, I can state to you confidently, that these animals do carry with them into the recesses of their dens their prey, or such parts of their prey, as the narrowness of the entrances and passages of their abodes will admit. I first examined some dens in the face of a hill about eighteen miles north of Poona in March 1825, near a place called Mahloonga. The rockiness of the ground disabled me from laying them open, but I pulled out myself, from some feet within the entrances of two dens, several bones. Bones also lay strewed about the mouths of the dens, but not in any great quantity. The hyænas evaded our pursuit, and the plans we laid to entrap them for some days, although they had the courage to come for two successive nights and devour more than three parts of a dead pony I had dragged to about one hundred yards from my encampment. Subsequently to this period, I had not an opportunity of examining another hyæna's den until the 23d December 1825. Being then encamped at Kowta, in the Pabool district, a den was pointed out to me about three and a half miles S. by E. from the village. I found it situated on the bank of a water-course. The den had several entrances and outlets. I had these carefully closed, and trusted I had secured the animals within. The depth of calcareous soil on the banks of the water-course led me to expect that I should not meet with any impediment in laying open this den. Leaving a man to watch until I could send a sufficient number of my people with tools to dig at it, in the course of a couple of hours I set fourteen men to work, and in a few hours more the whole den was laid open to the day; they had closed it up before the hyænas had returned home, and therefore did not meet with them. We found the den to consist of several passages on two different levels; some of these terminated in the exits and entrances, others in small chambers, not of any determinate form. In the lowest passage, at the depth of several feet from the surface, and 18 feet from the nearest entrance, I found numerous bones, broken and whole. These bones appeared to be those of the camel, buffalo, ox, hog, dog, and sheep; but you will be enabled to judge for yourself, as I have sent you some of them dug out of the den. At 24 feet from the entrance I took out the rib of an ox. Not near so many bones were found outside the den as inside, some few only were lying about the mouths of the northern entrances, and none whatever in the bed of the water-course below the southern entrance. The Latitude of this den is 18° 21″ N. nearly; and Longitude 74° 24′ E. The country near is amygdaloid greenstone in horizontal strata, and the elevation of the dens above the sea, determined by the boiling temperature, is 1650 feet.

I had almost despaired of getting you the skeleton of a hyæna, when fortunately, on my march from the Pabool to Cheencholee, on the 14th February 1826, I saw a large male and a female basking in the sun, with a couple of good sized cubs tumbling about them. The country is a table land, and perfectly open. The beasts were about half a mile from the road. I was obliged to approach them without disguise or concealment. As I neared them, the cubs disappeared in the den, and the female walked slowly away; but the male waited very coolly until I got within a hundred yards of him, when a ball from my gun brought him down. I had shot him through the shoulder, and on running up to him found he had sufficient strength left to move; and fearful he would get into his den, distant only five paces, I put a ball through his head. I regret this now very much, as it broke the skull into fragments, and it will occasion you a good deal of trouble to put them together again. My people had most of them passed on to the new ground of encampment eight miles distant; and as it was getting very hot, I did not think it necessary to dig out the cubs. The hyæna family I found had been regaling themselves on the remains of a jackass, some of whose bones, with the half putrified flesh on them, were lying about. The rest of the animal was doubtless in the den, as I pulled out from one of the passages a hind-leg and haunch, with part of the flesh on it, which the hyænas had been disabled from taking into the recesses of the den, by the leg having stiffened into so angular a form, as not to admit of its passing where the rock narrowed.

I have to remark a very singular fact with respect to the habits of these carrion beasts. It was evident from the accumulation of dung on the same spot, in a hollow about ten feet from the entrance of the den, and from this substance not being found in any other place, that these beasts, young and old, resorted regularly to a chosen spot; in short, that they had thought it necessary, in their domestic arrangements, to render a spot sacred to the goddess of filth. A very few words will now close the hyæna's history. The beast I had killed was taken to my tents, carefully skinned, and the skin cured in the native way, by being rubbed with turmeric and salt, and subsequently with thick acid milk. The flesh was boiled off the bones; and the skeleton, skin, and some of the bones found in the several dens, were packed into a box; put on board the Pyramus, and directed to you, and I trust you will receive this box almost as soon as you get my letter. I have omitted to remark, that porcupines' quills are commonly found in hyenas' dens; these animals, therefore, must be their prey. The hyenas, although sometimes as large or larger than a stout mastiff, contrive to creep along very narrow passages in their dens. I have farther only to remark of the hyena, that it is a cowardly beast. It never attacks where there is any risk; and, when chased and driven to extremity, submits to be killed almost without resistance. When the beast does bite, and gets a fair hold, the power of the jaws is so great as to admit of their fracturing any bone of a horse or an ox.

(Signed) W. H. Sykes.

To the above letter of Captain Sykes, I add no farther note or comment. Your readers will judge for themselves how far it may confirm the theory I have proposed in my *Reliquiæ Diluvianæ*, to explain the accumulation of teeth and bones in the Cave of Kirkdale.

P. S.—I beg to correct an omission that occurs in No. XXVIII. of your Journal, p. 363. in the description of fragments of gnawed bones, from the cavern of Kent's Hole, near Torquay, that are stated to have been sent to the Edinburgh Museum by myself. They were only transmitted through me, and at my request; but they were both discovered and presented by the Reverend J. M'Enery of Torquay, a gentleman who, during two years' past, has exerted himself with the greatest zeal and success in exploring the contents of this cavern, and who has formed the most extensive and most instructive collection of gnawed and mangled fragments of skeletons of antediluvian animals, that has yet been made. It is highly gratifying to me to add, that the conclusions he has drawn from his own independent observations in the larger cavern of Kent's Hole, are in perfect harmony with those I had founded on a display of similar phenomena, though on a less extensive scale, in the cave of Kirkdale.

On the growth and preparation of Straw used in the Tuscan Trade *.

THE following observations have been extracted from some valuable communications which have reached the Highland Society from Mr H. Hall of Florence, Mr Boswell of Kingcausie, and others; and will perhaps afford information on some points of management in the growth and preparation of the straw used in the Tuscan trade, which may not yet be quite familiar in this country.

"The seed from which the straw for plaiting is grown, is a small round grain of wheat, called *grano marzuolo*, or more properly *grano marzolano*. It is so called from being sown in the month of March, and differs from common wheat in appearance, from its rounder and

* Extracted from the printed List of Premiums of the Highland Society of Scotland for 1827.

shorter shape. It is an error to suppose, that hats are made from rye, or any other grain in Tuscany. This *marzolano* straw is cultivated for the sole purpose of being made into hats; and is grown chiefly in the vicinity of Florence, and on the hills on both sides of the valley of the Arno. The growth of the straw is thus almost exclusively confined to a limited part of the province of Tuscany. A few years ago, the Pope, aware of the source of wealth which this manufacture produced in that quarter, attempted to introduce the culture of it into his States. From the habits of the people, difference of soil or climate, or from all these causes conjoined, the plan did not succeed; and the Grand Duke of Tuscany having now allowed the prepared straw to be exported, the idea of cultivating it elsewhere seems to be altogether abandoned. Tuscan women, in the mean time, have settled themselves in various places, such as Vienna, Petersburgh, &c., where they carry on the manufacture with straw grown in Tuscany.

" The seed is sown on good ground, but not rich; some sow it on poorish land. In general, vines and olives bound the fields in which it grows, or are planted at intervals in the interior of these fields, like orchards in this country. The practice in sowing flax is known to every agriculturist; and nearly the same holds in regard to the *marzolana*, where the qualities especially to be obtained, are fineness, tenacity, and toughness.

" To obtain the first, it is sown so thick, that each blade touches another. Manure is never made use of on the ground to be under *marzolana*. The seed is sown on the ground in a flat state, and a person must be taught the method of sowing it, which is done " underhand." The seed is then covered in, by hoeing the ground with a draw-hoe, about three times the size of our common turnip-hoe. This is done as near the first of March as the season will permit. From the beginning to the middle of July (according to the season), it is ready, which is known by the ear being fully shot, but before it is formed into grain. The plant is then, if a good crop, eighteen inches in height. The straw is not cut, but plucked by main force from the soil, and then exposed for the purpose of bleaching, not in bundles, but scattered about in meadows or gravel grounds, exposed to the evening dew and the midday sun, until it is perfectly yellow; but constantly watched, to gather it together, and put it under cover at the least appearance of rain, which would spoil it, and make it turn out completely speckled. After it is sufficiently bleached, it is tied in bundles, and brought to the manufactory, where children are employed to pluck the only part of the straw which serves for plaiting, that is, what is comprised betwixt the ear and the first joint in the stalk. If the weather is fine, in fifteen days after the crop is pulled, it will be ready to work into plait, " treccie," as it is called. The natives say, that the dew tends greatly to whiten it; but if any rain falls it is ruined. The manner of separating the top joints is by a smart jerk of the hand. These are made up for sale, and the remainder thrown to the dunghill, for no animal will eat it.

" To obtain the whiteness so much prized, the straw is smoked with sulphur previous to being worked; the plait is also smoked, and, lastly, the hat. About Sienna, the process is simply a little sulphur set on fire in the bottom of a large chest, bunches of the straw being placed on long hazel rods across, and the lid shut down. Elsewhere, the articles are described as being placed in a small close room, in which a chafing dish of sulphur is placed and set fire to. Sometimes the operation requires to be done twice before it succeeds.

"The straw for use is classed or stapled like our wool. Children or inferior hands, work the course thick straw, while good hands work the fine only. Whether fine or coarse, it is only the part on which the spike grows that is made use of, and it is always the same plait, consisting of thirteen straws, which is worked. In the fine plait, there is a very great waste of straw, as they reject all that is in the least too thick, and they cut off a considerable part of the straw where it comes near the flower spike. Fine plait is not accounted good, unless very much drawn together, for which end it is worked very wet. The bunches of straw are always put into a small jar filled with cold water, which stands beside the worker. After being smoked and pressed, the plait is made up into hats by women, who do nothing else; it is put together by the edges, not overlapped. On the operation of pressing a great deal depends. There are only two good machines for that purpose in the country.

"Such is the practice for procuring the hat-straw. What they sow for seed is in other ground: Not one-fourth of the seed is used, and the grain is allowed to come to maturity in the usual way. It is said to be a capital wheat for *vermicelli, macaroni,* &c. and also for making into bread.

"It ought to be taken into view, that, for the use of the manufacture in Scotland, the straw should not exceed one-eighteenth of an inch in diameter. When coarser, it does not answer the market; and much of the very finest straw is not required, because the bonnets made from it are too expensive."

Remarks on Dr Latta's Observations on the Artic Sea and Ice. In a communication from the Rev. Mr Scoresby to Professor Jameson *.

On reading Dr Latta's "Observations on the Arctic Sea and Ice †," in the last number of the Edinburgh New Philosophical Journal, I was rather surprised at the following hasty, and, if I mistake not, unwarrantable remark. Speaking of the climate of Spitzbergen, Dr Latta refers to my Account of the Arctic Regions, saying "Mr Scoresby, biassed by the indications of the thermometer, reasons himself into the supposition, that the climate, during summer, is more temperate than even

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* Read before the Wernerian Society, 10th March 1827.

† Edinburgh New Philosophical Journal, October—December 1826.

Scotland, and gives to the circle of perpetual congelation an altitude of 7791 feet,—a statement contradicted by facts."

Now, in this bold remark, Dr Latta first ascribes to me a statement I never made, that I am aware of; then bluntly says, that it is contradicted by facts! I do mention it, indeed, as a remarkable circumstance, that, on mountains of 3000 feet elevation in Spitzbergen, the snow should sometimes be wholly dissolved at their summits, when, in so much lower a latitude, Ben-nevis should occasionally exhibit a crest of snow throughout the year (Vol. i. p. 123.) But I nowhere reason myself into the supposition that the climate is therefore warmer. I only reason that " the *upper* line of congelation, where frost perpetually prevails," is much higher on the Arctic lands than was to have been expected from its mean temperature. And, applying the known law of diminution of temperature, on ascending in the atmosphere, to the summer heat of Spitzbergen, I observe, that " it will require an elevation of 7791 feet for reducing that temperature to the freezing point;" and hence I reckon this to be about the altitude of perpetual freezing,—p. 126.

What facts Dr Latta can bring forward, to shew that a thawing temperature never occurs so high, I know not; especially when, by observation of the thermometer, I found the temperature in Spitzbergen so high as 37° Fahr. at *mid-night*, at an elevation of about 3000 feet.

Not thinking it right to allow a bold assertion, which I believe to be unfounded, to pass before the Society as correct, nor an assertion declared to be dependent upon facts to retain such a basis, unless these facts can be substantiated, I have ventured to trouble the Society with these remarks. Besides, I acknowledge my feeling to be that which is no doubt common to authors, greatly averse to the charge of such theorising views as to be capable of reasoning myself into conclusions contradicted by facts; an equal aversion, also, to be charged with asserting what, to the best of my knowledge, I never did. As such, I think it behoves Dr Latta, either to bring forward the facts which contradict my statements, or to have the candour to acknowledge the mistake he has fallen into. 4

Bridlington Quay,
January 6. 1827.

On the Coniometer. In a Letter from Professor LESLIE to Professor JAMESON.

MY DEAR SIR,

HAVING just seen a paragraph in the *Annals of Philosophy* for March 1827, copied from the *Annales de Chimie et Physique*, in which my contrivance of an instrument to measure the specific gravity of powders is reclaimed for M. Say, Captain of Engineers, who, it seems, perished in the famous Egyptian Expedition; I trust you will allow me to offer some explanation.

I was aware that attempts had been made to apply the law of Mariotte, in ascertaining the specific gravity of a substance which could not be immersed in water, but supposed them to have proved unsuccessful; and all this I stated at the time to the persons who witnessed my experiments. When I first visited Paris in 1802, my kind friend the late M. Guyton-Morveau shewed me an apparatus for that purpose; and it then appeared to me very clumsy and unmanageable. I have no recollection of the nature of its construction, and only a sort of faint impression that it was somehow connected with an air-pump. Indeed, were it worth while, I could easily point out two several methods of discovering, by help of a good air-pump, the absolute bulks, and consequently the specific gravities, of powders and very porous substances.

I have now looked into the article referred to in the 23d volume of the *Annales de Chimie*, and will most readily admit, that the *Stereometer* of M. Say is substantially the same as my *Coniometer*. But of this coincidence I was quite unconscious, when I designed my instrument. I made no boast of discovery, and only mentioned it as a simple contrivance, which could be directed to some very useful and curious researches. I permitted, indeed, a gentleman who admired its application, to draw up a popular description of it in his own way; but I deferred giving any account of it myself, till I had brought it to greater perfection, and was enabled to produce a series of correct and interesting results. So little, however, did it engage my attention, that I have suffered it to remain nine months for alteration, in the hands of the artist. A year has nearly elapsed before any chemical philosopher has challenged its originality; and Dr

Thomson, Regius Professor of Chemistry at Glasgow, whose acuteness, memory, and extensive reading, are universally acknowledged, has, within these very few days, ordered his workman in Edinburgh to execute for him a copy of the instrument. For myself, I can positively aver, that I never chanced to light on the Memoir of M. Say; and that, although I have been very diligent, of late years, in collecting philosophical apparatus, I have not found any account of his stereometer in elementary works of science, or met with that instrument in the physical cabinets I have seen either at home or abroad. I suspect it has been confined to the Polytechnic School, and am yet to learn what sorts of experiments have been made with it.

While I willingly concede, then, the right of priority, and cordially give to the late M. Say the praise of ingenuity and accuracy of conception, I must consider his stereometer as an imperfect project, and scarcely applicable, in its original form, to practice. The coniometer possesses several decided advantages over the instrument figured in the *Annales de Chimie: 1st,* The part for receiving the powder being long and narrow, the capsule is easily and nicely applied; but in the stereometer, the recipient is a broad shallow cup, the lid of which, fitting with difficulty, may shut up an undue share of air. *2dly,* The long slender tube is easily pressed down into a wider one, containing mercury; whereas Say's instrument is plunged into an enormous cistern of mercury, or at least a very tall receiver. *3dly,* In the coniometer, the scale engraved on the slender tube marks at once the absolute bulk of the powder or porous substance, or rather the weight of an equal volume of water; there is a sliding scale on the outer tube, and an adjustment for the variation of the altitude of the barometer. *4thly,* The slender tube has besides another set of numbers engraved, corresponding to the triplication, as the former does to the duplication, of the volume of included air. By comparing the two results, we are enabled to determine, whether the air contained in the porous substance exists in a condensed state, and to calculate the degree of condensation. *5thly* and *lastly,* The coniometer has already indicated some very curious and interesting results, which I regard, however, at present as only approximative. As soon as I have brought the instrument to a more perfect form, I purpose to institute a series of accurate experiments with it.

In conclusion, I think, a journalist certainly entitled to remark, in a tone of right feeling, those coincidences which must at times occur in the history of science, when different persons happen to strike into the same path of inquiry; but to hunt incessantly after obscure, vague and distorted charges of plagiarism, only betrays the workings of a base and malignant disposition. I ever am, &c. (Signed) JOHN LESLIE.

QUEEN STREET, *March* 9. 1827.

List of Rare Plants which have Flowered in the Royal Botanic Garden, Edinburgh, during the last three months; with Description of a new species of Euonymus. Communicated by Dr GRAHAM.

10*th March* 1827.

Banksia latifolia.

——— serrata.

Dichorisandra thyrsiflora.

Euonymus scandens.

E. scandens; fruticosa, scandens, radicans; foliis lanceolato-ovatis, crenato-serratis, venis obliquis; pedunculis filiformibus, axillaribus bis (terve ?) dichotomis; germine scabro.

DESCRIPTION.—*Shrub* climbing to a great distance. *Branches* very long, cylindrical, green with brown scars, adhering to every thing in contact with them, by long, flattened, branching, white threads, which at first spring in linear tufts, but afterwards throughout the whole length of the branches, and hanging loose on all sides, conceal these in an entangled mass. *Leaves* opposite, somewhat decussating, the older ones somewhat coriaceous, the younger shining and membranous, bright green, and paler on the back, ovate or ovato-lanceolate, acuminate, crenato-serrate, the serratures being frequently, especially on the ovate leaves, compound, veins oblique, and, as well as the middle rib, prominent on both sides, reticulations at the edges most distinct on the under. *Petioles* channelled, approximate on the branches, distichous on the flowering-shoots (¼inch long); *stipules* minute, brown, lacerated, one on each side of the petiole; *buds* lanceolate, pointed, covered by imbricated blunt scales, some of which are persistent upon the base of the twig. *Bracteæ* small, awl-shaped, brown, reflected, slightly fringed, with brown glands at their edges. *Peduncles* axillary twice (or thrice ?), dichotomous, filiform, angular, straight, nearly three times as long as the petiole. *Calyx* very small, green, tetraphyllous, segments rounded, persisting, at every period concave, and closely applied behind the bases of the stamens. *Corolla* yellowish-white, 4-petalous, petals rounded, minutely toothed, reflected, attached by small claws, which are about the length of the calyx, and concealed. *Stamens* 4; *filaments* whitish and tapering, scarcely longer than the claw of the petals, at first erect, afterwards reflected, inserted into broad, flattened, green bases between the petals; *anthers* yellow, of two roundish lobes, about as long as the filaments. *Germen* flattened, yellowish-green, indistinctly warted. *Stigma* at first deep green and sessile, after the shedding of the pollen paler, blunt, and continuous with a stout, linear, furrowed style equal in length to the filaments.

This species was received from the Botanic Garden, Calcutta, under the name here adopted, in 1823, its native country uncertain, probably Nepal. It approaches nearly to *E. echinata* and *E. vagans* of Flora Indica; but is distinguished from the former by the oblique veins of the leaves, and from the latter by its rooting stem, and probably by its spiny fruit, though, as this has not yet ripened in the Botanic Garden, the appearance of the germen only can be stated.

Liparia sphærica.

Mirbelia speciosa.

Penæa squamosa.

Perdicium brasiliense.

Celestial Phenomena from April 1. *to July* 1. 1827, *calculated for the Meridian of Edinburgh, Mean Time.* By Mr George Innes, Aberdeen.

The times are inserted according to the Civil reckoning, the day beginning at midnight.—The Conjunctions of the Moon with the Stars are given in *Right Ascension.*

APRIL.

D.	H.	′	″		D.	H.	′	″	
1.	9	28	38	☌ ☽ ε ♉	14.	18	18	42	☌ ☽ ν ♏
1.	21	36	18	Im. III. sat. ♃	15.	20	50	55	☌ ☽ ρ Oph.
2.	0	15	22	Em. III. sat. ♃	16.	2	7	–	☌ ♄ η ♊
2.	18	22	2	☌ ζ ♉	16.	5	33	11	Im. III. sat. ♃
3.	2	52	57	Em. I. sat. ♃	16.	17	50	30	☌ ☽ 2 μ ♐
3.	10	26	12	☌ ☽ ♄	17.	19	32	45	☌ ☿ φ ♒
3.	18	45	19	☌ ☽ ν ♊	18.	15	5	32	☾ Last Quarter.
4.	14	16	51	☽ First Quarter.	18.	15	38	33	☌ ☽ ♅
4.	21	21	24	Em. I. sat. ♃	18.	21	17	–	☌ ♀ 96 ♒
5.	18	44	–	Inf. ☌ ☉ ☿	19.	21	42	27	☌ ☽ β ♑
6.	18	22	7	☌ ☽ 1 α ♋	20.	1	9	28	Em. I. sat. ♃
6.	19	23	30	☌ ☽ 2 α ♋	20.	19	38	1	Em. I. sat. ♃
8.	0	45	39	☌ ☽ π ♌	20.	21	16	2	☉ enters ♉
9.	1	34	23	Im. III. sat. ♃	22.	13	8	5	☌ ☽ ♀
9.	4	13	13	Em. III. sat. ♃	23.	9	31	53	Im. III. sat. ♃
9.	22	44	59	☌ ☽ ♌	24.	0	54	47	☌ ☽ ☿
11.	1	2	33	☌ ☽ ♃	25.	20	25	–	Em. II. sat. ♃
11.	23	11	55	◯ Full Moon.	26.	2	47	37	● New Moon.
11.	23	15	23	Em. I. sat. ♃	26.	3	3	38	Em. I. sat. ♃
11.	23	26	39	☌ ☽ α ♍	27.	21	32	12	Em. I. sat. ♃
12.	16	58	37	☌ ♀ λ ♒	28.	1	47	50	☌ ☽ ♂
13.	10	17	16	☌ ☽ 2 α ♎	29.	15	47	46	☌ ☽ ε ♉
14.	6	54	58	☌ ☽ κ ♎	30.	1	38	47	☌ ☽ ζ ♉
14.	11	20	3	☌ ☽ λ ♎	30.	13	31	9	Im. IV. sat. ♃
14.	15	50	47	☌ ☽ 1 β ♏	30.	21	57	32	☌ ☽ ♄
14.	15	52	4	☌ ☽ 2 β ♏	31.	2	5	33	☌ ☽ ν ♊

MAY.

D.	H.	′	″	
2.	23	1	17	Em. II. sat. ♃
3.	-			☿ greatest elong.
4.	2	36	57	☌ ☽ 1 α ♋
4.	3	39	22	☌ ☽ 2 α ♋
4.	7	8	45	☽ First Quarter.
4.	13	26	27	Im. I. sat. ♃
6.	14	15	42	☌ ♄ μ ♊
7.	8	41	45	☌ ☽ ν ♌
8.	3	16	–	☿ very near μ ♓
8.	6	49	3	☌ ☽ ♃
8.	9	7	5	♂ very near 1 κ ♉
8.	9	21	21	♂ very near 2 κ ♉
9.	9	56	7	☌ ☽ α ♍
10.	1	37	49	Em. II. sat. ♃
10.	20	43	54	☌ ☽ 2 α ♎
11.	8	8	41	○ Full Moon.
11.	16	49	38	☌ ☽ κ ♎
11.	21	8	36	☌ ☽ λ ♎
12.	1	20	49	Em. I. sat. ♃
12.	1	32	50	☌ ☽ 1 β ♏
12.	1	34	5	☌ ☽ 2 β ♏
12.	3	57	2	☌ ☽ ν ♏
13.	5	43	1	☌ ☽ ρ Oph.
14.	2	1	7	☌ ☽ 2 μ ♐
14.	3	27	41	♂ very near γ ♉
14.	21	28	48	Im. III. sat. ♃
15.	0	3	22	Em. III. sat. ♃
15.	22	31	49	☌ ☽ ♅
16.	4	15	42	☌ ☽ β ♑
17.	22	42	50	☾ Last Quarter.
20.	21	43	49	Em. I. sat. ♃
21.	21	32	43	☉ enters ♊
22.	11	0	34	☌ ☽ ♀
22.	15	14	26	☌ ♀ ο ♓
24.	5	10	24	☌ ☽ ☿
25.	18	23	24	● New Moon.
27.	0	24	–	☌ ☽ ♂
27.	8	6	–	☌ ☽ ζ ♉
27.	23	38	17	Em. I. sat. ♃
28.	8	31	24	☌ ☽ ν ♊
28.	10	11	10	☌ ☽ ♄
31.	9	27	31	☌ ☽ 1 α ♋
31.	10	30	48	☌ ☽ 2 α ♋

JUNE.

D.	H.	′	″	
2.	20	37	29	☽ First Quarter.
3.	17	19	34	☌ ☽ ν ♌
3.	22	47	24	Em. II. sat. ♃
4.	14	29	39	☌ ☽ ♃
5.	19	11	48	☌ ♂ 132 ♉
5.	19	54	46	☌ ☽ α ♍
7.	7	23	51	☌ ☽ 2 ♎
8.	3	38	44	☌ ☽ κ ♎
8.	7	57	24	☌ ☽ λ ♌
8.	12	22	25	☌ ☽ 1 β ♏
8.	12	23	40	☌ ☽ 2 β ♏
8.	14	46	10	☌ ☽ ν ♏
9.	4	32	–	Inf. ☌ ☉ ☿
9.	15	35	50	○ Full Moon.
9.	16	19	2	☌ ☽ ρ Oph.
10.	12	14	46	☌ ☽ 2 μ ♐
12.	6	28	39	☌ ☽ ♅
12.	13	0	48	☌ ☽ β ♑
12.	16	11	26	☌ ☽ 132 ♉
12.	21	55	58	Em. I. sat. ♃
15.	17	41	–	☌ ☿ ♂
16.	8	14	8	☾ Last Quarter.
21.	19	21	34	☌ ☽ ♀
22.	5	10	11	☌ ☽ ε ♉
22.	6	11	3	☉ enters ♋
23.	14	6	11	☌ ☽ ζ ♐
24.	9	53	28	● New Moon.
24.	21	28	46	☌ ☽ ♂
24.	23	27	52	☌ ☽ ♄
26.	1	39	26	☌ ☽ ☿
26.	15	58	22	☌ ♂ ♄
26.	21	23	9	Im. III. sat. ♃
27.	15	17	32	☌ ☽ 1 α ♋
27.	16	21	–	☌ ☽ 2 α ♋
28.	23	2	49	☌ ☽ π ♌
31.	0	3	39	☌ ☽ ν ♌

Times of the Planets passing the Meridian.

APRIL.

D.	Mercury. H. '	Venus. H. '	Mars. H. '	Jupiter. H. '	Saturn. H. '	Georgian. H. '
1	12 32	9 17	13 53	23 58	17 23	7 24
5	12 0	9 20	13 48	23 41	17 6	7 7
10	11 29	9 22	13 42	23 19	16 50	6 49
15	11 4	9 24	13 37	22 57	16 33	6 30
20	10 42	9 26	13 32	22 37	16 15	6 11
25	10 30	9 27	13 27	22 13	15 56	5 52

MAY.

D.	Mercury. H. '	Venus. H. '	Mars. H. '	Jupiter. H. '	Saturn. H. '	Georgian. H. '
1	10 21	9 30	13 21	21 48	15 35	5 27
5	10 20	9 32	13 18	21 31	15 22	5 12
10	10 22	9 34	13 12	21 9	15 4	4 53
15	10 28	9 36	13 6	20 49	14 46	4 34
20	10 37	9 38	13 1	20 29	14 29	4 14
25	10 52	9 41	12 57	20 9	14 12	3 54

JUNE.

D.	Mercury. H. '	Venus. H. '	Mars. H. '	Jupiter. H. '	Saturn. H. '	Georgian. H. '
1	11 18	9 45	12 49	19 40	13 49	3 24
5	11 38	9 48	12 45	19 25	13 34	3 7
10	12 8	9 50	12 40	19 6	13 17	2 48
15	12 34	9 53	12 35	18 47	13 1	2 28
20	12 58	10 0	12 30	18 28	12 44	2 8
25	13 20	10 4	12 24	18 9	12 27	1 48

Proceedings of the Wernerian Natural History Society.

(Continued from p. 191.)

1826, *Dec.* 16.—THE Secretary read Mr Audubon's account of the habits of the Vultur Aura, or Turkey-Buzzard, in which he exploded the opinion generally entertained of its extraordinary power of smelling. (See preceding Number of this Journal, p. 172—184.) Mr Audubon being present, afterwards shewed to the Society his mode of fixing recently killed birds in various attitudes, against a board marked with squares or division lines, corresponding to similar lines pencilled on the sheet of paper on which the drawing is to be made.

A specimen of the Sword-fish, Xiphias Gladius, seven feet in length, found in the Firth of Forth, and transmitted by Mr Slight, assistant to Robert Stevenson, Esq. civil engineer, was exhibited, and described by Professor Jameson. The Professor also shewed specimens of Jet-coal, the sort used on the continent for making ornaments, found in Wigtonshire, by Sir Andrew Agnew, Bart. These specimens, he mentioned, were found under peat-moss and above clay, on the property of Sir Andrew Agnew.

1827, *Jan.* 13.—At this meeting the following gentlemen were admitted members:

NON-RESIDENT.

WILLIAM BALD, Esq. Civil Engineer, Ireland.
GEORGE BENTHAM, Esq. Montpellier.

FOREIGN.

JOHN JAMES AUDUBON, Esq. Louisiana.
Mr CHARLES FRED. HARTTMAN.

Mr Audubon read a memoir on the habits of the Alligator, containing much new information regarding that animal. (See the present Number of this Journal, p. 270, *et seq.*)—Dr Grant then read an account of the anatomy of the Octopus ventricosus, and exhibited a dissected specimen from the Firth of Forth, of large size, and apparently of full growth.

A stuffed specimen of the Tapir of America was exhibited at this meeting; and the members were then invited by the President to view, in another apartment, some live animals, lately brought from Chili, by the Right Hon. Captain Lord Napier, of the Diamond frigate, particularly the Felis Puma, or American lion.

Jan. 27.—At this meeting Dr Grant read an account of the structure of the eye of the Sword-fish, illustrated by a magnified sketch, and by preserved parts of the eye, taken from the animal lately killed in the Firth of Forth.

The Rev. Dr Scott of Corstorphine then read a dissertation on the *Saphan* of the Sacred Writings, proving it to be the Hyrax Syriacus, although rendered *coney* in our common version.

Feb. 10.—At this meeting the Secretary read a communication from the Rev. William Scoresby of Bridlington, containing descriptions of some remarkable Rainbows. (Printed in the present Number, p. 235, *et seq.*)

Professor Jameson then read Mr William Bald's geological survey of Clare Island, on the west coast of Ireland, illustrating the same by maps and sections executed by Mr Bald.

The Professor then gave a general descriptive account of a splendid series of the Pheasants and Peacocks of India, specimens of which were placed on the table. A stuffed specimen of a Persian Sheep, presented to the Royal Museum by James Gibson Craig, Esq. was also exhibited. Mr Audubon laid before the meeting several specimens of the coloured Plates of his great work on American Ornithology, executed by Mr Lizars of this city; and they excited general admiration.

SCIENTIFIC INTELLIGENCE.

NATURAL PHILOSOPHY.

1. *Repulsion of Heat inversely as the square of the distance.*—Sir Isaac Newton has shewn, *Principia*, Lib. ii. Prop. 23 *, that if the repulsion between the particles of a gas were inversely as the square of the distance of their centres, the cube of the pressure would be as the fourth power of the density, and *vice versa*. Now this is precisely the relation which we formerly saw should subsist between the pressure and density of air containing a constant quantity of heat, if, as appears from experiment, the specific heat under a constant volume be to that under a constant pressure as 3 to 4 †; and, therefore, whilst the quantity of heat connected with each particle of air is constant, the repulsion between them is inversely as the square of their distance ‡. This being the law common to magnetism and gravitation, scarcely leaves a doubt that the true ratio is that of 3 to 4. It is also the *actual* law of gaseous repulsion; for that first given by Newton, and generally adopted, making the repulsion inversely as the *simple* distance, really compares the re-

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* Some allege that this proposition requires each particle to act only on those next it; but it holds equally true, whilst each acts on a constant number, however great, if similarly situated.

† See equation (C) page 336. vol. i. of this Journal.

‡ Any tendency in the particles to gravitate toward each other, would not affect a law similar to its own.

pulsions in cases where not only the distances, but the quantities of heat are different. The above principle of the repulsions being inversely as the square of the distance, might easily be shewn to accord with the law of temperature and the law of Boyle. Any variation in the quantity of heat, will, *cæt. par.*, produce proportional variations in the logarithms of the repulsions. Perhaps the same property belongs to magnetism or electricity, if not to gravitation itself. HENRY MEIKLE.

2. *The Beech-Tree a Nonconductor of Lightning.*—Dr Beeton, in a letter to Dr Mitchill of New York, dated 19th July 1824, states, that the beech-tree (that is, the broad-leaved or American variety of *Fagus sylvatica*) is never known to be assailed by atmospheric electricity. So notorious, he says, is this fact, that, in Tenessee, it is considered almost an impossibility to be struck by lightning, if protection be sought under the branches of a beech-tree. Whenever the sky puts on a threatening aspect, and the thunder begins to roll, the Indians leave their pursuit, and betake themselves to the shelter of the nearest beech-tree, till the storm pass over; observation having taught these sagacious children of nature, that, while other trees are often shivered to splinters, the electric fluid is not attracted by the beech. Should further observation establish the fact of the nonconducting quality of the American beech, great advantage may evidently be derived from planting hedge-rows of such trees around the extensive barn-yards in which cattle are kept, and also in disposing groups and single trees in ornamental plantations in the neighbourhood of the dwelling-houses of the owners.

HYDROGRAPHY.

3. *Silica in Springs is dissolved by means of Carbonic Acid.*—Dr Karsten remarks, that, if so feeble an acid as the acetous, is capable of dissolving silica, it is not improbable that the carbonic acid may have the same property. This conjecture he has confirmed by experiment. The experiment may be made as follows. Decompose a portion of liquor silicum by means of a superabundance of any acid, the muriatic, for example, and neutralize the clear fluid with carbonate of ammonia, at the lowest possible temperature. The carbonic acid evolved by this

process combines with the water; and, if the neutral fluid is preserved in a well-closed glass-vessel, it may be kept for many weeks, without exhibiting any precipitation of silica. But if it is exposed to the air, or, better, if the solution is heated in an open vessel, it is decomposed in proportion to the escape of the carbonic acid, and the siliceous earth is deposited on the walls of the vessel in a gelatinous state. This result shews, that the great quantity of silica met with in many mineral springs, particularly hot springs, is held in solution by carbonic acid. It is true, that we cannot in this way explain how the siliceous earth was first dissolved,—for the generally received opinion, that the earth is simply washed out of the strata in the vicinity of the springs, is, according to Karsten, untenable.

ZOOLOGY.

4. *Tit-Lark caught at Sea.*—I have, at this moment, before me (says Dr Traill of Liverpool) extracts from the journal of my intelligent friend Captain Andrew Livingston, which, among other things, notices, that a small bird alighted on the brig Jane of this port, in Lat. 47° 4′ South, Long. 43° 19′ West, on September 11. 1825. It was caught, and when examined here, proved to be the common tit-lark (*Alauda pratensis.*)

5. *Egyptian Antiquities in Liverpool Museum.*—We have in our Museum, many fine Egyptian antiquities; among these is a beautiful papyrus, found in the hand of a mummy. It is upwards of 20 feet in length, the hieroglyphics beautifully executed, and interspersed with numerous pictures. One of these is a representation of the Egyptian Last Judgment, as described by Diodorus Siculus; in which the spirit of the deceased is ushered by a genius before the god *Thoth*, who sits with his tablets writing down the result of a trial, then before him, in which the deeds of the deceased are weighed in a balance, the vibrations of which are intently watched by *Cerberus*. In an upper compartment, the happy issue of the trial is announced by the introduction of the human spirit, under the guidance of the same genius, to *Osiris*. We have an unrolled head of a mummy, a young female, with high thin nose, and long auburn ringlets, confirming the opinion of Cuvier, Blumenbach, and others, that the Egyptians (of the era, at least, of this mum-

my) were not *Negroes*. We have also several mummies shoes, and a beautiful sandal of plaited palm leaves, all which are made "*right and left*," so that even this modern fashion has had an Egyptian origin. I have, in my possession, several Egyptian antiquities, among the rest an exquisite bronze figure of *Harpocrates*, with his finger on his lips, and the sacred beetle on his head. The contour of the body, and grace of the head, are quite Grecian.—*Letter from Dr Traill.*

6. *Notice regarding the Common Star-Fish, Asterias rubens.*—On the 6th of March last year, M. Eudes Deslongchamps observed the beach at Colville to be covered with star-fish. When the waves retired, and there was still an inch or two of water upon the sand, he saw them rolling out in the form of balls, which, on examination, he found to consist of five or six individuals, closely united and clinging together by their rays. In the centre of each of these balls was a full grown specimen of *Mactra stultorum*. The asteriæ were arranged along the edge of the valves, which were always separated to the distance of two or three lines; they were applied to them by their lower surface. On detaching them from the shell, it was remarked, that they had introduced between its valves, large round vesicles, with very thin walls, and filled with a transparent fluid. Each asterias presented five pendent vesicles, arranged symmetrically about the mouth. These vesicles were of unequal size: two of them were commonly larger, and about the size of a very large hazel-nut; the other three were not larger than a pea. They appear to be connected with the animal by a very short and narrow peduncle. At the other extremity was a round open hole, through which the fluid, contained in the vesicle, flowed gently, and drop by drop. The walls of these vesicles were very thin; the upper half, however, was thicker than the other and longitudinally wrinkled. At the end of a few seconds, the vesicles having contracted and discharged their contents, were scarcely larger than a grain of ordinary shot. When the sea had left the asteriæ some moments dry, they quitted the animal which they were in the act of sucking, and immediately after, the place of the vesicles could no longer be distinguished. The shells, that had been seized

upon by these animals, were found in various states of destruction; some so far gone as to have only the adductor muscles remaining; but all of them had lost the faculty of closing their valves, and appeared to be dead. If testacea be the ordinary food of the asteriæ, an enormous quantity of them must be destroyed, if we may judge by the number of these animals. M. Deslongchamps inclines to the opinion that the asteriæ attack the mactræ while the latter are still alive, and that, probably, by means of some fluid, capable of producing torpor, they force them to open their shells, and thus allow the introduction of the singular bodies described, and which act as suckers. He is the more inclined to think so, that none of the mactræ, which he examined, had the least smell, or presented any other indication of having been dead for any time. It must, however, be remembered, that bivalve shells of this, or any other analogous species, tossed about by the waves, are no longer in their natural state, but have been raised from their native haunts under the sand, either by boisterous weather, or after intense frost, by even a scarcely more than ordinarily troubled state of the sea. Shells in this state are frequently observed on our shores. In some the animals are dead, in others so much weakened, as to be unable to close their shells, while others may, at least after gales, be for a time apparently as sound as ever. Now, it is more than probable, that the asteriæ could only attack those which were absolutely dead or dying, and from which the insertion of their suckers could experience no opposition; for it would be impossible for them to insinuate even a pretty solid substance, much less a mere vesicle, between the closed valves of a living shell; and, on the other hand, how should the asteriæ contrive to make the shell of a vigorous animal open, in order to let them throw in their imagined torporiferous fluid?

BOTANY.

7. *Conclusions of M. Dureau de la Malle's Inquiries, respecting the Ancient History, Origin, and Native Country of the Cereales, and especially Wheat (Triticum hibernum and æstivum), and Barley (Hordeum vulgare and hexastichon).*—

1. That the city of Nysa, the native country of wheat and barley, is the same as Scythopolis or Bethsané, and is situated in the valley of the Jordan. 2. That the identity of the wheat and barley, anciently cultivated in Egypt and Palestine, with our *Cereales*, is certain. 3. That the habitat of all the vegetables, animals, and minerals, indicated by the most ancient monuments, as existing in the country of barley and wheat, has been confirmed beyond doubt. 4. That the comparison of the various zodiacs, the migrations of the worship of Ceres, confirm this origin of the *Cereales*. 5. That the greater number of species of the genera *Triticum*, *Hordeum*, and *Secale*, whose habitat is known, being indigenous in the East, the testimony of history accords sufficiently with the rules of criticism established by science ; and that the valley of the Jordan, the chain of Libanus, or the part of Palestine and Syria, which borders upon Arabia, may with great probability be assigned to our *Cereales*, as their native country.

8. *Instructions for Collecting and Preparing Fungi for Herbariums, and for Preserving them from the Attacks of Insects and their Larvæ.* By M. C. H. Persoon.—A few words regarding the proper time for gathering Fungi, and the localities in which they are found, precede these useful instructions. The following are the principal rules of preservation given by this celebrated mycologist:—1. To gather the coriaceous and suberose fungi, before they begin to get old, lest they should contain germs of destruction, the most formidable of which are the eggs of insects, and to expose them from time to time to the rays of the sun. 2. To subject to pressure, without squeezing too much, the thinner species, to change the paper often, and expose them to the open air. 3. To leave in the open air, until perfectly dry, the gelatinous fungi, such as the *Tremellæ*, *Auriculariæ*, &c. When immersed in water, they resume their original form and colours. 4. To model in wax, or immerse in weak spirits, the species whose forms cannot be exactly preserved. 5. To gather the *Lycoperdineæ* when half mature, and let them dry in the air, that they may bear a slight degree of compression, without being deformed. 6. To preserve the *Trichiaceæ* and *Isaria*, which grow upon chrysalids, in small boxes furnished with cotton, in order to retain

their delicate forms, which would be destroyed by the slightest shock. 7. To dry, in the usual manner, by a moderate degree of pressure, in grey paper, the *Fungoids* of a thin and papyraceous consistence, as well as the epiphyllous fungosities. 8. Lastly, After complete desiccation, to inclose them in paper bags, to prevent the attacks of insects and worms, and especially to defend them against the contact of foreign bodies. In this manner, says the author of the *Synopsis Fungorum*, these productions may be preserved for a long time, in order to compare them with one another, examine them without fear of losing them, and communicate them to others.

9. *Effects of certain Manures on the qualities vf Plants.*—Among the fertilizers of the soil, high importance is attached, and deservedly, to that mass of matter which results from the process of putrefaction upon organic substances undergoing corruption after death. By reason of its efficacy, it is assiduously procured to fertilize poor soils, to renovate exhausted ones, and prevent good ones from wearing out. Animal manures have a peculiar rankness. Some of them stimulate, or, it may almost be said, cauterize with vehemence. Hence they require admixture of milder materials to mitigate their force. Yet, after the offal and scrapings of large cities, have been mingled with soil in such proportion as not to destroy the life of plants, but to promote their vegetation, they have been considered as communicating, in many cases, a disgusting or offensive quality to some of the vegetables they nourish. They have been charged with imparting a biting and acrimonious taste to radishes and turnips. Cabbages are less sapid and delicate. Potatoes have been observed to borrow the foul taint of the ground. It has been traced to the bulb of the onion. Millers observe a strong and disagreeable odour, in the meal of wheat that grew upon land highly charged with rotten recrements of cities. The like deterioration of quality, has even been remarked in tobacco raised in cow-pens. And stable-dung has been accused of imparting a disagreeable flavour to asparagus. It seems as if some portion of the foul matter of the manure was absorbed by the vegetable radicles, and, after passing unassimilated through the sap-vessels, was converted by the process of nutrition to living substances. This condition of the vegetable species, seems to

receive illustration from analogies in the animal kingdom. Ducks are rendered so ill-tasted from stuffing down garbage at the kitchen door, as sometimes to be offensive when brought as food to the table. The quality of pork is acknowledged to be modified by the food of the swine. The bitterness of partridges has been ascribed to the buds upon which they live; and the peculiar flavour of piscivorous wild fowl, is rationally traced to the fish they devour. Thus a portion of nutrimental matter passes into the living bodies of plants and animals, in certain proportion, without having been entirely subdued, or assimilated. It becomes, therefore, a subject of curious and important reflection. The horticulturist mostly calculates on the quantity of his crop. It is, however, a becoming subject of research, that he should likewise attend to the quality; or perhaps the consumer, his customer, may inform him that an offended palate and injured health, will induce a careful provider to seek uncontaminated articles for his table.—*Dr Mitchill's Discourse at the Anniversary of the New York Horticultural Society*, 1826.

ARTS.

10. *New Mode of applying Graphite, or Black Lead, in Drawings.*—Mr C. Galpin, the inventor of this improvement in the management of graphite, as applied to drawing, having long regretted that a material of so pleasing a neutral colour, should only be capable of producing broad shades, by means of a laborious repetition of lines or touches, commenced a series of experiments with reference to this subject, which, however, did not at first lead to any useful result, on account of the granular separation of the substance, when applied to paper. At length, having thought of reducing it to an impalpable powder, and using it with a brush, he obtained the most complete success, having found that every possible degree of shade can be produced with the nicest uniformity, and in less than a twentieth part of the time required in the ordinary manner. The process is described as follows:—The instruments required are, a small piece of muslin, filled with black-lead reduced to fine powder, which is called a *shader*; a *palette*, made of thick card board; and a *brush* of medium size. The shader is rubbed two or

three times on the palette, near one extremity, by which a small portion of the lead is sifted, as it were, through the muslin ; the brush is passed round in the pulverised graphite, and on some other part of the palette, to adjust the shade required ; the brush is then applied to the paper, to produce a sky, or other expanse of shade, with a circulating motion. To produce a darker shade, the graphite may be rubbed in with alder, pith, or any similar substance, brought to a point.—*Gill's Technical Repository*, 1827.

11. *On Etching and Dyeing at once figures on Ivory ; by Mr J. Cathery.*—The usual mode of ornamenting ivory in black, is to engrave the pattern or design, and then to fill up the cavities thus produced with hard black varnish. The demand for engraved ivory in ornamented inlaying, and for other purposes, is considerable, although the price paid for it is not such as to encourage artists of much ability to devote themselves to this work, which consequently is trivial in design, and coarse in execution. Mr Cathery's improvement consists in covering the ivory with engraver's varnish, and drawing the design with an etching needle. He then pours on a menstruum composed of 120 grains of fine silver, dissolved in one ounce measure of nitric acid, and then diluted with one quart of pure distilled water. After half an hour, more or less, according to the required depth of tint, the liquor is to be poured off, and the surface is to be washed with distilled water, and dried with blotting paper ; it is then to be exposed to the light for an hour, after which the varnish may be removed by means of oil of turpentine. The design will now appear impressed on the ivory, and of a black or blackish-brown colour, which will come to its full tint after exposure for a day or two to the light. The property which nitrate of silver possesses, of giving a permanent dark stain to ivory, and many other substances, has been long known ; but Mr Cathery has the merit of having advantageously applied it in a department of art in which it is likely to be of considerable service, by improving the quality of the ornament, and at the same time of diminishing the cost. Varieties of colour may also be given, by substituting the salts of gold, platina, copper, &c. for the solution of silver.—*Gill's Repository*, Feb. 1827.

NEW PUBLICATIONS.

1. *Essay on the Theory of the Earth.* By Baron George Cuvier; with Geological Illustrations by Professor Jameson. Fifth edition. Translated from the last French edition, with numerous additions by the Author and Translator. Eleven Plates. Blackwood, Edinburgh; Cadell, London. 14s.

On the suggestion of Professor Jameson, the celebrated essay of Cuvier was translated by the late Robert Kerr, Esq. F. R. S. E., and under the revisal of the present editor, who also added to the original a series of notes and illustrations. The success of the work was great. It was speedily republished in America, and translated, with its notes and illustrations, into the German and Italian languages. Another edition was soon required. This, in its turn, was speedily exhausted. Although, in the *third* edition, as in the former, the impression, was great, a *fourth* and enlarged *edition* appeared in 1822. The present, which is the *fifth edition*, is translated from the last edition of the illustrious author, and may be considered nearly as a new work, from the numerous additional facts and views which it contains. The many thousand copies of this work now circulated throughout the British Empire, and indeed in every country where the English language is known, is a proof not only of the very general interest excited by geological facts and reasonings, but also of the absurdity of the opinion still entertained by some of the inutility of this branch of natural history. On this subject, Professor Jameson, in the preface to the present edition, has the following remarks:

"Geology, now deservedly one of the most popular and attractive of the physical sciences, was, not many years ago, held in little estimation; and, even at present, there are not wanting some who do not hesitate to maintain, that it is a mere tissue of ill observed phenomena, and of hypotheses of boundless extravagance. The work of Cuvier now laid before the public, contains, in itself, not only a complete answer to these ignorant imputations, but also demonstrates the accuracy, extent and importance of many of the facts and reasonings of this delightful branch of Natural History. Can it be maintained of a science, which requires for its successful prosecution an intimate acquaintance with Chemistry, Natural Philosophy and Astronomy,—with the details and views of Zoology, Botany and Mineralogy, and which connects these different departments of knowledge in a most interesting and striking manner,—that it is of no value? Can it be maintained of Geology, which discloses to us the history of the first origin of organic beings, and traces their gradual developement from the monade to man himself,—which enumerates and describes the changes that plants, animals, and minerals, the atmosphere, and the waters of the globe, have undergone from the earliest geological periods up to our own time, and which even instructs us in the earliest history of the human species,—that it offers no gratification to the philosopher? Can even those who estimate the value of science, not by intellectual desires, but by practical advantages, deny the importance of Geology, certainly one of the foundations of agriculture, and which enables us to search out materials for numberless important economical purposes?

Positive geology or geognosy, as Cuvier, in his life of Werner, remarks, originated with that remarkable man; and all that has been done towards unravelling the structure of the crust of the earth since his views were made known, has been in harmony with them. The Editor remarks,

"Geology took its rise in the Academy of Freyberg, with the illustrious Werner, to whom we owe its present interesting condition. This being the case, we ought not, (as is at present too much the practice), amidst the numerous discoveries in the mineral kingdom which have been made since the system of investigation of that great interpreter of nature was made known, forget the master, and arrogate all to ourselves. In this island, Geology first took firm root in the north: in Edinburgh, the Wernerian geognostical views and method of investigation, combined with the theory of Hutton; the experiments and speculations of Hall; the illustrations of Playfair; and the labours of the Royal and Wernerian Natural History Societies, excited a spirit of inquiry which rapidly spread throughout the empire; and now Great Britain presents to the scientific world a scene of geological acuteness, activity, and enterprise, not surpassed in any other country."

Independent of the numerous additions to the text of the Essay, the editor has added upwards of two hundred pages of notes and illustrations on the following important topics.

On the Subsidence of Strata. Deluge. Formation of Primitive Mountains.
The distribution of Boulder-Stones in Scotland, Holland, Germany, Switzerland and America.
The Alluvial Sand of the Danish Islands in the Baltic, and on the coast of Sleswigh.
The Sand-Flood.—Sand-Flood in Morayshire. Sand-Flood in the Hebrides, &c. Moving Sands of the African Deserts.
Action of the Sea upon Coasts.
The Growth of Coral Islands.
The Level of the Baltic.
Fossil Remains of the Human Species.
Account of the Displacement of that part of the Coast of the Adriatic which is occupied by the Mouths of the Po.
The Universal Deluge.
The Action of Running Waters.
Connection of Geology with Agriculture and Planting.
Account of the Fossil Elk of Ireland.
Account of the Living Species of Elephant, and of the Extinct Species of Elephant or Mammoth.
Account of the Caves in which Bones of Carnivorous Animals occur in great quantities.
Cave containing Bones at Adelsberg, in Carniola.
View of the Genera of Fossil Mammifera, Cetacea, Aves, Reptilia, and Insecta; with their Geognostical Number and Distribution.
View of the Classes, Orders, or Families of Animals, occurring in a Living or Fossil state; with their Geognostical Distribution.

This work, so rich in well authenticated and well arranged geological facts, and abounding in beautiful views of the mineral and animal kingdoms, cannot be too strongly recommended. It ought to find a place in the library of every one who takes an interest in the natural, and even the civil, history of the planet we inhabit.

2. *Illustration of the Geology of Sussex, containing a general view of the Geological relations of the South Eastern part of England; with Figures and Descriptions of the Fossils of Tilgate Forest.* By GIDEON MANTELL, Esq. F. R. S. Fellow of the Royal College of Surgeons, F. L. S. M. G. S. &c. One volume quarto.

M. MANTELL is already advantageously known to geologists, by his interesting and valuable volume on the geology of Sussex. The present elegant work is a further proof of his skill and activity; and, therefore, we truly regret to find, from the preface, that this will, in all probability, be the last time we shall have an opportunity of noticing his geological labours, as he intimates his intention of taking leave of this department of Natural History. Sussex, Mr Mantell informs us, is composed of portions of all the secondary formations of England, from the Purbeck limestone to the tertiary deposits; outliers of the London and Isle of Wight basin, and accumulations of diluvial and alluvial matters. The regular deposits are the *plastic clay* and *London clay*, *chalk*, *shanklin sand*, *weald clay*, and the *sands and clays of Hastings*. All these different deposits are carefully and luminously described; the various organic remains with which they abound well described, and many of the more remarkable represented in a series of twenty beautiful lithographic plates. The stratification of the Forest of Tilgate, which has excited so much interest on account of its organic remains, is fully described, and evidence adduced of its being older than chalk. The description of the organic remains of Tilgate Forest is concluded with the following striking observations, which also close the work.

"In concluding this description of the organic remains of Tilgate Forest, we would repeat, what we have elsewhere remarked, that the vast preponderance of the land and fresh-water exuviæ over those of marine origin, observable in these strata, warrants the conclusion that the Hastings beds were formed by a very different agent from that which effected the deposition of the Portland limestone below, and the sands and chalks above them. The seas in the primitive ages of our planet were inhabited by vast tribes of multilocular shells, which, however variable in their species, were not only of the same family, but also of the same genera, namely, *Belemnites*, *Ammonites*, and *Nautilites*. These shells, if we may draw any conclusions from our knowledge of the habits of the recent species of the only genus that still exists, were indisputably inhabitants of the ocean; and the presence of their remains in any considerable quantity in a stratum, affords a fair presumption that such stratum is a marine deposit. The converse of this proposition, we conceive, must hold good in a case like the present, where not a vestige of these ancient marine genera can be traced, among innumerable remains of terrestrial vegetables and animals, and of fresh-water testaceæ. The occasional occurrence of marine exuviæ affords no grounds for a contrary opinion, since this fact is no more than might be expected under such circumstances, and is in strict accordance with what may be observed in the deltas and estuaries of all great rivers.

"We cannot leave this subject, without offering a few general remarks on the probable condition of the country through which the waters flowed that deposited the strata of Tilgate Forest; and on the nature of its animal and vegetable productions. Whether it were an island or a continent, may not be determined; but that it was diversified by hill and valley, and enjoyed a climate of a higher temperature than any part of modern Europe, is more than probable. Several kinds of ferns appear to have constituted the immediate vegetable clothing of the soil; the elegant *Hymenopteris psilotoides*, which probably never attained a greater height than three or four feet, and the beautiful *Pecopteris reticulata*, of still lesser growth, being abundant every where. It is easy to conceive what would be the appearance of the valleys and plains covered with these plants, from that presented by modern tracts, where the common ferns so generally prevail. But the loftier vegetables were so entirely distinct from any that are now known to exist in European countries, that we seek in vain for any thing at all analogous without the Tropics. The forests of *Clathrariæ* and *Endogenitæ* (the plants of which, like some of the recent arborescent ferns, probably attained a height of thirty or forty feet), must have borne a much greater resemblance to those of tropical regions, than to any that now occur in temperate climates. That the soil was of a sandy nature on the hills and less elevated parts of the country, and argillaceous in the plains and marshes, may be inferred from the vegetable remains, and from the nature of the substances in which they are inclosed. Sand and clay every where prevail in the Hastings strata; nor is it unworthy of remark, that the recent vegetables to which the fossil plants bear the greatest analogy, affect soils of this description. If we attempt to pourtray the animals of this ancient country, our description will partake more of the character of romance, than of a legitimate deduction from established facts. Turtles of various kinds must have been seen on the banks of its rivers or lakes, and groups of enormous crocodiles basking in the fens and shallows.

"The gigantic *Megalosaurus*, and yet more gigantic *Iguanodon*, to whom the groves of palms and arborescent ferns would be mere beds of reeds, must have been of such prodigious magnitude, that the existing animal creation presents us with no fit objects of comparison. Imagine an animal of the lizard tribe, three or four times as large as the largest crocodile, having jaws equal in size to the incisors of the rhinoceros, and crested with horns; such a creature must have been the Iguanodon. Nor were the inhabitants of the waters much less wonderful; witness the Plesiosaurus, which only required wings to be a flying dragon; the fishes resembling Siluri, Balistæ," &c.

3. *Mathematical and Astronomical Tables for the use of Students of Mathematics, Practical Astronomers, Surveyors, Engineers, and Navigators.* By WILLIAM GALBRAITH, M. A. Oliver & Boyd. Edinburgh. 9s.

THIS portable and cheap volume is well worthy of the attention of the practical men alluded to in the title page, and we have no doubt, that, when its merits come to be sufficiently known, it will supersede the use of every other with which we are acquainted. It is needless to mention, that Mr Galbraith gives all the ordinary tables to be found in works with similar objects, such as the logarithms of numbers, logarithmic sines and tangents, and others, without which no surveyor, seaman, or astronomer, can advance a step; and we shall confine ourselves in this notice to an enumeration of such additions and improvements as Mr Galbraith has made, and which we think claim for his work, as we have said above, the notice of all men who are really at work on such subjects.

In the first place, we consider that Mr Galbraith has great merit for giving, in a clear, well ordered, and perfectly scientific style, such a course of demonstrative reasoning on the theory as well as the practice of his subject, as cannot fail to be very useful to students who have a real wish to understand what they are about, and whose better taste and judgment have heretofore been offended by these epitomes which, to use their slang phrase, have been reduced to the lowest capacity. The various methods of obtaining the longitude, are discussed at some length, and with singular clearness. We are not aware that in any other work of this elementary nature, those minute corrections in the lunar method are given; and, in fact, we suspect few navigators are aware of their importance. We allude to the equations for second differences in the distances, which are correctly given only for every 3 hours in the Nautical Almanac, but which are not found in strictness, for an intermediate period, by simple arithmetical proportion. This equation, in some cases, amounts to 6 seconds of distance, 12 seconds of time, or 3 minutes of longitude. Mr Galbraith has computed two little tables for obtaining the proper correction (Introduction, page 102.) Another small correction on account of the oblique semidiameter, is found in two tables by Dr Young, given at page 101. And a table is given by Mr

Henderson of Edinburgh, for another correction still, namely, that arising from the effect on the horizontal parallax of the moon, caused by the oblate figure of the earth. We recommend Mr Galbraith, in his next edition, to bring all these corrections distinctly under the reader's view at one place.

Our author does not confine himself, however, to the problems in ordinary use, such as lunar observations, occultations of the fixed stars, chronometrical observations, and the measurement of heights by the barometer, which last is admirably executed, but enters also with the full spirit of an observer, and all the minute accuracy of a computer, into the elegant disquisitions dependent upon the figure of the earth, the velocity of sound, and other topics of high interest.

We shall now proceed to point out briefly those improvements and additions which we have been most struck with in the tables.

In Table II. of the common logarithms, there are added proportional parts, which greatly facilitate its use.

Table V. or logarithmic tangents, &c. has two sets of arguments, one for time, and one for arc, besides proportional parts for seconds at the bottom.

We are decidedly of opinion, however, that, for most practical purposes, it is infinitely better to have separate tables for converting time into arc, and the reverse; and we have reason to believe, accordingly, that Mr Galbraith stopped the press to give tables LXI. and LXII. at our suggestion. In the next edition we hope he will place these two tables by the side of XXX. and XXXI., for converting solar into siderial time, and the reverse, and near XXXII. for converting mean time into parts of the equator. These are all eminently useful; and we are glad to observe Mr Galbraith giving them at full length, to single seconds, and not in the usual abbreviated shape, which is very teazing.

Tables VI. and VII., for natural sines, tangents, &c. are too contracted, being given to degrees only; if given at all they should be to minutes.

Table IX., for taking out the proportional parts for daily differences of declination, right ascension, &c. we do not much like; as it requires the use of the proportional logarithms in the next table. We approve more of the table of proportional logarithms to twenty-four hours by Lax and others, which gives the answer at one inspection.

Tables XIII. gives the correction to be added to the sun's altitude, and combines the dip, refraction, parallax and semi-diameter. We confess, however, we prefer that these corrections should not be slumped together in this way, and have always made it a rule to teach our young friends to shun such tables, and take out each correction separately.

Table XVI. has been re-computed, expressly for this work, from the sun's horizontal parallex taken at 8.″68.

Table XVII. gives Mr Ivory's refractions, but it has been considerably extended, and, as we think, improved, by having the refractions and their logarithms to every 10′ from the zenith to the horizon.

The addition of proportional parts to the three succeeding tables for the corrections due to the thermometer and barometer is very praiseworthy, as it materially facilitates their application.

We observe, that a column has been added to table XXVII. of Equations for second differences, by which they are adapted to the sun's declination; and although, in ordinary cases, no correction for the irregularity of the sun's motion is necessary, it does become of consequence in very accurate observations for latitude made near the Solstices.

Table LIX. gives the logarithms of the numbers in Rossel's well known table for correcting the longitudes determined by chronometer, when the rate has been found to have varied. Everything which contributes to the accuracy of such determinations is valuable; and we think Mr Galbraith, by dwelling so frequently on these minute corrections, does essential service to science, by making observers aware how easily and safely they may be taken into account.

Table LXIII. contains, in a compendious shape, many extremely useful numbers, with their logarithms and complements.

Tables LXVI. and LXVII., for the third and fourth differences of the moon's motion, are by Mr Henderson, a very ingenious mathematician in Edinburgh.

The last table, for finding the latitude by the Polar Star, is by Captain Kater, and is sufficiently accurate for sea purposes. We agree, however, with that observer, in thinking the direct method the most satisfactory one.

List of Patents granted in England, from 8*th December* 1826 *to* 16*th January* 1827.

1827,

Dec. 8. To Thomas Machell of Berners Street, Oxford Street, London, surgeon, for improvements on apparatus applicable to the burning of oil, &c.

To Robert Dickinson of New Park Street, Southwark, for an invention for the formation, coating and covering of vessels or packages for containing, preserving, or conveying goods, whether liquid or solid, &c.

13. To Charles Pearson of Greenwich, Esq. Richard Wilty of Hanley, Staffordshire, engineer, and William Gillman of Whitechapel, engineer, for a method of applying heat to certain useful purposes.

To Charles Harsleben of Great Ormond Street, Esq. for his machinery for facilitating the working of mines, and extraction of diamonds, &c. gold, silver, &c. from the ore, the earth, or the sand; applicable likewise to other purposes.

To John Costigni of Collon, in the county of Louth, civil engineer, for improvements in steam machinery or apparatus.

To Peter Mackay of Great Union Street, Borough Road, for improvements, by which the names of streets and other inscriptions will be rendered more durable and conspicuous.

18. To William Johnston of Droitwich, for improvements in the mode of process and form of apparatus, for the manufacturing of salt, and other purposes.

To Maurice de Jough of Warrington, cotton-spinner, for improvements in machinery or apparatus for preparing rovings, and for spinning and winding fibrous substances.

20. To Charles Harsleben, of Great Ormond Street, Esq. for improvements in building ships and other vessels, applicable to various purposes for propelling the same.

To Thomas Quarrill, of Peter's Hill, London, for improvements in the manufacture of lamps.

To William Kingston, master mill-wright, of Portsmouth Dockyard, and George Stebbing, mathematical instrument-maker, of High Street, Portsmouth, for improvements on instruments or apparatus for the more readily or certainly ascertaining the time and stability of ships or other vessels.

Dec. 20. To Melvil Wilson, of Warnford Court, Throgmorton Street, for improvements in machinery for cleaning rice.

To Charles Scidler, of No. 1. Crawford Street, Portman Square, for a method of drawing water out of mines, wells, pits, and other places.

To Frederick Andrews, of Stanford Rivers, Essex, for improvements in the construction of carriages, and in the engines or machinery to propel the same, to be operated upon by steam or other suitable power.

To Charles Random, Baron de Barenza, of Target Cottage, Kentish Town, for improvements in gunpowder-flasks, powder-horns, or other utensils of different shapes, such as are used for carrying gunpowder, in order to load therefrom guns, pistols, and other fire-arms.

21. To Valentine Bartholomew, of Great Marlborough Street, for his improvement in shades for lamps, &c.

To John Gregory Hancock, of Birmingham, plated beading and canister hinge manufacturer, for a new elastic rod for umbrellas and other like purposes.

22. To —— Thomas, of Vall Grove, Chelsea, Esq. for his process of rendering boots, shoes, and other articles, water-proof.

To David Redmund, of Greek Street, Soho, engineer, for improvements in the construction and manufacture of hinges.

29. To Elijah Galloway, of the London Road, Surrey, engineer, for a rotatory steam-engine.

1827,

Jan. 9. To John Whiting, of Ipswich, architect, for improvements in window sashes and frames.

11. To James Frazer, of Houndsditch, engineer, for an improved method of constructing capstans and windlasses.

To James Frazer, of Houndsditch, engineer, for an improved method of constructing boilers for steam-engines.

15. To William Wilmot Hall, of Baltimore, America, at present residing in Westminster, for an engine for mooring and propelling ships, boats, carriages, mills, and machinery of every kind.

To William Hobson, of Markfield, Stamford Hill, Middlesex, for an improved method of paving streets, lanes, roads, and carriage-ways in general.

To James Neville, of New Walk, Shad-Thames, engineer, for an improved carriage, to be worked or propelled by means of steam.

To William Mason, of Castle Street East, Oxford Market, Westminster, patent axletree-maker, for improvements in the construction of those axletrees and boxes for carriages known by the names of mail-axletrees and boxes.

16. To Robert Copeland, of Wilmington Square, Middlesex, for improvements on a patent already obtained by him for combinations of apparatus for gaining power.

Feb. 1. To Robert Barlow of Jubilee Place, Chelsea, for a new combination of machinery, or new motion for superseding the necessity of the ordinary crank in steam-engines, and for other purposes where power is required.

Feb. 1. To John Frederick Daniell, Esq. of Gower Street, Bedford Square, for improvements in the manufacture of gas.

To John Oldham of Dublin, for improvements in the construction of wheels for driving machinery impelled by water or wind, also applicable to propelling boats, &c.

To Ralph Hindmarsh of Newcastle-upon-Tyne, master-mariner, for an improvement in the construction of capstans and windlasses.

To Robert Stirling, Clerk, minister of Galston, in Ayrshire, and James Stirling, engineer, of Glasgow, for improvements in air-engines for moving of machinery.

To John White of Southampton, engineer and iron-founder, for improvements in the construction of pistons or buckets for pumps.

To Samuel Parker, Argyle Place, Argyle Street, Westminster, bronzist, for improvements in the construction of lamps.

3. To Antoine Adolphe Marcellin Marbeot, of No. 38. Norfolk Street, Strand, for improved machinery for working or cutting wood into all kinds of mouldings, rebates, cornices, or any sort of fluted work.

List of Patents granted in Scotland from 13*th December* 1826 *to* 24*th February* 1827.

1826.

Dec. 13. To James Yandell of Broad Wall, in the parish of Christ Church, Surrey, private person, for "certain improvements in apparatus for cooling and heating fluids."

14. To Henry Charles Lacy of Manchester, in the county palatine of Lancaster, coach-master, for "a new apparatus on which to suspend carriage bodies."

To Thomas Machell of Berners Street, Oxford Street, in the county of Middlesex, surgeon, for "certain improvements on apparatus applicable to the burning of oil and other inflammable substances."

20. To Dominique Pierre Deurbrouck of Leicester Square, in the county of Middlesex, Esq. for an invention communicated to him by a foreigner residing abroad, "of an apparatus adapted to cool wort or must previous to its being set to undergo the process of fermentation, and also for the purpose of condensing the steam arising from stills during the process of distillation."

29. To Count Adolphe Eugine de Rosen, of Prince's Street, Cavendish Square, in the county of Middlesex, for an invention communicated to him by a foreigner residing abroad, "of a new engine for communicating power to answer the purposes of a steam-engine."

To William Bush of Broad Street, in the city of London. Esq. for "certain improvements in propelling boats and ships, and other vessels or floating bodies."

1827,

Jan. 15. To Henry Richardson Fanshawe of Addle Street, in the city of London, silk-embosser, for "an improved winding machine."

To Mose Poole of the Patent-Office, Lincoln's Inn, in the county of Middlesex, gentleman, for an invention communicated to him by a foreigner residing abroad, "of certain improvements in the machines used for carding, slubbing, slivering, roving, or spinning wool, cotton, waste silk, short staples, hemp, or flax, or any other fibrous materials, or mixtures thereof."

Feb. 2. To John Frederick Daniell of Gower Street, Bedford Square, in the county of Middlesex, Esq. for "certain improvements in the manufacture of gas for the purposes of illumination."

To Maurice de Jongh of Warrington, cotton-spinner, for "certain improvements in machinery or apparatus for preparing rovings, and for spinning, twisting, and twining fibrous substances."

7. To James Fraser of Houndsditch, in the city of London, engineer, for "a new method of constructing steam-boilers."

13. To Robert Stirling, minister of Galston, in the county of Ayr, North Britain, and James Stirling, engineer in Glasgow, in the county of Lanark, North Britain, for "certain improvements in air-engines, for the moving of machinery."

16. To James Fraser of Houndsditch, in the city of London, for "an improved method of constructing capstans and windlasses."

24. To Robert Bush and William King Westley of Leeds, in the county of York, flax-spinners, for "certain improvements in machinery for heckling or dressing, and for breaking, scutching, or cleaning hemp, flax, or fibrous substances."

LIST OF PLATES.

Plate I. Fig. 1–5. Little Andaman Island, &c.
6–9. Awn of the Seedvessel of Stipa pennata.
10. Anatina villosiuscula.
11. Venerupis Nucleus.
II. Illustrations of Dr Grant's Observations on Spongia.
III. Fig. 1. Eruption of American Lakes.
2. Libellulite of Solenhoffen.
IV. Illustrations of Mr Scoresby's observations on Rainbows.
V. Explanatory of Mr Barlow's view of Magnetism.

Memorandum.—Want of room has obliged us to delay several Articles and Notices of New Publications, and also to limit more than usual the Scientific Intelligence.

INDEX.

Abel, Dr Clark, his account of a colossal orang outang killed in Sumatra, 371.

Air, Mr H. Meikle's experiments with respect to the specific heat of, 328.

Alexander, Cornet J. E., his notice regarding the Little Andaman Island, 43.

Alligator, Mr Audubon's observations on the natural history of the, 270.

Andaman, Little, Cornet Alexander's notice regarding it, 43.

Anatina villosiuscula, description of, 370.

Arctic sea and ice, Dr Latta's observations on the, 86.

———————— Mr Scoresby's remarks on Dr Latta's observations on the, 382.

Arnott, G. A. Walker, Esq. his account of a tour to the south of France and the Pyrenees, 241.

Arsenic, J. L. Berzelius's remarks on its detection in cases of poisoning, 338.

Arts, notices in the, 207, 398.

Asterias rubens, notice regarding, 394.

Astronomical calculator, notice respecting Mr Innes's, 211.

Audubon, Mr J. J., his account of the habits of the turkey buzzard, 172. —observations on the natural history of the alligator, 270.—notice regarding his intended work on American ornithology, 210.

Banks, Sir Joseph, Baron Cuvier's historical eloge of, 1.

Barlow, Mr P., his account of experiments and observations on the magnetic needle made during Parry's third voyage, with remarks, 347.—his observations on the tides in the upper part of the Thames, 49.

Beech-tree, a non-conductor of lightning, 392.

Berzelius, J. L., his remarks on the detection of arsenic, 338.

Bismuth cobalt-ore, description of, 200.

Bohr, Mr G., his account of a visit to the glaciers of Justedal and the Mantle of Lodal, 255.

Bonnet, Charles, Baron Cuvier's biographical memoir of, 213.

Botany, notices in, 207, 395.

Boué, Dr A. his observations on serpentine and diallage rocks, 265.

Brome, a new substance discovered in sea water, 201.

Buch, Baron Von, his observations made during a visit to Madeira, 73.

Buchanan, D., Esq. his account of fresh water found in the sea far from land, 369.

Celestial phenomena, from Jan. 1. to April 1. 1827, 188.—from April 1. to July 1. 387.

Cereales, their origin and native country, 395.

Chemistry, notices in, 193.

Coal, M. Karsten's observations and experiments on the different kinds of, 280.—of Höganäs, 196.

Cockles, Mr Trevelyan's remarks on those found in Yorkshire at a distance from the sea, 367.

Coloured shadows, Messrs Zschokke and Treschsel's observations on, 367.

Coniometer, Professor Leslie's description of the, 384.

Cordierite found in Norway, 199.

Crystallization of sulphate and carbonate of lead, 197.

Cuvier, Baron G., his historical eloge of Sir Joseph Banks, 1.—his biographical memoir of Charles Bonnet and H. B. de Saussure, 213.

Darwar, geognostical structure of the country around, 194.

Don, Mr David, his account of the affinities of the Empetreæ, 59.—remarks on the rhubarb, purple-coned fir, and mustard-tree, 304.—description of the genus Malesherbia, 320.

Dwight, Rev. S. Edwards, his account of the eruption of two lakes in America, 146.

Egyptian antiquities in the Liverpool museum, 393.

Empetreæ, Mr D. Don's remarks on the affinities of the, 59.

Eruption of lakes in America, Mr Dwight's account of the, 146.

Esmark, Professor, his remarks relative to the geological history of the earth, 107.

Essay on the Theory of the Earth, notice respecting a new translation of Cuvier's, with notes and illustrations by Professor Jameson, 400.

Esser, Dr C. H. Ludwig, his remarks on the luminousness of the eyes of animals, 164.

Expedition, overland Arctic, information respecting the, 161.

——— Capt. Parry's intended one to the North Pole, Dr Latta's remarks on, 86.

Eyes of animals, Dr Esser's remarks on their luminousness, 164.

Eyes, M. Prevost's considerations regarding the shining of those of the cat and dog, 297.

Fungi, M. Persoon's instructions for collecting and preserving, 396.

Geology, notices in, 194.
Geology of Sussex, notice respecting Mr Mantell's work on the, 402.
Geological history of the earth, Professor Esmark's remarks tending to explain the, 107.
Geological observations relative to the countries discovered by Captains Parry and Ross, Professor Jameson's, 104.
Glaciers of Justedal, Mr Bohr's account of a visit to the, 255.
Glass, easy mode of cutting, 207.
Gold, its distribution in the Uralian Mountains, 197.
Graham, Dr, his list of rare plants flowering in the Edinburgh Botanic Garden, 184, 388.
Graphite, new mode of applying it in drawings, 398.
Grant, Dr R. E., his observations on the structure and functions of the sponge, concluded, 121.—description of two new sponges, 203.—description of Octopus ventricosus, 309.
Greensand formation in Sweden, 196.
Guilleinin, M. his account of a gelatinous quartz, 324.

Hydrography, notices in, 201, 392.
Hyæna cave discovered on the banks of the Garonne, 197.
Hyænas, Professor Buckland and Capt. Sykes on the interior of the dens of living, 377.
Hygrometer, Mr Meikle on the use of a simple syphon as a, 366.
Hygrometers and evaporation, Mr H. Meikle's remarks and experiments relating to, 22.

Ice, thickness of salt-water, 202.
Innes, Mr George, his calculations of celestial phenomena from Jan. 1. to April 1. 1827, 188.—from April 1. to July 1. 1827, 387.
Insects, circulation discovered in, 202.
Iodine and lithia in the mineral springs of Theodoreshall, 202.
Irish furze, broom, and yew, different from British, 207.
Iserine and iron sand in Cheshire, 200.
Ivory, mode of etching and dyeing figures on, 399.

Jameson, Professor, his observations on the geology of the countries discovered by Captoins Parry and Ross, 104.
Jamesonite, Mr H. Rose's account of the chemical composition of, 341.
Jet discovered in Wigtonshire, 197.

Karsten, M., his observations and experiments on the different kinds of coals, 280.

Latta, Dr Thomas, his observations on the Arctic Sea and Ice, 86.
Lead mines of the south of Spain, Mr Witham's remarks on the, 375.
Leech, notice regarding a species of, 202.
Leslie, Professor, his enumeration of instruments necessary for meteorological observations, 141.—on the coniometer, 384.
Libellulite, account of one found at Solenhoffen, 195.
Lindsay, J, Esq. his meteorological observations made in Jamaica, 317.
Longchamp, M., his remarks respecting nitre, 193.
Luminousness of the eyes of animals, Dr Esser's remarks on the, 164.—M. Prevost's observations on the same subject, 297.

Macgillivray, Mr W., his description of two species of Conchifera, 370.
Macvicar, Mr John, his account of the seed of Stipa pennata, 343.
Madeira, Von Buch's observations made during a visit to, 73.
Magnetic iron-ore, a hill of, in Siberia, 196.
Magnetic needle, Mr Barlow's account of experiments relative to its variation and intensity, made during Parry's third voyage, with remarks, 347.
Malesherbia, Mr D. Don's description of the genus, 320.
Mathematical and astronomical tables, notice regarding Mr Galbraith's, 404.
Mathematics, notice regarding a work of Baron Dupin's on, 208.
Manures, their effects on the qualities of plants, 397.
Meikle, Mr Henry, his remarks and experiments relating to hygrometers and evaporation, 22.—on the experiments to determine the specific heat of air under volume and under pressure, 328.—remarks on the use of a simple syphon as a hygrometer, 366.
Meteors seen in India, 191.
Meteorological observations, Professor Leslie's remarks on the mode of conducting, 141.—made in Jamaica by Mr J. Lindsay, 317.
Meteorology, notices in, 191.
Mineralogy, notices in, 197.
Mustard-tree, Mr D. Don's account of it, 306.

Natural philosophy, notices in, 391.
Nitre, notice regarding M. Longchamp's opinion as to its formation, 193.

Octopus ventricosus, Dr Grant's description of, 309.
Orang outang, Dr Abel's account of one killed in Sumatra, 371.—notice respecting the same, 207.

Parry, Captain, Dr Latta's observations on his intended expedition to the North Pole, 86.

Patents granted in England, from 18th September to 18th November 1826, 211; from 8th December 1826 to 16th January 1827, 407.
——— granted in Scotland, from 9th September to 8th November 1826, 212; from 13th December 1826 to 24th February 1827, 409.
Phosphorus discovered in kelp, 194.
Plants, Dr Graham's list of rare ones flowering in the Edinburgh Botanic Garden, 184, 386.
Platina, geognostical position of, in America, 197; in Siberia, 199.
Prevost, M. Benedict, his observations regarding the shining of the eyes of the cat, and other animals, 297.
Purple-coned fir of Nepal, Mr D. Don's account of the, 306.
Publications new, 208, 400.
Pyrochlore, Description and Analysis of, 342.

Quartz, Mr Guillemin's account of a gelatinous, 324.

Rainbows, Rev. Mr Scoresby's description of remarkable, 235.
Repulsion of heat inversely as the square of the distance, 391.
Rhubarb, Mr D. Don's remarks on, 304.
Royal Society of Edinburgh, proceedings of the, 190.
Rose, M. his account of the chemical composition of zinkenite and Jamesonite, 341.

Saussure, Horace Benedict de, Baron Cuvier's Biographical Memoir of, 213.
Scoresby, Rev. W. his description of remarkable rainbows, 235; remarks on Dr Latta's observations on the Arctic Sea and Ice, 382.
Selenium in red copper-ore, 201.
Serpentine and diallage rocks, Dr Boue's observations on, 265.
Shells, marine, found 200 feet above the level of the sea, 195.
Silica in springs dissolved by carbonic acid, 392.
Smith, Dr, queries respecting the hyena proposed by him, 204, 205.
Sponge, Dr Grant's observations on its structure and functions, 121.
Sponges, Dr Grant's description of two new species of, 203.
Spider, account of a narcotic species of, 206.
Stipa pennata, Mr Macvicar's account of its seed, 343.
Stomach of birds, instance of remarkable power of the, 206.
Straw, account of the growth and preparation of that used in the Tuscan trade, 380.
Sulphate of iron, magnificent crystals of it found at Bodenmais, 200.
Sword-fish, notice of one caught in the Frith of Forth, 202.

Tides in the river Thames, Mr Barlow's observations regarding the, 49.
Tit-lark caught at sea, 393.
Tour to the south of France and the Pyrenees, Mr Arnott's, 241.
Treschsell,' M. his remarks on coloured shadows, 32.
Trevelyan, W. C. Esq. his remarks on the marine cockles found in Yorkshire, at a distance from the sea, 367.
Turnbull, Alexander, Esq. his notice respecting the geological structure of the country around Darwar, 194.

Vegetation, account of its establishment at the surface of the globe, 64.
Venerupis nucleus, description of, 371.
Vultur aura, Mr Audubon's account of the habits of, 172.
Vulture shot in Somersetshire, 206.

Water fresh, found in the sea far from land, 369.
Water-spouts in the Irish Channel, 192.
Wernerian Natural History Society, proceedings of the, 191, 389.
Winds in the polar regions, 193.
Witham, H. Esq. his remarks on the lead mines of Spain, 375.
Wohler, F. his description and analysis of pyrochlore, 341.

Zinkenite, M. H. Rose's account of its chemical composition, 341.
Zoology, notices in, 202, 393.
Zschokke, M. his remarks on coloured shadows, 32.

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