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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THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

BIOGRAPHICAL MEMOIR OF SIR HUMPHRY DAVY. *By Baron* CUVIER*.

A CELEBRATED academician, who had risen from the humblest condition to the highest ecclesiastical and literary honours, said, on the day of his admission into the academy, "Should there be found in this assembly a young man born with a love for labour, but wholly destitute of assistance or encouragement, and in whom the uncertainty of his destination weakens his susceptibility to the excitement of emulation, let the sight of my situation at the present moment inspire him with hope." Nothing indeed can be at once more affecting or encouraging, than to witness merit, by the power of perseverance, surmounting the obstacles which misfortune had opposed to it, and, gradually emerging from obscurity, become at last an object of general notice, and obtain, with the just approbation of all, the advantages which our societies can confer on those by whom they are merited.

Conspicuous examples of this kind are afforded by the two celebrated chemists, with whom I propose to occupy your attention during the present meeting, both of whom were born in a state almost of entire privation, yet each supported with firmness the difficulties of his condition. From the time when they

* This interesting Eloge of Sir H. Davy, not yet published, was communicated to us in proof-sheet, through the goodness of our friend Mr Pentland of Paris.—EDIT.

had made some progress in science, and their first works were made known to the public, they became the objects of general favour; were received in the world, and in proportion as their discoveries increased, they advanced to fortune, and were loaded with honours; no jealous voice interrupted this unanimity of sentiment regarding them, or, if such was ever raised, it was not till they had obtained a position in society which sheltered them from its effects, and reduced those who were jealous to the necessity of being only envious *.

Sir HUMPHRY DAVY, Baronet, formerly President of the Royal Society of London, Foreign Associate of the Academy of Sciences in the Institute, was the son of Robert Davy and Grace Millet, and was born at Penzance, a small town in the county of Cornwall, the most remote portion of England towards the west, on the 17th day of December 1778.

His family is said to have possessed at one period considerable landed property in the parish of Ludgvan, near Penzance; but Robert Davy, his father, was reduced to a very small farm on the banks of the Boye, called St Michael, from a rock bearing some resemblance by its situation, and by having a convent upon it, to that distinguished by the same name on the coast of Normandy. With a view to increase his limited income, he exercised in Penzance, for a long period, the profession of gilder and carver in wood; but not succeeding in his profession, he abandoned it, and soon after died, in 1794, leaving his widow in a destitute situation with five children, the youngest of whom was little more than four years of age. This respectable woman did not, however, lose courage; occupied incessantly with the education of her children, in order to procure the means of supporting them, she opened a shop, and subsequently kept a lodging-house, for those whose health led them to visit this county, which is celebrated above the rest of England for the mildness of its climate.

Her eldest son, the young Humphry, turned to the best account the limited means of instruction which this remote county presented, and some of his teachers have since pretended to boast

* The other individual alluded to, is the celebrated Luis-Nicolas Vauquelin, who died on the 15th October 1829.—TRANS.

of a scholar so celebrated; but he has always said, that if there was any thing original in his ideas, it was owing to the negligence and indifference of the persons entrusted with his education, who permitted him to indulge, without restraint, in all the caprices of his fancy. Many men of genius, in relating the history of their early lives, could make the same observation. That mode of instruction, indeed, which is calculated for the majority, is not easily adapted to those eccentric intellects whose first ideas are superior to those of their companions, and not unfrequently to those of their masters. The exertions used to make them conform to the common method, have only the effect of obstructing their progress. It is fortunate, therefore, both for themselves and for society, that they should be thus neglected. Left to himself, Davy occupied his time in hunting, fishing, and traversing this picturesque country, already attempting to celebrate its beauties in verse, for from his infancy he was both an orator and a poet. He had the power of expressing his impressions in a very vivid manner; and when he entered the school, his little companions were accustomed to surround him, and forget every thing else, in listening to the recital of what he had seen. His reading did not make a less forcible impression on his mind than his observations; no sooner had a translation of Homer fallen in his way, than he began to compose an epic poem, of which the subject was Diomede; a composition, says one of his former schoolfellows, very incorrect, and abounding in violations of the established rules, and of good taste, but full of life and varied incident, displaying a richness of invention, and a freedom of execution, which evince a true poet.

It was necessary, however, that he should engage in more serious occupation, and his mother bound him for five years as an apprentice to an apothecary named Borlase, a member probably of the same family as the minister of the parish of Ludgvan, to whom we are indebted for a natural history of the county of Cornwall, and an account of its antiquities, two works which are still of considerable value on account of the documents which they contain. This apothecary, as is always the case in England, likewise practised surgery and medicine. Young

Davy was often obliged to visit his patients, and convey to them medicines, an occupation quite in accordance with his early habits, and which had the effect of rendering him still more active. While traversing this rich country, he recited aloud either Homer's verses or his own; for he had already composed many. It was at this time that he wrote his ode on Mount St Michael, and a poem on Mount's Bay, two of his best verse compositions. The play given to his active faculties by these solitary walks, led him to explore some of the mysteries of metaphysics, and as far as may be judged from some letters and stanzas written at this period, which were afterwards published, but in a very modified form, under the title of *Life*, he was absorbed in all the abstractions of pantheism, and spoke of God and of the world, like a Bramin, or a professor of German philosophy.

But the county of Cornwall is not merely a picturesque country; its primitive rocks, their various relations, the metallic veins which they contain, and deep mines, sunk at a period antecedent to any authentic record, render it a country pre-eminently geological and chemical; and such an individual as we have described Davy to be, could not listen to conversations on the working and uses of metals, the different processes to which they are subjected, and the relations which subsist between them and the rocks in which they are enclosed, without having his attention drawn to those branches of natural science which treat of the structure of the globe, and the nature of the materials of which it is composed. A fortuitous circumstance was the means of engaging his youthful mind in active study. Mr Gregory Watt, son of our late Associate, who brought to perfection the steam-engine, and made it an agent which will change the entire aspect of society, was sent to Penzance on account of an affection of his breast, and lodged in the house of Mrs Davy. The young apothecary, attracted by his handsome figure and elegant manners, became desirous of gaining his friendship; but the English are backward to form friendships, especially when there is a difference of fortune or rank. To recommend himself to notice, Davy entertained Mr Watt with chemistry, of which he had already acquired a slight and practical knowledge in the house of his master, although it did not fit him to converse on the subject with one well versed in its principles. Some one to whom he mentioned his intention, procured for him an English translation of Lavoisier's chemistry. In two days he had made himself completely master of it, and it is very remarkable, that, in entire ignorance of the objections which Priestley and others of his countrymen had raised against the theory advanced in that celebrated work, he declared that there occurred to him another explanation of the phenomena; and he began seriously to engage in developing it. The animated discussions which he had with Mr Watt on this subject, had only the effect of confirming his resolution; the poet and the metaphysician decided at once on becoming a chemist. The state of his affairs was such, as to render it no easy matter to procure even the requisite instruments; but in this, as in every thing else that he undertook, his courage and perseverance surmounted all obstacles. Old tobacco-pipes, and a few glass-tubes purchased from a travelling vender of barometers, formed his first apparatus. The surgeon of a French ship, stranded near Land's End, shewed him his instruments, and having observed a utensil of very common and familiar use among us, the form of which apparently differs in the two countries, he conceived the possibility of rendering it the principal piece in a pneumatic machine; and to this purpose, so different from that for which it was intended, it was in reality applied. It is thus that, in the case of many great men, privation has proved the most useful master.

The experience which he acquired on this occasion was never afterwards lost. During his whole life, Mr Davy never wanted a resource in his investigations; the simplicity of his apparatus was always as remarkable as the originality of his experiments, and the elevation of his views; and even when he travelled into places the most remote from scientific aid, he was never more at a loss to bring to the test of experiment any new idea that occurred to him, than he was when he commenced his first labours in the shop of his master at Penzance.

After some further exercise, he took from his own neighbourhood the subject of his first experiment. He wished to ascertain with what kind of air the vesicles of fuci are filled, and determined, with as much precision as the most accomplished che mist could have done, that marine plants act on the air in the same manner as land plants. This was in 1797, when he was not quite eighteen years of age.

About this time, Dr Beddoes, who had been obliged by political dissensions to leave the Chair of Chemistry in the University of Oxford, came to establish himself at Bristol, where he formed, with the assistance of the family of the celebrated Wedgwood, an establishment called *The Pneumatic Institution*, the principal object of which was to try the action of various gases on diseases of the lungs; he commenced at the same time a periodical collection, entitled *Contributions from the Western Provinces*, in which he inserted the researches of the physicians and chemists of that part of England. It was to this individual that Davy addressed his essay, and Beddoes, surprised at finding a young apothecary of Penzance capable of such investigations, was very anxious to attach him to his institution.

For this purpose, it was necessary to dissolve the contract of apprenticeship which he had formed with Borlase, according to the somewhat Gothic practice which prevails in Great Britain. Mr Davies Gilbert now President of the Royal Society, undertook the negotiation, which was speedily completed; for the apothecary, who apparently cared but little for scientific discoveries, and still less for metaphysics and poetry, shewed no reluctance to restore to liberty a youth whose qualities he regarded with no favourable eye, although destined to become so soon after the light of chemistry, and the honour of his country *.

But Beddoes estimated men by a different standard; and speedily discerning the intellectual qualities of his new assistant, he did not employ him merely in that capacity, but entrusted him with his laboratory, and permitted him to perform all the experiments he judged necessary to extend his knowledge of gases, and gave the use of his amphitheatre to deliver lectures.

* It is due to the character of Davy's first master to state, that the readiness with which he surrendered the indenture, originated in motives entirely the reverse of those here ascribed to him. It was because he appreciated the talents of the young chemist, and from a wish to promote his advancement, that the arrangement was effected with so much facility. See Paris' Life of Sir H. Davy, i. 55.—Trans.

It was in the Pneumatic Institution that Davy discovered, in 1799, the properties of *nitrous oxide gas*, or as it is now called, protoxide of azote, and the extraordinary effects it produces on certain organizations *. Many persons on inhaling it experience only uneasiness and symptoms of asphyxia; others are affected with decided asphyxia; but in some it produces intoxication of a peculiar kind, exciting sensations of the most delicious nature, and so superior to all other kinds of pleasure, that they would permit themselves to die in that state without making the slightest effort to escape from it.

It is easy to imagine the eagerness with which this new manner of producing intoxication was received in a country where the old method was practised to a much greater extent than at present, as it led to the hope of an agreeable variation in an enjoyment become too monotonous; the name of the young chemist of Penzance was therefore speedily popular throughout the three kingdoms.

In order to do him full justice, however, it must be added, that the courage which he had shewn was not less remarkable than the singularity of the discovery. He gives a fearful description of the state into which it threw him. The loss of voluntary motion did not at first diminish his sensations; he saw and heard all that was going on around him; but in proportion as the species of asphyxia increased, he lost the power of perceiving external things; a crowd of images rose in his mind, and he seemed to be making discoveries, and forming theories of the most sublime description. But let it not be supposed that this mode of intoxication more than any other can teach any thing new. When a friend snatched from him the receiver of the dangerous gas, his first words were only the old formula of idealism, *Nothing exists but thought; the universe is composed only of impressions and ideas of pleasure and pain.* This system had been long the subject of his thoughts. He made a still more dangerous experiment by respiring carbonic gas, but it produced only pain and depression; and it is not impro-

* Researches, chemical and philosophical, chiefly concerning nitrous oxide and its respiration. 8vo. London, 1800. Translated into French, *Annales de Chimie*, tom. xli. p. 305; xlii. p. 33 and 276; xliii. p. 97 and 324; xliv. p. 43 and 218; xlv p. 97 and 169; also into *Bibliothcque Britannique*, tom. xix. xx. xxi.

bable that these rash attempts contributed to produce that sudden change in his constitution which terminated in his premature death.

At this period Bristol was filled with enthusiastic young men, fond of novelty, and forward to express their sentiments, whose speeches, in the midst of those dissentions which the French revolution had excited in England, caused this town to be regarded as the principal seat of democracy.

These youths, in concert with their correspondents in different parts of the kingdom, had formed a design to raise their friends to situations which were most likely to make them the objects of public favour, and in prosecution of their plan, they resolved to use their efforts to place the young professor in a sphere of wider influence. Our former associate, Count Rumford, had established in London the Royal Institution, designed to spread among the higher classes of society the useful discoveries of science. Being naturally of an unaccommodating disposition, he had already quarrelled with Dr Garnet, his professor of chemistry; and it was resolved to propose Davy, who was urged to come forward and be presented to him.

Every one will remember that, with all his great and noble qualities, Count Rumford was not distinguished for affability; the almost infantine appearance of the candidate, who always looked younger than he really was, joined to manners somewhat provincial, and the remains of a Cornwall accent, rendered the Count even more repulsive than usual, and Davy's timidity, increased by such a reception, was little calculated to remove the effect of his first appearance. The persons by whom he was introduced had to employ much art and solicitation to obtain permission for him to give some lectures, in a particular apartment of the house, on the properties of gases; but more than this was not needed. From the first, the variety of his ideas and their ingenious combinations, the warmth, vivacity, perspicuity, and originality of their exposition, all the interest which the united talents of the poet, the orator, and the philosopher can confer on the teaching of chemistry, had the effect of enchanting the small number who had ventured to come and hear him. They immediately spoke of him with so much enthusiasm, that the place of meeting was unable to accommodate the influx of auditors, and his lectures had to be transferred to the great amphitheatre of the establishment.

The Royal Institution was at that time supported by all that was most elevated in Great Britain, both in birth and in intellect; ladies of the highest rank attended the lectures, as well as the most distinguished noblemen and youths of the country.

The youth of a professor who had scarcely advanced beyond the age of boyhood, his handsome figure, and ingenious manners, contributed not less than his lively eloquence to conciliate the affection of such a public. In a short time he became so much in fashion, that not an evening party appeared complete when he was not present. This was such an entire revolution in his condition, that he required not less courage to continue his labours in this sudden prosperity, than he needed to commence them in the midst of misfortune. Some even pretend that he permitted himself to be more elated by his reception in the great world, than was due to his genius and circumstances. But what young man of twenty would have better resisted such a temptation? He did not at least renounce science; for in the midst of the pleasures which it was so natural for one of his age to wish to enjoy, he ceased not for a moment to multiply the titles which had been the means of obtaining them for him.

But who ought to have experienced greater happiness? From the time of his first regular course, which was given in May 1801, a continued series of lectures, experiments, and discoveries, which succeeded each other with unparalleled rapidity, and which have elucidated the most important branches of Physics and Chemistry, essentially modified their doctrines, and led to the most beneficial and unexpected applications to the wants of society, secured for their author the admiration of the civilized world, and the gratitude of his country. Nominated a member of the Royal Society in 1803, and appointed secretary in 1806; commissioned by the Board of Agriculture to teach the application of Chemistry to that branch of public economy; united in 1812 to a lady of great wealth, and high intellectual endowments; and honoured, the same year, with knighthood, being the first person so distinguished by the Prince Regent; created Baronet in 1818, when this Prince mounted the throne;

and, finally, elected to the distinguished station of President of the Royal Society in 1820, on the death of Sir Joseph Banks, by a majority of two hundred against thirteen, an office which he continued to hold for seven years:—the young apprentice of Penzance enjoyed without interruption all the honours which a great state could confer on those who do it honour. These marks of esteem were confirmed by the approbation of foreigners. Crowned by the Institute in 1807, when the war with England was at its height; associated with that body in 1817; called upon in like manner to enjoy the honours of all the celebrated academies; Mr Davy had to boast of the approbation of Europe as well as of his own country. But our nature does not admit of perfect happiness in the present world; and when all around us is prosperous, we not unfrequently carry within ourselves the poison that embitters our existence. In the exposition which I am about to give of Mr Davy's labours, continued without interruption for upwards of twenty-five years, and published in sixty different memoirs and papers, it will be understood that I can attend only to the principal results and fundamental discoveries. I shall, therefore, pass rapidly over his first experiments, made in the Royal Institution in 1803, to determine the proportions of tannin in the different substances used in tanning *. Those of the following year (1802), on the different combinations of azote with oxygen, that is to say, on nitrous oxide and the nitrous gas now named protoxide and deutoxide of azote, and on the proportions of their elements, as well as those of hydrogen and azote, which are acquiring a more general importance in Chemistry, were the natural consequences of his first observations on nitrous gas, and the invention of a new eudiometer resulted from them†. A solution of muriate, or of sulphate of iron, impregnated with nitrous gas, was found to absorb oxygen with greater facility than any other substance.

* An account of some experiments and observations on the constituent parts of certain astringent vegetables, and on their operation in tanning.—*Roy. Soc. London*, 24th Feb. 1803; *Phil. Trans.* xcxiii. p. 233; *Nicholson's Journal*, v. p. 256.

† An Account of a New Eudiometer.—*Nicholson's Journal*, 4to, vol. v. p. 175; *Biblioth. Brit.* vii. p. 246; *Ann Chim.* tom. xlii. p. 301.

We are unable to bestow much time on his mineralogical discoveries, although they are doubtless far from unimportant. In 1805, his analysis of a stone from Devonshire, which had been named *wavellite*, furnished to this science a new species. It is a combination of pure alumina with water *.

The same year he published a new method of analyzing stones containing a fixed alkali, by means of the boracic acid †.

He proved more evidently than had been previously done, and contrary to his own conjectures on the subject, that the diamond produces on combustion only pure carbonic acid ‡. In 1822, he proved that iron and silex are dissolved in the thermal waters of Lucca §. Rock-crystal and other stones often contain in cavities in their interior gases and liquids; and as these substances must have been inclosed at the time of their formation, a knowledge of their nature was not without interest in the ancient history of the globe. Mr Davy found them to consist of pure water and pure azotic gas ‖.

Much light was likewise thrown on many branches of physics by the observations made in the course of his researches. The nature of the changes of colour produced by heat on the surface of steel ¶; the formation of mists over the surface of rivers **; the application that may be made of liquids formed by the con-

* An Account of some analytical experiments on a mineral production from Devonshire, consisting principally of alumina and water.—*Roy. Soc. Lond.* 28th Feb. 1805; *Phil. Trans.* xcv. p. 155; *Biblioth. Brit.* xxx. p. 303; *Ann. de Chimie*, lx. p. 297.

† *Roy. Soc. Lond.* 16th May 1815; *Phil. Trans.* xcv. p. 231; *Annales de Chimie*, tom. lx. p. 297.

‡ Some experiments on the combustion of the diamond and other carbonaceous substances.—*Roy. Soc. Lond.* 23d June 1811; *Phil. Trans.* civ. p. 557; *Ann. de Chimie et de Physique*, i. p. 16; *Bibl. Britan.* vol. lvii. p. 124.

§ Memoria sopra di un deposito trovato nei Bagni di Lucca.—*Atti della Real. Acad. Neapolit.* v. ii. p. 9; *Ann. de Chimie et de Physique*, tom. xix. p. 194.

‖ On the state of water and aëriform matter in cavities found in certain crystals.—*Roy. Soc. Lond.* 13th June 1822; *Phil. Trans.* v. cxii. p. 367; *Ann. de Chim. et de Phys.* tom. xxi. p. 132.

¶ Ann. of Philosophy, vol. i. p. 131; *Bibl. Brit.* vol. lv. p. 157.

** Some observations on the formation of mists in particular situations.—*Roy. Soc. Lond.* 25th Feb. 1819; *Phil. Trans.* vol. cix. p. 123; *Ann. de Chim. et de Phys.* xii. 195.

densation of gases as mechanical agents *; finally, the colour of the water of rivers and of the ocean †; were subjects that attracted his attention, and produced instructive and interesting papers.

Particular mention ought to be made of the course of lectures which he delivered before the Board of Agriculture in 1803, and which were published in 1813 ‡. It was thus that a young man of twenty-two, who had no practical experience of the subject, unexpectedly enlightened the proprietors and most experienced cultivators in Great Britain.

Such occupation, however, as we have been alluding to, may be said to have formed only a kind of diversion from his severer studies. His experiments on the decomposition of bodies by galvanic electricity were of a superior order, and it was to them that he owed his sudden elevation, by the unanimous voice of Europe, to the rank of one of the first chemists of our age. No one will dispute that there was never displayed, in such a lengthened investigation, a greater degree of perseverance, method, and precision; and rarely have these qualities been crowned with more brilliant success.

An observation casually made by Galvani in 1789, in which he had seen the parts of a dead animal become convulsed when a metallic communication was established between a nerve and the muscle, had excited the attention not only of the learned but of the vulgar: some believed that they saw in it the explanation of all the vital phenomena, and the means of recalling even the dead to life. Volta referred these facts to their true cause, viz. the electricity produced by the contact of two metals; and, in his endeavours to render the influence of the metals more considerable, he increased the number of the plates, and separated them by others of less conductive power; thus constructing his famous pile, the constant source of an electricity

* *Roy. Soc. Lond.* 27th April 1823; *Phil. Trans.* v. cxiii. p. 193; *Ann. de Chim. et de Phys.* tom. xxv. p, 80.

† Salmonia (2d edit.), p. 316; *Bibl. Univ.* tom. xl. p. 114.

‡ Elements of Agricultural Chemistry, in a Course of Lectures for the Board of Agriculture, 4to and 8vo, Lond. 1813. Translated into French, 12mo, Paris 1820, and into German, by F. Wolf, with additions by A. Thaer, 8vo, Berlin 1814.

which is continually renewed. Scarcely had physicians become acquainted with this new and admirable instrument, than they wished to try its effects on every kind of substance.

About the year 1800, Messrs Carlisle and Nicholson, introducing into the water metallic wires corresponding to the two poles of the pile, saw with surprise that oxygen was evolved near the positive thread, and hydrogen near the negative one.

The same year, perhaps before them, Ritter, in Germany, had arrived at a more precise result, by placing water in two separate vessels, but communicating with each other by means of sulphuric acid: oxygen and hydrogen were produced indefinitely, each at its pole. He thence concluded, not that the pile decomposed water, but that the two gases are only water combined with the two kinds of electricity. When an animal fibre, or even the fingers, formed the communication between the two vessels, muriatic acid also appeared at the positive wire; and some had even concluded, from this circumstance, that this acid was formed of hydrogen less oxygenated than water. Alkalies likewise appeared, of different kinds, according to the circumstances in which the operation was performed.

In 1803, two Swedish chemists, Messrs Hisinger and Berzelius, by repeated experiments, had ascertained the fact, that the decomposing action of the pile extends to bodies of every kind; that it invariably causes acids and oxygenated substances to appear towards the positive pole, and alkalies towards the negative one; thus opening a way to the explanation of these different anomalies.

Mr Davy had observed with attention the progress of these experiments, and, even in 1800, and under the eye of Beddoes, he had operated on water, placed in two separate vases, but employing a strip of bladder as the means of communication. In this experiment, muriatic acid likewise appeared *. In 1801 he had made known to the public a kind of pile, differing in some respects from that of Volta, in which a single plate of metal alternated with two liquids†. In 1802, he had ope-

* Notice of some observations on the causes of the galvanic phenomena, and on certain modes of increasing the powers of the galvanic pile of Volta.—*Nicholson's Journal*, 4to, vol. iv. p. 337, 380, and 394.

† An account of some galvanic combinations formed by the arrangement

rated on various liquids with a very powerful pile, and observed many singular disengagements of gas. He at last engaged in a series of profound investigations, which he prosecuted with the utmost perseverance for some years, and definitely established the theory of this new order of phenomena. The result was published in 1806 *, in a memoir, entitled *Bakerian Lectures*, so called because they were delivered in one of these foundations which are pretty numerous in England, the object of which is to direct the attention of the learned to certain special subjects in which the founder felt an interest. After the most minute precautions, he succeeded in demonstrating that, when water is pure, it is decomposed by electricity into gaseous matter alone, viz. into oxygen and hydrogen, in the proportions in which they enter into its composition. Submitting to the same agent bodies of different kinds, he carried to the highest degree of generalization the law of Hisinger and Berzelius; and, even reverting to the principle on which it was founded, he came to the conclusion that *chemical affinity is nothing else than the energy of opposite powers of electricity*—a conclusion which, combined with another law established in 1804 by Mr Dalton, on definite proportions, afforded to Berzelius principles for the establishment of an entirely new system of chemistry and mineralogy.

It was for this great and important service that the Institute, at its public sitting in January 1808, awarded to Mr Davy the prize founded for the advancement of galvanism, an honour which has not since been conferred on any one except M. Oerstedt for his brilliant discovery of the relations between galvanism and electricity. Soon after, Mr Davy, by prosecuting the same views, obtained a success still more flattering, because exclusively his own; I allude to the discovery of the metallic nature of fixed alkalies. For a long time chemists had been struck with

of single metallic plates and fluids, analogous to the new galvanic apparatus of Volta.—*Roy. Soc. Lond.* 18th June 1801; *Phil. Trans.* vol. xci. 397; *Biblioth. Brit.* vol. xvii. p. 237.

* On some chemical agencies of electricity.—*Roy. Soc. Lond.* 20th Nov. 1806; *Phil. Trans.* vol. xcvii. p. 1, 1807; *Ann. de Chimie*, tom. lxiii, p. 172 and 225; *Journal de Physique*, t. lxiv. p. 421; *Biblioth. Brit.* t. xxxv. p. 16.

the analogies of the fixed alkalies with alkaline earths, and of the latter with metallic oxides, and Lavoisier had even announced the possibility of these earths being oxides, incapable of being reduced by the ordinary means. With respect to the fixed alkalies properly so called, whatever conjectures had been formed as to their composition, results from some combinations with azote; the analogy with ammoniac had led to this idea; but in science the most happy conjectures are unavailing, if not confirmed by experience.

Mr Davy being in possession of such a powerful means of decomposition as the pile, did not despair of resolving the important problem. After having tried it without success on some aqueous solutions, he took potash sufficiently moistened to make it serve as a conductor, and having placed it in the circle of a powerful battery, the positive side produced a violent effervescence, while at the negative side there appeared small globules, resembling quicksilver in colour and lustre, but so combustible that they were covered almost while they formed, with a white crust of potash, and which, when thrown upon water, remained on the surface, and burned with a bright flame and considerable heat; it was the same upon ice, and it looked as if he had recovered the wild fire so famous in Byzantine history, to which it is probably owing that Europe is not at the present day under the influence of Mahometanism. The same phenomena presented themselves with soda, and whatever were the conductors, the produce of the combustion was always potash or soda; an envelope of naphtha was the only means of preventing these metallic globules from attracting oxygen, so as to counteract their tendency to combustion. It was in vain that some contended that these new substances were combinations of hydrogen, or even carbon, with the alkalies; rigorous analysis speedily exposed the error of such an hypothesis, and it remained demonstrated that potash and soda resulted from the combination of oxygen with bases resembling metals in their external characters, but infinitely lighter, and having an infinitely stronger attraction for oxygen. Potash contains 84 centiemes, and soda 76 centiemes, of metal. These bases, which are as perfect conductors of heat and electricity as the other metals, become soft at 12° of Reaumur, and at 30° become liquid like mercury, and evaporate at a red heat*. Klaproth, the first individual in our days who discovered a new metal, wished to question their metallic quality on the ground of their specific lightness; and in fact all the known metals are heavy, but in very different degrees. Tellurium, for example, is four times lighter than platina, and there is no reason why *sodium* and *potassium*, (the names by which Mr Davy distinguished the new substances) although six times lighter than tellurium, should be excluded from that class of substances to which they belong by all their other attributes.

This grand discovery was made in 1807, and formed the subject of the Bakerian Lecture for the month of November of the same year†. It could not fail to lead a mind like Davy's to new researches and new ideas; he tried the same process on many other earths, and Berzelius did the same, proving that they must all be regarded as oxides.

The great Swedish chemist, having electrified negatively some mercury in contact with a solution of ammonia, succeeded in producing an amalgam; and Mr Davy, who had arrived at the same result by more simple means‡, observed the mercury become solid, and lose three-fourths of its specific gravity, by the addition of a quantity of gas, scarcely equivalent to $\frac{1}{2300}$ of its weight; he was led, therefore, to think that the ammonia had likewise a base, and that perhaps the azote and hydrogen, of which it is composed, are themselves metallic oxides §. Rising

* The more correct statement is this:—Potassium at 50° Fahr. is soft and malleable, but melts at 136½°; sodium is soft and malleable at the common temperature of the atmosphere, and melts at 194° F.

† On some new phenomena of chemical changes produced by electricity, particularly the decomposition of fixed alkalies, and the exhibition of the new substances which constitute their bases, and on the general nature of alkaline bodies.—*Roy. Soc. Lond.* 12th and 19th November 1807. *Phil. Trans.* of London, vol. xcviii. p. 1. *Ann. de Chimie.* lxviii. p. 203–225. *Biblioth. Brit.* vol. xxxviii. p. 3.

‡ An account of some analytical researches on the nature of certain bodies, particularly the alkalies, phosphorus, sulphur, carbonaceous matter, and the acids hitherto undecompounded; with some general observations on chemical theory. *Roy. Soc. Lond.* 15th December 1808. *Phil. Trans.* vol. xcix. p. 39. *Ann. de Chim.* tom lxxii. p. 244, and lxxiii. p. 5. *Biblioth. Brit.* vol. xlii. p. 27. *Journ. de Phys.* tom. lxix. p. 360.

§ New analytical researches on the nature of certain bodies. 1st, Further inquiries on the action of potassium or ammonia, and on the analysis of am-to the highest generalities, he took into account nothing in nature but oxygen and unknown bases; varying even his explanations, as in algebra, in which a diversity of forms may lead to the same result, he inquired whether hydrogen might not be the principle of metallization, and whether oxides might not be reduced to combinations of bases with water, thus reverting, so to speak, to the ancient hypothesis of phlogiston, under another form. This tendency may be observed in many other of Mr Davy's memoirs, and perhaps he may be suspected in this of a little national jealousy. But although unsuccessful in overthrowing the French theory of combustion, he adduced at least such a striking exception, that instead of longer retaining the character of a general explanation, it became applicable only to particular cases of phenomena which required an explanation of a more elevated nature; and this forms the third and most important of his discoveries. It was already known by the experiments of Bertholet, that sulphuretted hydrogen, which does not contain oxygen, acts like an acid; oxygen, therefore, is not always the principle of acidity. On the other hand, the experiments of Mr Davy went to prove that it is the principle of alcalinity as well as of acidity, and thus its name was not justified by its nature. It was soon to be shewn that hydrogen has the power of producing acids, not less than oxygen.

For a long time chemists had attempted in vain to discover the base of muriatic acid; but after the explanations proposed by Bertholet, they supposed that this other acid, so celebrated for the uses to which it is applied in the arts, and which is obtained by causing muriatic acid to pass over oxide of manganese, and named *dephlogisticated muriatic acid* by Steele its discoverer, resulted from the combination of muriatic acid with oxygen of the oxide; it was consequently named *oxygenated muriatic acid*, and nothing appeared more simple than to extract from it the muriatic acid, by depriving it of this oxygen with which it was believed to be surcharged. MM. Gay-Lussac and Thénard attempted it, but could never succeed without the addition of water or at least of hydrogen. This pheno-

monia. 2d, On sulphur and phosphorus. 3d, On carbonaceous matter. 4th, Muriatic acid. *Roy. Soc. Lond.* 2d February and 16th March 1809. *Phil. Trans.* vol. xcix. p. 450. *Biblioth. Brit.* vol. xliv. p. 42.

menon appeared to them remarkable; water, they said, is an ingredient necessary to the formation of muriatic acid; but how does it happen to adhere so forcibly, that no means are sufficient to disengage it? May it not be only by one of these elements that it concurs in forming this acid? and may not the oxygen which is disengaged during the operation, and which is supposed to proceed from the oxygenated muriatic acid, be simply another element of water? Thus, neither oxygenated muriatic acid, nor common muriatic acid, would contain oxygen.

This opinion they ventured to express at the end of their memoir as a possible hypothesis; but they dared not support it in the face of their old masters, in whose eyes the theory of Lavoisier had acquired almost a religious sanctity *.

Mr Davy, who was under no such restraint, read a memoir in 1810 †, in which he advances this hypothesis, and supports it by a multitude of additional experiments ‡. The pretended oxygenated muriatic gas was therefore an agent of combustion equal with oxygen; at the same time when becoming to us a simple substance, it required a simple name; that of *chlorine* was given to it, subsequently abridged and changed to *chlore.*

A theory so new, it will readily be believed, was not so soon adopted as it was proposed. Mr Murray, a skilful chemist of Edinburgh, and Berzelius himself, defended the old theory with as much spirit as perseverance. Never was a scientific dispute conducted with so much propriety on both sides; to each experiment and explanation of an adversary, the other replied by experiments and explanations which seemed not less important, and the chemical world appeared in a state of suspense, when the appearance of a new substance caused the scale to turn in Mr Davy's favour, by associating with chlorine in its properties, and especially by producing combustion and acidification.

* Memoires de la Soc. d'Arcueil, tom. ii. p. 357.

† Researches on the Oxymuriatic Acid, its nature and combinations, and on the elements of the muriatic acid. *Roy. Soc.* 12th July 1810. *Phil. Trans.* vol. c. p. 231. *Ann. de Chem.* tom. lxxvi. p. 113 and 129. *Journ. de Phys.* tom. lxxi. p. 321. *Biblioth. Brit.* vol. xlv. p. 229.

‡ On some of the combinations of oxymuriatic gas and oxygen, and on the chemical relation of these principles to inflammable bodies. *Roy. Soc.* 15th November 1810. *Phil. Trans.* vol. ci. p. 1. *Ann. de Chem.* tom. lxxviii. p. 298. *Journ. de Phys.* tom. xlii. p. 358. *Biblioth. Brit.* tom. xlvii. p. 34, 245, 340.

This was *iodine*, discovered by M. Curtois, a dealer in saltpetre, well skilled in chemistry, a substance on which M. Gay-Lussac * and Mr Davy made some curious experiments †.

Fluoric acid, to discover the base of which many fruitless attempts had likewise been made, was soon arranged in the same class, according to a suggestion of M. Ampère ‡. At last, Gay-Lussac himself discovered a combination of carbon and azote *(cyanogène)* which acts like chlore, fluor, and iodine, and which produces acids without the addition of oxygen. Prussian blue is the well known produce of one of two acids and the oxide of iron.

Henceforth it is an admitted doctrine in chemistry, that acidity depends on the mode of combustion, and not on a material principle; and the name of Mr Davy is attached to this important proposition, not because he was the only individual by whom it was established, but because he was the first to announce it with precision. It is, in fact, this explanation of phenomena, under a clear and general form, which constitutes invention in the eyes of the majority, who are unable to follow in detail the various phases through which a truth is obliged to pass, before it become matured for ordinary minds.

By these three grand series of investigations, relating to the chemical action of the pile, the metallization of alkalies, and their combination without oxygen,—by the truths of primary importance which resulted from them,—by the multitude of new experiments, new views, and exquisite appreciation of all the phenomena which had concurred in the demonstration of

* Sur un nouvel acide formé avec la substance decouverte, par M. Courtois. Inst. 6th Dec. 1813. *Ann. de Chim.* tom. lxxxvii. p. 311. Note sur la combinaison de l'iode avec l'oxygène. Inst. 20. Dec. 1813. *Ann. de Chem.* lxxxviii. p. 319.

Mem. sur l'iode. Inst. 1er Août, 1814. *Ann. de Chem.* tom. xci. p. 1. *Bullet. Phil.* 1814, p. 112.

† Some experiments and observations on a new substance which becomes a violet-coloured gas by heat. *Roy. Soc.* Lond. 20th Jan. 1814. *Phil. Trans.* vol. civ. p. 74. *Ann. de Chem.* tom. xcii. p. 89. *Journ. de Phys.* tom. lxxix. p. 153. *Biblioth. Brit.* vol. lvi. p. 248.

Further experiments and observations on iodine. *Roy. Soc.* Lond. 16th June 1814. *Phil. Trans.* vol. civ. p. 487. *Biblioth. Brit.* vol. lvii. p. 243.

‡ Ann. de Chimie et de Physique, tom. ii. p. 20. Mémoire sur un Classification naturelle pour les corps simple. Ann. id. tom i. p. 295 and 373. tom. ii. p. 5. et 105.

these truths,—Mr Davy, not yet thirty-two years of age, occupied, in the opinion of all that could judge of such labours, the first rank among the chemists of this or of any other age; it remained for him, by direct service rendered to society, to acquire a similar degree of reputation in the minds of the general public. The first opportunity of accomplishing this, was afforded by a request made to him, to point out proper means of preventing the fatal effects of the frequent explosions which take place in coal-pits.

There escapes insensibly from beds of coal, when they are wrought, a certain quantity of inflammable gas, which, mingling with a portion of atmospheric air, is kindled by the miners' lamps, and explodes with a dreadful detonation, frequently destroying great numbers of the workmen. Cavendish was acquainted with its nature, and especially its specific lightness, and his discovery suggested the principle on which aerostatic balloons were constructed. No one, however, had taken any steps to prevent these destructive effects, when one of these explosions happened in 1812 in a mine called Felling, and killed, in an instant, upwards of a hundred miners, under circumstances so appalling, that all belonging to the profession became alarmed. Each morning they took leave of their families like soldiers about to mount a breach. Roused by interest, a committee of proprietors of mines tried how to prevent the danger, and Mr Davy was invited to point out the means which science could afford for this purpose.

To others it would have seemed as if an impossibility had been asked; as if he had been required to carry fire into a magazine of powder, and yet prevent its explosion; but Mr Davy did not despair, and perhaps his genius never appeared in a more conspicuous light, or more deserving of admiration, than in this instance.

This was not one of those cases in which the result is attained by a consecutive series of experiments, accumulated by chance, rather than suggested by experience; the problem was proposed, and the means of solving it were to be sought for in the general principles of science, without expecting aid from others, or from chance.

Mr Davy began by analyzing the gas, determining the quantities of carbon and hydrogen of which it is composed, and the proportions by which its combination with common air produces more or less violent detonations. He then examined at what degree of heat combustion took place, and according to what laws it is propagated. He observed that it could not take place in tubes of small dimension, even when every circumstance was favourable to its production, because the size of the tubes sufficiently cooled the gas to prevent its combustion. He thence concluded that by preventing the air from coming in a volume on the wick, and causing it to enter by long and narrow apertures, and only in suitable quantities to support the light, detonation could not ensue, even though the proportions of the air should be most favourable to produce that effect.

He was thus led to construct a lantern, the communication to the interior of which was through the intervals of numerous concentric tubes, and which had a chimney covered with a plate pierced with small holes, or formed of metallic gauze. This first attempt did not give him satisfaction, but led to the conception of something more perfect. He submitted solids to numerous experiments, that he might seize the just degree of cooling power which they possess, and discovered many physical facts full of interest, among others the greater intensity of the heat of flame, than even that of metal at a white heat. Thus a wire of platina became red in a mixture, the combustion of which was too slow to produce flame,—a surprising fact, for which no explanation has been found. The result of all these experiments was, that a metallic gauze may be formed, the meshes of which may be of that precise diameter fitted to cool the inflamed air which traverses them, and at the same time prevent its combustion, and which may be permeable to air and light without being so to flame. The invention therefore was brought to the degree of simplicity necessary for the men to whom it was destined, and formed consequently a complete solution of the problem *.

* On the Safety Lamp for coal-miners, and some researches on flame. 8vo. London 1815.

On the fire damp of coal mines, and on methods of lighting the mine so as to prevent its explosion. *Roy. Soc. Lond.* 9th November 1815. *Phil. Trans.* v. cvi. p. 1. *Ann. de Chim. et Physique*, tom. i. p. 136.

A single envelope of this metallic gauze, whenever employed with requisite precaution, henceforth secures miners from the terrible danger which threatened their lives; air ready for explosion may surround their lamp without any other danger than that of extinguishing it, and even then, if there be suspended over the wick a spiral wire of platina, it will become incandescent by the decomposition of the detonating gas, and afford light to the miner as long as there are any remains of respirable air.

This instrument, now used in the greater number of mines, and introduced by Mr Davy himself into those of Hungary, has been the means of preserving the lives of many useful men: and its services would have been of even greater importance, had it not been for the indifference which has prevented its adoption in some countries, and negligence in observing the rules prescribed by its inventor in others. Men's minds are usually so little occupied with the thoughts of death, that the most trifling present annoyance has more influence than the greatest danger when it appears somewhat remote.

It now looked as if Mr Davy might be asked to make a discovery, adapted to the necessities of any particular case. The copper-sheathing of ships is oxidized by sea water, and in a numerous navy like that of England, the expense of renewing it is enormous. The Admiralty in 1823, asked him to suggest a preservative, and he was not long in complying with their wishes; he had only to refer to former discoveries to be enabled to add one more to their number.

According to his practice, he first sought to give a precise account of the phenomena. Copper immersed in sea-water, produces a bluish-green powder, on which is deposited the carbonate of soda, an obvious proof that the marine salt has been decomposed; but, according to his theory of muriatic acid, this could not take place without oxygen, and as no hydrogen appeared, it could not be the water that furnished this oxygen but the atmospheric air which it contained. On the other hand, according to his theory of the correspondence between chemical action and the electrical condition of bodies, it was in consequence of its positive electricity relatively to the salts contained in the water, that the copper disengaged oxygen; it followed, therefore, that the process would be stopped by rendering the surface of the copper slightly negative, and this his experiments on the voltaic pile rendered a matter of easy attainment. The metal which, alternating with copper in the pile, assumed most powerfully the positive state of electricity, iron for example, or what was still better, zinc, must necessarily produce the desired effect. On the experiment being tried, it was found that a single grain of zinc, a small nail of iron, protected upwards of a square foot of copper; and vessels whose sheathing had been prepared in this manner, performed a voyage to America and returned, without the copper presenting any appearance of oxidation. It was found, however, that strict attention required to be paid to the proper proportions, too great a quantity of the preserving metal rendering the copper too negative, a state in which there was deposited an earthy crust which attracted shell fish and marine plants; and it is even asserted, that, notwithstanding the accurate solution of the problem regarded in its purely chemical relations, this unforeseen circumstance occasioned the necessity of abandoning the practice altogether. Perhaps Mr Davy would have discovered a remedy for this inconvenience, had not the party whom jealousy had raised against him, rendered him unwilling to institute any further inquiries.

A similar cause had some years before arrested him in a labour from which the most important advantages to literature and history might have been expected to result.

Every one knows the degree of interest taken by the Prince Regent, now George IV., in the unrolment of the manuscripts found at Herculaneum. He supported a director and several workmen, who had already succeeded in unrolling more than a thousand; and as every thing encouraged the hope that chemistry would afford the means of facilitating the operation, Mr Davy was sent to Naples for the purpose in 1818. A careful examination of these rolls, and a strict inquiry into the causes which had reduced them to their present condition, led him to conclude that it would be impossible to devise a simple method of softening them; but he suggested numerous improvements on the plan followed, which were received with expressions of gratitude by the conservators of the collection. Another scientific Englishman, however, skilled in the study of manuscripts, Mr Elonsby, having attempted to decypher some of those which had been unrolled, the sentiments of the conservators underwent a sudden change, and so many impediments were thrown in the way of farther investigation, that the undertaking was entirely abandoned. This journey afforded to Mr Davy an opportunity of investigating a subject of interest in the history of the arts, viz. the nature of the colours used in painting by the ancients. Some on the walls of Pompei or Herculaneum were sufficient to form the subject of analysis. He found that they were nearly as numerous as our own, and that many seemed to have been even better prepared, since they had resisted the effects of time for so many ages *.

This journey likewise supplied many new observations on volcanoes †, but which always bore relation to the ideas he had previously embraced. The excessive incandescence of lava at the moment of its ejection, the noise that precedes it, and the water, salts, and exhalations by which it is accompanied, all tended to confirm the idea he had entertained from the time of his first experiments on alkalies, that the principal cause of these remarkable phenomena is the action of sea-water on metals, which he supposes to exist, not yet oxidized, in the interior of the earth. This supposition reconciled a great variety of views on the primitive state of the globe, and the various changes which its surface has undergone, by which he sought to unite in a single system all the observations of later times relating to the subject, from those of Herschel on nebulæ, to those of the latest naturalists on the nature and relative position of earthy deposits, and on the remains of animals and vegetables which they contain.

These hypotheses were not unworthy of a genius which had made so many real discoveries, but he did not assign to them the importance of truths of the first order. He did not give them to the world till the publication of a work in which his imagination expatiates on numerous other subjects and of a much higher nature, his *Consolations in Travel*, the last of his

* Some experiments and observations on the colours used in painting by the ancients.—*Roy. Soc. Lond.* 23d February 1815. *Phil. Trans.* vol. cv. p. 97. *Ann. de Chim.* tom. xcxvi. p. 72. and 193. *Biblioth. Brit.* vol. lix. p. 226. and 336, and lx. p. 129.

† On the phenomena of Volcanoes.—*Roy. Soc. Lond.* 20th May 1828. *Phil. Trans.* vol. cxviii. p. 241.—*Ann. de Chimie et de Physique*, vol. xxxviii. p. 133.—*Biblioth. Univ.* vol. xxxix. p. 121.

labours, with which he continued to be occupied nearly to the time of his death *.

The progress and destination of the human species, and the fate of thousands of worlds, of which astronomers have perceived but a small proportion, are the subjects of a dialogue, in which the poet is not less conspicuous than the philosopher, and in which, among fictions, a great power of reasoning is applied to questions of the most serious nature. One would have said, that once escaped from the laboratory he had resumed the tranquil reveries and sublime thoughts which had formed the delight of his youth: it was in some measure the work of a dying Plato.

In the same way he had amused himself, during a previous indisposition, by giving in a series of dialogues all the information his experience as a fisher had supplied on the natural history of the trout and salmon; and the curious observations which his work on this subject contains, will render it always of importance in the science of ichthyology †.

But it must be confessed, that however ingenious these writings may appear, science has to regret that his mind was diverted by them from its appropriate pursuits. The state of his health, however, rendered it necessary, for he became so weak, that at times an entire forgetfulness of all chemical researches was the only means of alleviating his distress.

He had not always the power of diverting his attention by intellectual exercises. Fishing, or some other occupation equally insignificant, filled up a portion of his time. In traversing with such rapidity so wide a field of science, he had likewise accelerated the course of his life, and his early triumphs were obtained at the price of premature infirmity. A third journey to Italy, and a residence of some duration at Florence and Rome, had not the effect on his present state of health that was anticipated.

Reduced to a state of considerable weakness, he was anxious to see his native country. Lady Davy and his brother Dr John Davy, who acted as his medical attendant, watched over him during the journey with the most tender solicitude. The sight of the fine prospects through which he passed, seemed for a

* Consolations in Travel, or the last days of a Philosopher. 8vo. London, 1830.

† Salmonia, or days of fly-fishing, in a series of conversations. 12mo. London, 1823.

moment to restore some of the recollections of his youth, but it was only the last gleams of a torch about to be extinguished. Having reached Geneva, without any symptoms that indicated his end to be so near, he expired suddenly in the night of the 28th and 29th of May 1829.

Thus at the age of fifty years, and in a foreign land, was the career finished of a genius whose name will shine with lustre among the crowd of celebrated names of which Great Britain has to boast. But why should I say a foreign land? To such a man no country can deserve that name, and least of all Geneva, where he possessed numerous intimate friends and admirers, who were continually occupied in spreading his discoveries over the continent; the mourning, therefore, could not have been greater, nor the obsequies more honourable, for one of their most respected citizens. The Magistrates, the whole University, students and professors, as well as all the foreigners in the town, considered it their duty to assist; each hastened to shew that science is cosmopolitan; and, as a mark of their highest esteem, the Academy of Geneva accepted of a foundation made in his honour by Lady Davy, by which a prize will be awarded every two years to the newest and most useful chemical experiments; so that his name will still remain attached to the truths long after to be discovered, in a science where his own discoveries were so important.

FACTS RELATING TO DILUVIAL ACTION IN AMERICA. *By the Hon. WILLIAM THOMPSON.* To Professor Silliman.

DEAR SIR,—When I had the pleasure of seeing you at New Haven last autumn, I intimated my intention of sending you my views of the geological features of Sullivan County, New York, and likewise the traces of diluvial action on the solid strata, with some of the proofs that present themselves, in every part of the county where the earth has been removed, so deep as to come to firm rock, below the effects of frost and other decomposing agents; but the snow came on so early in the fall, and my health has been so indifferent this spring, that I have been obliged to defer it until the present time. Perhaps I shall not even now be able to write any thing new or interesting on this subject, especially as I find that Sir James Hall, many years since, described traces of diluvial action in Scotland, and Mr David Thomas of Cayuga, has made similar observations in the western part of this state, as appears in vol. xvii. p. 408. of your Journal. I have examined this part of the State with considerable care, and have found that in more than fifty different places where I have seen the solid strata, the grooves and furrows appear from an inch to one-fourth of an inch deep, and from one-fourth of an inch, to three and four inches wide; and in some cases they run due north, and in every direction from north to twenty-five degrees south of east. I have found them also in the bottoms of cellars, of excavations made in digging wells, and where the earth has been removed by making roads, and in many instances where I have uncovered the solid rock for the purpose of observing the effects of the diluvial action. I have paid some attention to this subject while travelling in the Eastern States, and I could find none of the furrows *, but the solid strata appears to be worn very smooth by attrition, by the motion of some bodies smaller and less solid than those which have produced the distinct traces, in this part of the state of New York.

It may be proper to remark first, that Sullivan County is bounded south and west by the Delaware River; north by Delaware and Ulster Counties, and east by Orange; that the county lies on the easterly part of the Alleghany range of mountains, and that the mean altitude of the county is on a level with the high lands below Newburgh,—about 1500 feet above the tide water; that this level is continued westerly through Sullivan County and the State of Pennsylvania, from the Shongham Mountains to the Susquehannah River; that a space of about fifty miles wide of this level lies continuously, in the Alleghany range, until you come to mountains of a greater height, on the west side of the Susquehannah; that the depth of the earth above the solid rock, gradually and regularly increases from Shongham Mountain to the Susquehannah; that the average depth of earth in Sullivan County, is not more than twenty-five feet, nor more than thirty-five through the State of Pennsylvania: that the range of the Kattskill Mountain, bounds

* The author will find notices of such appearances in Massachusetts, by Mr Appleton, vol. xi. p. 100 of Silliman's Journal.

the north part of Sullivan; that south of this space of 50 miles, the altitude of the mountains considerably increases; in this intermediate space, it appears that tops of the ridges had been dilapidated by mighty force, and that the current had pressed easterly, and often times carried large pieces of rock to a considerable distance, say from 50 to 200 rods, and if the fragments are of very considerable size they always rest in the solid strata. In many instances, sections of the strata were broken out and raised by the violence of the current, and left on the tops of the highest hills. I have seen an instance where a rock 20 feet square has been carried half a mile on the level surface of the strata that are covered about three feet with earth, and there left in that position; the violence of the current having ceased to effect its farther removal from its original position.

The upper strata of the whole section of the county before the deluge, appear to have been composed of a common grey sandstone, covering the surface of the rock from 12 to 24 inches thick. This seems to have been the last marine formation; it is full of fissures and cracks, being broken into small angular pieces by the first violent surges of the deluge, and now scattered on the surface of the ground.

The next lower strata are puddingstone, filled with quartz and felspar, and other primitive minerals; its parts are generally water-worn, and are from the size of a robin's to that of a hen's egg. The next rock underneath is the old red sandstone, which is universally found in the bottom of the valleys; on the tops, however, of the highest hills, the red clay-slate is universally found, and, for 80 or 90 miles west, gives a reddish colour to all the soils of the county, and passes southerly through New Jersey and Pennsylvania.

The valleys in this section of country uniformly run from north to south, are in many instances from 1000 to 1200 feet deep, and are the beds of the large streams. The lesser valleys are covered with pieces of red and grey sandstone, of a convenient size for making fences. The most free and feasible land is always found on the tops, and on the eastern sides of the hills, the western sides being uniformly steep and broken. The whole of the earth or soil appears to have been removed from the solid strata at the deluge, and most, if not all the upper strata of sandstone, were then broken up. A small portion of the puddingstone was also broken up in large square blocks, and occasionally pieces of the old red sandstone were detached from the bottom of the valleys. It is probable that previous to the deluge, there was little or no soil on this section of the country, that the hills, valleys, and streams, were the same previous to the deluge that they are at this time, excepting that the hills were dilapidated and lowered, and the deep valleys were made still deeper by the tremendous cataracts and surges, the water being carried violently over the high ledges and hills, and then, in crossing the ridges from west to east, falling 1000 or 1200 feet into the valleys. While contemplating such a scene, our imaginations must fall infinitely short of the reality. The single wave that totally destroyed the town of Lima, or the surge that overwhelmed the Turkish fleet in Candia, comes nearer to the terrific scene than any similar events that are recorded. That these large masses of rock should be broken up and thrown upon the tops of high hills will appear in no way surprising, when we consider what must be the effect of the precipitation of the cataracts into deep valleys, and of their subsequent violent refluxes over the high hills; a power more than sufficient to raise the larger masses of rock that were left on the high grounds in the county.

That water has the power to carry rocks and other heavy bodies over the tops of mountains, is evinced by the simple fact, that the only place where the millstone is found within 200 miles, is at Kizerack, on the west side of Shongham Mountain, 15 to 20 from Esopus or Kingston, up the Roundout Hill. At this place, all the country or Esopus millstones are sold. Now, over a greater part of the west side of Shongham Mountain, which is composed of the millstone grit, this rock has been carried to the height of 1000 or 1200 feet, so as to pass over the top of the mountain, and it lies scattered through the country for many miles east, between Newburgh and the Shongham Mountain, and as there is no other similar stone within 200 miles, this is conclusive evidence that the violence of the surge carried the rock over the top of the mountain, and left them in the position in which we now see them; some of the stones weigh from three to four tons.

Professor Eaton, in his geological survey of the Kattskill or

Alleghany, says, "that all the eastern slope of the Alleghany is capped or protected by the millstone grit;" but what he called the millstone grit, I call the conglomerate or puddingstone; both are formed in part of quartz, but in the true millstone grit, the fine parts are formed by abrasion of the quartz only, while common sand mixed with globular pieces of quartz, forms what he calls the millstone grit of the Alleghany range.

I have never been able to find any grooves or furrows on the west side of the hills and ridges in the county; nothing appears but the traces and breaches where the rocks have been torn up by some violent agent. It very rarely happens that any traces can be found in the red argillaceous sandstone; it is not sufficiently wide to sustain the force of heavy bodies moving in contact with it; although, in some instances, the grooves appear for fifteen or twenty feet, and then the strata are rough and broken, but the traces are mostly on the solid puddingstone, and the common grey sandstone, which remained solid and unbroken at the Deluge. In those cases where the old red sandstone appears, if the slope or side of the hill faces the north, I have seen three or four instances in which the furrows run in that direction for half a mile, and on meeting a ridge of rocks in the low grounds, the furrows turned due east, and, after passing the obstruction, again turned north-east, or east. Not a mile from the same place, on descending from the same high ground, the furrows run east, tallying with the face of the hill. On the high lands west of the Shonghams, and where there could be no obstruction for seventy or eighty miles, I examined ten or twelve different places in which the furrows were deep and distinct, and found them to run from ten to twelve degrees north of east; and they continued in the same direction for a considerable distance down the mountain; at no great distance to the south, the furrows tended twenty-five degrees south of east, leading to a low opening in the Shougham Mountain, through which the currents of water naturally run. I have rarely examined the strata below the decomposing effects of frost, without discovering distinct traces of diluvial action. Near the banks of streams, I hardly ever found any such marks, but the solid strata appeared broken and very little altered by attrition. In one place, where the earth was removed, and where there was no visible obstacle to alter the current of water, the furrows crossed each other, shewing that the current took a new direction, after the first furrows were made. About twelve or fourteen miles west of Newburgh, I found the marks on the solid greywacke to run nearly north and south. At Coxakie, in Green County, in digging a well, and coming to the solid strata, the furrows ran northerly and southerly about in the direction of the mountain. I found that in different places, between thirty and forty miles apart, the furrows ran about ten degrees north of east, especially where the current had a free course for any considerable distance, without any obstacle. Where the solid strata remained, but a part has been removed by some powerful agent. On examination, I have found, that the corners of rocks have been worn off by abrasion from eighteen to twenty-four inches, and that the furrows made on the rocks by the abrasion of hard substances, were very distinct, although the edges of the rocks were rounded. This fact is of frequent occurrence. On the high land, as well as on the low, the furrows appear near small streams, in every possible situation, showing, without a doubt, that the rivers and hills remain now as they were before the flood. Pieces of the solid strata with the furrows on them, are often found where part of the strata was broken up after the furrows were made, but more of the argillite than of any other rock appears in fragments. It was supposed that these grooves were made by the Indians, before the settlement of the country by the white people. Large fragments of rocks or boulders are found in every part of the country, which fragments, in passing over the surface of the strata, have doubtless made these furrows. Most of them have the corners worn off. There are but few instances in which other stones are found besides the natural strata of the country. In some instances the stones are composed altogether of sea-shells; in two instances I have found palm-leaves and ferns incorporated in the soft grey slate. The soil is much fuller of the small particles of quartz and feldspar than in Orange County, or in the New England States. The disintegration produces a fine sand, upon which there rises an abundant growth of pine and hemlock. For three hundred miles to the westward, it is evident that the soil or earth was raised and increased very much by the Deluge, and the mountains and ridges were lowered, and robbed of their loose stones, by the same cause. The opening of about fifty miles wide through this part of the Alleghany ridge, has probably tended, in some measure, to control and direct the course of the current of water. The mastodon appears not to have been a native of this section of the country, but was probably an inhabitant of the champaign countries to the west, and the bodies may have been borne, on this mighty current, through falls and cataracts, to the low, basin-like counties of Ulster and Orange, where they were finally deposited. Before the Deluge, the counties of Orange and Ulster were probably formed of low sharp ridges of greywacke and limestone, and narrow short valleys running in different directions, with little or scarcely any soil or earth either in the valleys or on the low sharp ridges, and of course such countries would not be the natural residence of the unwieldy mastodon. The carcasses of these animals were probably in some cases brought whole, in others they were lacerated and torn asunder, or bruised, and the bones broken, before the flesh had decayed and dropped from them. This appears from the place and the condition in which the bones are found. The first skeleton found in Orange, was taken out of a swamp near Crawford, on the Newburgh Turnpike. This carcass was deposited entire and unbroken in a pond or basin of water, and after the flesh was decayed from the bones, they were spread over an area of about thirty feet square; the outlet of this pond is a firm rock; the pond has been filled up by decayed vegetable substances, and now forms a swamp of about ten acres, covered with maple and black ash. In the north part of this swamp, about two years ago, on digging a deep ditch to drain the ground, a skeleton of the mammoth was found; this skeleton I immediately examined very minutely, and found that the carcass had been deposited whole, but that the jaw-bone, two of the ribs, and a thigh-bone, had been broken by some violent force, while the carcass was whole; on taking up the bones this was evident from every circumstance. Two other parts of skeletons were, some years since, disinterred, one near Ward's Bridge, and the other at Masten's Meadow, in Shongham; in both instances the carcasses had been torn asunder, and the bones had been deposited with the flesh on, and, in two or three instances, the bones were fractured. That the bones were deposited with the flesh attached to them, appears from the fact, that they were found closely attached to each other, and evidently belonged only to one part of the carcass, and, on a diligent search, no part of the other bones could be found within a moderate distance of the spot. If the animal had died where the bones were found, the whole skeleton would have been found at or near the place. Great violence would be necessary to break the bones of such large animals; in the ordinary course of things, no force adequate to that effect would be exerted. I think it therefore fair reasoning to say, that, at the Deluge, they were brought by the westerly currents to the place where they were found; that the carcasses were brought in the first violent surges, and bruised, broken, and torn asunder, by the tremendous cataracts created when the currents crossed the high mountain ridges, and fell into the deep valleys between Shougham mountain and the level countries at the west; that those carcasses that came whole to the place where they finally rested, arrived after the waters had attained a greater height, and were probably less violent, and of course the bodies were less liable to be beaten and bruised by coming into contact with the rocks. This view of the fact appears to me fairly to account for the condition in which the bones of the mammoth are found.

I have thus given a desultory sketch of a number of facts relating to the currents of water at the Deluge, and their effects on the face of the country. If they should not appear to be new, they may still be received as evidences of diluvial effect in different parts of our country. I have a number of specimens which I can send you, of rocks containing the traces left on the different strata, and should any additional information be required, I will cheerfully furnish it.—*American Journal of Science and Arts*, vol. xxiii.

ON A GRADUAL ELEVATION OF THE LAND IN SCANDINAVIA.

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Communicated by the Author.

OF the various changes which slowly operating causes gradually produce on the earth's surface, those which affect the extent of arable or otherwise improveable land, attract the earliest and most general attention. Such changes are in progress in almost every country, either along the banks of rivers or the shores of the sea, and have long been observed and universally known. Numerous instances of the encroachments of the sea are to be met with along the east coast of Great Britain, as well as on the opposite shores of Norway, Denmark, and Holland; and the recent floods in Morayshire show how destructive even small rivers may become under certain circumstances.

At the mouths of rivers, examples of the growth of land, and the gradual formation of banks and islands, are frequently met with. On the coasts similar phenomena are much more rare; for though the sea, during its slow but incessant encroachments upon the land, carries off much soil, it deposits it again chiefly in the less agitated parts of its own bed, either filling up its greatest depths, or forming submarine hills of sand and gravel, similar to those already found scattered over so large a portion of the globe.

Some peninsular tracts of land occur on the opposite coasts, of which, both effects of the sea may be observed, the one being washed away, while the other is increased by continual deposits. North Jutland presents an example of this kind. The Jutlands form the north-western termination of that extensive arenaceous deposit, which stretches from the Skaw, through Denmark, Prussia, Poland, and much of the east of Europe. The surface in North Jutland consists in general of loose sand, of large heaths, and of moss, more or less suceptible of improvement, all resting upon chalk. Occasional tracts of arable land occur; but the chief value of the country consists in its pasturage, and this value increases towards the south, till we reach the rich meadow lands of Holstein.

* Read before the Royal Society of Edinburgh in 1833.

In some places the chalk rises to the surface, forming gentle undulations, as in the neighbourhood of Gudumlund, in others, hills of gravel, mixed with flints, are met with; but in general, nothing is to be seen even on the sea-coast, but the prevailing sandy deposit, here and there cemented together into a more or less compact sandstone. The action of the sea upon land of so loose a texture is very powerful, and accordingly, the west coast of Denmark, like that of Holland, has from time immemorial been gradually washed away, and encroached upon by the water. On the east coast, again, a compensation, though to a much less extent, is in continual progress. When the agitated waters of the North Sea, urged by a westerly wind, rush along the Skager-rack, and double the Skaw, they reach a comparatively sheltered spot, where they are at liberty to deposit the sand and gravel they have hitherto borne along with them. The consequence is, that, on certain parts of this coast, the land is slowly but sensibly increased. In some places, where the moorland is in a state of nature, the successive additions are distinctly observable. From the gravel hills, a few miles south of the Lyme Fiord, I was much interested in remarking on the new land a series of slightly curvilinear furrows, marking out the repeated accessions made to it from a period probably very remote. The waters, on passing from the German Ocean to the Baltic Sea, deposit the sand along such parts of the coast as are not in the line of the great current, and every new storm from the east carries them forward on the beach, constituting, probably, a new furrow and a new addition to the growing land. Traces of an ancient beach are found many miles inland, and the names of many of the farms and residences of the proprietors, such as *skipsted* (shipstead) *höstemark* (highest ground) confirm the conclusions as to the reach of the sea in ancient times, which the general appearance of the land suggests.

But there occur very striking instances of the gradual increase of the land or recession of the sea, for which a very different cause must be assigned, and to one such instance it is the chief object of the present paper to draw attention.

It has been long observed that the waters of the Baltic sea are retiring from the land in many parts of Sweden and Finland,—a fact proved, among other evidence, by the increasing distance of buildings, and other fixed objects from the edge of the waters. Along the greater part of the Swedish coast, we meet with examples of this recession of the waters. In some places the harbours are becoming shallower; in others, the scarped faces of the rocks indicate a fall in the mean level of the water; while in places now dry, rings are occasionally met with in the rocks, marking the places where, in former times, the fishermen moored their boats. At different elevations, also, the rocks are not only rounded and water-worn, but frequently present round holes or pits of various depths, which ancient eddies have scooped out of the solid rock. These, I have often observed in the northern suburbs of Stockholm, but they occur in many places even in the interior of Sweden, and are objects of superstition to the common people.

In many other countries, indications of a change in the relative level of the land and water are to be met with, but in none, except Sweden and Finland, am I aware of its having been found to be still in progress. A whole coast has been observed to be sensibly elevated by a sudden convulsion, as was the case a few years ago in South America; but in Scandinavia, there are no convulsions nor traces of volcanic action, and the apparent change of level takes place, not by starts, but by a succession of small and individually imperceptible alterations. Towards the head of the Bothnian Gulf, this change is sufficiently conspicuous to attract the notice of the common people,—at Lulea a mile of land being gained in twenty-eight years, and at Pitea half a mile in forty-five years; and it is more or less observable along the Finland and Swedish coasts, till we approach the southern provinces of the latter kingdom, where it ceases to be sensible. This latter fact is not only curious in itself, but of considerable importance, as a test of the manner in which the phenomena are produced.

The attention of the Swedish philosophers having been drawn to this subject early in the last century, a series of accurate observations was made, the mean height of the waters of the Baltic carefully determined, and lines representing the true elevation chiseled out upon the rocks at different favourable positions along the coast. Similar observations have since been repeated at various intervals, the most recent and extensive having been made in 1821, under the joint direction of the Swedish Academy and the Russian Minister of Marine. The result of these comparative admeasurements is, that, along the greater part of the Baltic, the mean height of the water appears to fall from three to five feet in a century, or about one foot every twenty-five years.

From a mere local observation of the phenomena along the Swedish coast, we should conclude with Celsius, Linnæus, and the other early observers, that the waters of the Baltic are gradually retiring. But when we consider that, though an inland sea, it communicates by the Sound and the Belts with the German ocean, it will be evident that the mean level of the Atlantic ocean itself must have fallen at an equal rate, if the change observable on the shores of the Baltic be due to a depression of the waters of that sea. Now, supposing such a fall of the level of the great seas to be physically possible, none such has at least ever been observed, and therefore, the apparent change of level of the waters on the coast of Scandinavia, must be due to a gradual elevation of the land itself. This conclusion is confirmed by the remarkable fact already adverted to, that, below a certain latitude, the change ceases to be sensible even on the Swedish coast; while there is sufficient evidence to shew that none has taken place on those of Pomerania, Holstein, and the Danish islands, during the last 500 or 600 years; whereas, were the level of the sea actually sinking, traces of it should be observable on every part of the shores of the Baltic.

That the land is slowly and insensible rising, is the general persuasion in Sweden, and it has been adopted by almost every geologist who has visited that country. Haussman and Von Buch, both of whom are intimately acquainted with the Scandinavian peninsula, have advanced and advocated this opinion; but there are other geologists who decidedly reject it. Among these is Professor Lyell, who characterizes the opinion of Von Buch as " an extraordinary notion," (Geology, vol. i. p. 265.) and attributes many of the phenomena to the " gradual filling up of the Baltic by fluviatile and marine sediment." (Ibid. p. 46.) That many examples of such filling up are to be met with is very probable, but they are wholly independent of the phenomena on which the proof of the change of level of the coasts of Sweden rest. Whatever can be accounted for on the principle of depositions, is clearly no evidence of the upraising of the land. Though, therefore, it has been argued that some of the phenomena formerly quoted in support of the change of level, such as the shallowing of harbours, the growth of land, and the increasing elevation of certain islands, may be accounted for by the supposed action of currents and rivers, the fact itself remains untouched, in so far as it depends on the apparent rising of rocks from the sea, or the change of the mean level of the Baltic waters, in reference to the scarped granite walls which confine them. The level of the sea is the only element involved in this investigation, which we can regard as unchangeable. If it can be made out, therefore, that the living rocks on the coast, while they retain their relative position in regard to each other, yet alter their level in regard to that of the water, we can ascribe the change only to an elevation of the land. Nor must we be deterred, as geologists too long were in regard to the bay of Baiæ, by any supposed stability even of a whole peninsula, resting assured that nature, quiescent as she now is, has still power enough to effect changes of a far more extensive character.

It occurs at once as an objection to the measurements of the mean level of the Baltic, that though there are in that sea no tides, yet the prevalence of easterly or westerly winds, by causing the current through the Sound and the Belts to set from the east or the west, effects a change of the level of the whole sea of several feet. This source of error did not escape the surveyors in 1821, but by observations of the maximum and minimum very near approximations were made to the truth. If we can obtain tolerably accurate determinations of the mean level of the sea, on shores where the ebb and flow of the tide present additional obstacles, the difficulty of determining that level in the Baltic, cannot be fairly advanced as a reason for rejecting the measurements obtained under the direction of the Swedish Academy.

In the Gulf, and on the coast of Finland, proofs of a change of level have also been observed, but they appear hitherto to be less satisfactorily established, than on the west and northern coasts of the Bothnian Gulf. It has even been proved, by the growth of ancient pines close to the sea on the coast of Finland, and by the similar position of the walls of the Castle of Abo, that in those spots at least no sensible change of the respective level of the land and water has for a long period taken place. This is decisive as to the permanence of the water's level, but it in no degree weakens the positive evidence of a rise of the land in many parts of Scandinavia.

It is only on the coasts that the *rate* at which the land rises can be determined by a reference to the level of the sea; but that it does rise, is proved by very many phenomena which present themselves within the coasts, and even in the very interior of Sweden. I shall advert to a few of these which are seen on the Lake Maeler, and some of the inland waters around Stockholm. This city stands at the head of an arm of the sea, about thirty miles within the shores of the Baltic, and at the junction of its waters with those of the lake Maeler. A small part of the lower city, chiefly about the Skipsbro, is built upon piles. The security of the buildings thus supported depends upon the piles being constantly under water; but after a lapse of a term of years some of them were observed to be giving way, and on searching for the cause, it was found that the sinking of the waters had gradually left the tops of the piles bare, and exposed them to decay.

It is well known also, that several of the small peninsulas on which the city or suburbs stand were formerly islands, and during the past summer two canals were in progress across two narrow necks of land, for the purpose of reviving the communication which the gradual elevation of the land had long ago interrupted. The *fisketorp* or fishing hut of Charles XI ? which in former times stood close by the deep water, is still preserved as a memorial of that monarch, though no longer near any spot where his favourite amusement can be enjoyed. But one of the most interesting examples, is presented by the beautiful lake which skirts the woods and pleasure grounds of the palace of Haga, in the northern suburbs of Stockholm. The position of this lake shews that it has formerly communicated with the sea, though now it is considerably above it, and entirely inland. As the sea retired, this sheet of water would also have been drained off, had it not been dammed up at the only outlet, to preserve the beauty of the promenade, one of the finest in the neighbourhood of the city. At present it is dammed up to the height of four or five feet, and the character of all the land around shews, that in ancient times it has been very much higher, and more extensive.

The upper parts of the Maeler, and its many arms and inlets, exhibit similar evidence of a rise of the land. Wherever the nature of its shores admits of it, it is girt by a rich belt of land gained from the waters, and beyond the present limits of its numerous branches extend large tracts of land already recovered and cultivated, small reedy lakes cut off by banks or marshes from the main body of the lake, or patches of flat land which seem to be still undergoing a gradual drainage. Whoever has sailed along the Maeler, made accessible like our own lakes by the introduction of the steam-boat, must have observed many instances of the recession of its waters, but they are still better seen on exploring by land the upper limits, where no boat can any longer penetrate. Near the palace of Ekolsund, the property of Dr Seton, at a distance of about thirty miles from Stockholm, an arm of the lake, from which it derives its name, has been shortened several miles by this natural drainage; and the long narrow canal which still admits vessels within a short distance of Upsala, is evidently the relic of a branch of the lake, at one period of great extent. The countless islands also sprinkled over the bosom of the Maeler, and which present so many varying beauties to the eye of the voyager, direct the mind back to that remote period, when they constituted only so many hidden rocks or sandbanks beneath the surface of a body of water much more vast than the lake now presents.

In many other parts of the North and Middle of Sweden, a similar drainage is observable, and that not only in the flatter districts, as around Cronstad, at the head of the lake Wener, but also in the mountainous and hilly country extending over Wermeland, Smoland, Dalecarlia, and part of several other provinces. The neighbourhood of Norköping also, and part of the line traversed by the great canal, afford of themselves, evidence of a lifting up of the land, sufficient to satifsy any unbiassed mind.

In the present state of our knowledge, therefore, there is every reason to believe that certain parts of the Scandinavian Peninsula are gradually rising, at a rate probably variable, but which recent admeasurements shew may at present be estimated at one foot in twenty-five years. Adopting this fact, we naturally inquire into its probable cause. Among the ordinary phenomena of volcanic action, we find nothing at all parallel to the case before us. They afford many examples of elevation even to a great extent, but these are all the result of a single impulse, or of a succession of violent impulses, applied within a short space of time. The elevation in Scandinavia is gradual and insensible. The country also, within the historical period, has been remarkably free from what is commonly understood by volcanic action; there is, consequently, no ground for attributing it to the causes usually assigned for that action. If, however, we define volcanic action, with Humboldt, to be the influence exercised by the interior of a planet on its exterior covering, during the different stages of refrigeration, we shall find, in such action, a cause sufficient to account for all the great changes of level which the several parts of our planet have successively undergone. But this is an extension of the meaning of such action, which is not generally received, and which, indeed, cannot be admitted, until it be more clearly shewn that the true volcanoes have their origin in the high temperature of the interior of the globe.

Taking for granted, therefore, what many geological phenomena render highly probable, that the temperature of the globe was in early times much higher than at present, we shall find, in its secular refrigeration, a cause not only for the elevation of ancient mountain-chains, but of the gradual elevation going on in Scandinavia in our own time. To obtain a general idea of the effects of such refrigeration, let us go back to the remote period, when the crust of the earth, even at the poles, was comparatively slight. In this state the polar, receiving from the sun less heat, would cool more rapidly than the equatorial regions. The contraction consequent upon cooling, would cause a depression parallel to, and an expansion at right angles to, the earth's axis; in other words, the force of contraction would aid the centrifugal, in gradually flattening the earth towards the poles and dilating it around the equator, where the resistance of the crust to the pressure from within would be least. This process continuing, a time would at length arrive, when the polar regions would no longer throw off any sensible quantity of heat; when their temperature would be constant, the caloric derived from the sun in summer being nearly equal to that lost by radiation in the winter, and when all sensible contraction consequently would cease. But it is obvious that such a term would arrive long before the equatorial parts of the earth had reached their maximum of cooling,—while they were still continuing to give off heat and to contract. The whole compressing force consequent upon contraction, would now be exerted in the equatorial regions, and the earth in this state may be represented by a globe encircled by a broad belt, compressing it at right angles to the axis. The effect of such a compressing force on the inner mass must be to displace it, and to produce a tendency to dilate in directions where the resistance is least. Now, the compressing force, under the circumstances stated, being insensible at the poles, all other things being equal, the eruption or displacement, whether violent and of short duration, or gradual and of long continuance, is most likely to take place in high northern latitudes. But there might occur in lower latitudes, weak points in the crust of the globe, which would be the first to yield; and wherever the point of minimum resistance occurred, there the convulsion would naturally take place. Where a *point* of small resistance occurred, an isolated mountain would be thrown up; a *line* would give direction to a mountain-chain; and, where neither occurred, it is easy to conceive that a large tract of country might be elevated either at once, if the resistance were at once overcome, or gradually,—the resistance of the crust and the compressing force at the equator, remaining uniform and nearly balanced.

If, therefore, we admit the theory of the gradual cooling of the globe, we recognise the existence, at every point on its surface, of a compressing force which, at the equator, is now a maximum, and in the elevation of the northern part of Scandinavia, an effort of the internal mass to liberate itself from that pressure, by displacing the crust of the earth at a point of minimum resistance.

If such be the cause of the elevation in question, it is plain that we cannot *a priori* prescribe to it any peculiar mode of action. A whole district may be elevated equally, so that all parts of it may retain the same relative level. A level plain, for example, may be elevated throughout, so as to be still level. The plain of Quito among the Andes, the table-land of Thibet, and the interior of Spain, may have been thus raised. Or the elevation may be greater in any given direction, so as to produce an inclination, and consequent draining of the surface; or it may be greater on two, or three, or all sides, than it is in the centre, and thus may constitute a basin.

Suppose Scandinavia to have been a plain on which the uplifting force from within was exerted, the effect might either have been equal over the whole surface, which it evidently was not, or greatest towards the North Cape, so as to produce a continued slope towards the Sound; or the greatest rise might have been on the west, in Norway and Sweden, or on the east in Finland, or there might have been an elevation on the N.E. and W. while the central portion remained nearly at its original level. The last of these seems to have been the true mode of action. Sweden, Finland, and Lapland have been all more or less elevated, while the central part, the bed of the Baltic Sea, has remained nearer its original level.

Nor is such an elevation towards three cardinal points destitute of probability on purely physical grounds. It is a result of observation, that cooling bodies, where the surfaces are sufficiently extensive, have a tendency to crack at right angles to the surface of greatest cooling; that is, at right angles to the direction of the greatest contractile force. To this tendency the origin of basaltic columns is traced. Now, the force of contraction in the equatorial regions acts powerfully at right angles to the earth's axis, and consequently tends to rend the brittle rocky crust by cracks or fissures running towards the poles. Certain lines of small resistance are thus generated, which, in former periods, have afforded a comparatively easy outlet to the fluid matter within, giving rise to ranges of mountains of greater or smaller extent. If two such fissures approach near each other at any point, it is consistent with observation that they should either run into each other spontaneously, or that the force from beneath, elevating the narrow neck which divides them, should thus produce a junction.

Now, such appears to be what has actually taken place in Scandinavia. We have one great chain of mountains running nearly the whole length of Norway and Sweden, till it terminates in the North Cape. Another smaller range, in a similar direction, through Finland, and beyond the head of the Bothnian Gulf, we find the latter inclining to the west, till it joins the former. A line of elevation is thus traced surrounding the basin of this inland sea, and embracing the entire country in which any rise of the land has been recently observed.

We need not rest satisfied, therefore, with simply considering the rising of these northern countries to be a compensation for the depression at the equator, but we may safely, I think, refer the rise to the line traced out by the ranges of mountains just described. It is probably due not only to the same force by which these mountain-chains were at first thrown up, but to this force exerted in precisely the same lines of direction. The central action is upon the mountain-chain, and the lower land rises gradually along with it.

There are two circumstances, independent of theory, which chiefly incline me to adopt this view. The first is, that when we go south beyond a certain latitude, where we may suppose that the elevation of the distant mountains ceases sensibly to affect the general level, we find no rise observable along the coast. The second is, that the rise is strikingly observable towards the head of the Bothnian Gulf, where the crossing of the Finland to the Norwegian range may not be without influence in increasing the effect. The same view also accounts for the less sensible and general rising on the Finland coast, for the mountains in that country cannot compare in altitude with the Scandinavian range.

Besides, if the central action of the elevating force lie upon the mountains, these should rise more than the low country, and there should be a considerable drainage towards the coast. Now, the interior of Sweden, in many provinces, exhibits, almost at every step, the results of drainage. In numerous places, the only spots of arable land are narrow strips gained from the lakes; and land long cultivated presents very frequeutly a bed of moss, a few inches or feet beneath the surface, shewing it to have been the seat of ancient waters. Some of the finest estates in Sweden have evidently been gained from the retiring lakes; and the appearances of drainage in the lake Maeler, seem to imply that the elevation of the land, now in progress, is greater as we approach the hilly country, than it has been found by admeasurement on the shores of the Baltic.

The indications of a lifting up of the scarped rocks at Uddevalla, on the west coast of Sweden, and of various places on the coast of Norway, within the present geological era, may also indicate a greater rise of Scandinavia towards the west and north, in the line of the mountains. The observations yet made on that coast, however, are not sufficiently numerous to prove that the phenomena on record are not the result of mere local convulsions.

If the views advanced in this paper be correct, it will appear, that though we may, in many cases, account for geological phenomena, by reference to causes still in operation, we cannot, with any degree of probability, conclude that they are now capable of producing effects as powerful as they seem to have done in ancient times. The cause which now raises the land in Scandinavia, four feet in a century, is the same, if we are correct in stating it, which, in remote periods, elevated a ridge of mountains to the mean height of 3000, and several of its peaks to upwards of 7000 feet. But how vast a period must elapse before such mountains could be raised at the present rate of elevation? Suppose it proved that the rising now in progress is greater at the mountains than on the coast, and allow it to be ten times greater—that the mountains now rise at the rate of forty feet in a century—still the action must have continued 7500 years to elevate the present range of Norwegian Alps to its mean height, and 17,500 to produce the highest elevations. But the general character of this, as of most other high mountain ranges, the great difference in height of the several culminating points, and the rapid decline of the whole range towards the east, shew that they have not been elevated by any action so slow and gradual as that now observed. Admitting the cause to be the same, it must in former times have acted with a much higher intensity.

Now, the theory we have advanced accounts for this higher intensity in the most satisfactory manner. The higher the temperature of the globe, the more rapid must the cooling have been, and the greater the contraction. In remote periods, therefore, the convulsions caused, wherever the compressed matter of the globe found a vent, must have been exceedingly powerful; and to such periods we must look for that intense action from which the highest mountain ranges have resulted. The earth is now approaching its minimum of temperature, and its mass consequently to a state of rest. It is contrary to the most certain physical laws, therefore, to suppose that, from the cause we have assigned, similar elevations could now result.

That the era when the expansive energy of the interior of the globe was powerful enough to produce such mighty results, must have been very remote, is proved by phenomena which present themselves over the entire surface of the globe. Within the limits of authentic record also, no very striking changes have been produced on the earth's surface, if we except such as are due to true volcanic action. In Sweden, we can define one period of eleven hundred years at least, within which the raising of the land now observable has been little more rapid than recent admeasurements prove it still to be. To advert to one proof only, the Church of Gammel, (Old) Upsala, about two English miles from the celebrated seat of learning, stands on the limits of the lower part of the plain of Upsala, and at a height, I should suppose, of not more than 100 feet above the present level of the Maeler. It bears marks of great antiquity, and is known to have been a temple of Thor, before the introduction of Christianity, a thousand years ago. At the present rate of elevation, the plain should rise about 50 feet in a thousand years. There cannot, therefore, have been a much more rapid elevation since the Pagan ritual was abolished.

In whatever way we explain it, there is, in my mind, no doubt of the fact, that a gradual elevation of the land in Scandinavia is now, and probably has long been, in progress. From this fact we derive a new principle to assist us in accounting for evidences of elevation on the coasts, and drainings on a large scale, occasionally observable in mountainous countries. Whereever ranges of mountains occur, especially in northern latitudes, we might, from analogy, expect to meet with some traces of elevation still in progress. In inland districts, supposing elevations to take place, the relative height of all objects must remain the same, all being equally uplifted. In such cases, barometrical measurements are the only means of determining the fact. But it is obvious, that gradual though slow elevations may take place for a long time, without being made sensible by this mode of admeasurement. It is only, therefore, where the chain of mountains has its course near the sea that we can easily determine whether the relative levels of the sea and land undergo any change. Series of observations, where circumstances are favourable, might lead to very interesting results; and, at all events, would prove whether or not the phenomena observed in Scandinavia have their counterpart in any other country.

Italy is placed in circumstances such as would justify the expectation that a gradual elevation of the whole peninsula may possibly be still detected; and, girt as it is on either shore by the tideless waves of the Mediterranean, the difficulty of making accurate observations cannot be great. It requires only that, on the rocks along the coast, a series of lines should be drawn as near as may be to the mean level of the sea, and the time of observation recorded. Ten, twenty, or thirty years after, the line of mean level, taken anew, would indicate if any, or how much, change had taken place. We know that, since the time of the Romans, parts at least of the Italian shore have been raised above their ancient level. Lines of mean level, drawn at different places along the whole coast, would shew how far these observed elevations are partial, and the result of local causes, or the indications of a general uplifting due to a cause operating along the whole range of the Appenines.

On the southern shore of the Bay of Biscay, from Bayonne to Corunna, along which the continuation of the Pyrenees extends itself, is another locality, where change of level may possibly be still observable. In America, almost the whole west coast may be expected to undergo a gradual rise.

In Scotland, and especially in the mountainous districts, we have evidence of the existence, in remote times, of a system of drainage similar to that still going on in Sweden. The cause was probably the same, though, whether that cause still operates on any part of our island, we have as yet no means of determining. Whether or not all elevation has ceased along those ranges of mountains which cross the country in a north-easterly direction, or diffuse themselves in partial ridges midway between both seas, it would be extremely difficult to ascertain. On the north and north-west coast only, is it likely that any very accurate observations could be made. And chiefly on the coasts of Ross-shire and Sutherland, from the proximity of the mountains to the standard level of the sea, might we expect to ascertain if any traces are observable of a still existing action of that force which the whole character of the country shews to have, in early times, so widely convulsed the highland districts of Scotland.

PORTOBELLO, *April* 1833.

SOME OBSERVATIONS ON PHOSPHORUS. *By* JOHN DAVY, *M. D. F. R. S., Assistant Inspector of Army Hospitals. Communicated by Sir* JAMES MACGRIGOR, *Director-General of the Army Medical Board.*

IN the Number of the Quarterly Journal of Science for July and December 1829, is a paper by Mr Thomas Graham on the slow combustion of Phosphorus, in which he has given an abstract of what was previously known on the subject; and has, besides, added several curious particulars, ascertained by himself.

Before I was acquainted with Mr Graham's paper, I had been engaged in a similar inquiry, the results of which I now propose to give. Although the greater number of them accord sufficiently with his, some of them are different, and a few of them I believe are new.

It is considered as a well established fact, that phosphorus does not shine in oxygen gas at a temperature below 64°. This is stated by Mr Graham, and by Dr Thomson in his System of Chemistry; it is also stated, that phosphorus does not combine with oxygen below the point of fusion. The results of my experiments have been different. In some instances, in which I have introduced phosphorus into oxygen obtained from chlorate of potash, it has not shone in the dark between 60° and 80°. In others, it has shone very feebly, even more feebly than in common air; the oxygen not having sensibly diminished in a volume in the course of several hours. In others, it has shone very brightly, sometimes by fits, flashes of light appearing and disappearing; and sometimes without interruption, with an intensity, though infinitely below the violent combustion of phosphorus, so much above its very slow one, that the heat produced fused the phosphorus, and the ascent of the water or mercury in the tube was visible in progress, and occasionally rapid, and yet never breaking out into vivid inflammation.

To what these differences of effect have been owing, I have not been able to ascertain; only this far, that they were not concerned with the purity of the gas, at least, in relation to the presence of small variable proportions of atmospheric air, or indeed any appreciable adulteration; or with the degrees of temperature. The most probable mode of explanation of the luminous appearances in different degrees is, that they are connected with the formation of different compounds of phosphorus and oxygen, according to the analogy of the degrees of light emitted by sulphur in combustion; but of the truth of this I have not been able to satisfy myself by experiment.

In accordance with the observations of others, I have found that when oxygen gas is rarefied, phosphorus shines in it; and that when condensed, it ceases to shine. With an augmented pressure of a column of mercury of 16 inches, when heated with a spirit-lamp in this gas, it emitted no light, till it fused; then it burst into flame and burnt explosively, and the oxygen was condensed in an instant.

Dr Ure states in his Dictionary of Chemistry, that phosphorus soon ceases to be luminous in dry atmospheric air, on account of the acid coat formed on it, which protects the surface from the farther action of the air. This I have not found to be the case. A stick of phosphorus suspended over strong sulphuric acid in a limited portion of atmospheric air, continued shining many hours, till, there was reason to suppose, all the oxygen was consumed; and the result has been the same when phosphorus has been introduced into air confined over mercury, and previously dried by the same acid; when its light ceased, a fresh portion of phosphorus thrown up did not kindle. In both instances, the luminous appearance was as bright as in common air that had not been artificially dried.

Compression and rarefaction in the instance of common air, has an effect analogous to that mentioned when speaking of oxygen. In a bent tube, under an increased pressure of 90 inches of mercury, phosphorus did not shine. When the experiment was reversed, it became luminous, and more so than under ordinary atmospheric pressure. The volume of atmospheric air compressed in one instance and rarefied in the other, was about one cubic inch.

The same effect is displayed in a striking manner by heating phosphorus in a retort securely closed. The compression from the intense heat produced when the phosphorus inflames, presently extinguishes the flame, which may be rekindled by allowing a portion of the confined air to escape.

When phosphorus is placed on the plate of an air-pump, under a receiver, and the air exhausted, the brightness of its light in the dark rather increases with the exhaustion, and, in the nearly perfect vacuum formed by a good pump, its light was not diminished. When the air has been suddenly readmitted, its light has been extinguished, and for a few seconds it has ceased to shine.

When phosphorus has been placed in distilled water under the receiver of an air-pump, and the air dissolved in the water has been exhausted, or taking it into the open air out of the water by a thread attached to it, it has shone with rather increased brightness. If now immersed in common water, and suddenly taken into the atmosphere, it has emitted no light. Many other effects similar to this might be mentioned, showing how circumstances, apparently very trifling, exercise an influence on phosphorus, and promote or impede, in a manner that could not have been expected *a priori*, its union with oxygen, and its luminous appearance depending on this union.

In accordance with the results of Mr Graham's experiments, I have found that the vapour of ether, oil of turpentine, and every other essential oil that I have tried, extinguished the light of phosphorus shining in common air. The vapour of alcohol, of camphor, and even of assafœtida at ordinary temperatures, has had the same effect. Phosphorus even fuses in the vapour of camphor without becoming luminous; and may even be sublimed with camphor without inflaming. The mixed sublimate of phosphorus and camphor exposed to the air on the warm hand, did not shine till rubbed, when it became brilliantly luminous. Phosphorus may also be boiled in and distilled from oil of turpentine without inflaming.

Though phosphorus inflames in pure chlorine gas, its light is extinguished when it is exposed to the vapour of chlorine, as when it is held over an aqueous solution of this substance. The same happens when it is exposed to the vapour of Iodine and Bromine.

It does not shine in nitrous oxide, though mixed with common air. When heated in this gas it melts, and at the subliming point decomposes the gas explosively with a bright flash. Its light is extinguished by nitrous acid gas or vapour, even when so much diluted with common air as hardly to be perceptible by the sense of smell.

The vapour of ammonia, of muriatic acid, of distilled vinegar, and of hydrocyanic acid, do not appear to prevent phosphorus from shining; they rather increase the brightness of its light. It shines in carbonic acid gas, and muriatic acid gas, when the minutest quantity of atmospheric air is present.

It appears to be soluble, or capable of rising in vapour in muriatic acid gas, carbonic acid gas, and hydrogen gas; for when these gases perfectly pure have been kept some time over mercury with phosphorus in them, a luminous appearance has been produced (bright flashes of diffused light), when they have been passed alone into a jar of common air. The same effect takes place, when the azote of atmospheric air, deprived of its oxygen by the *slow* action of phosphorus, is thrown into the atmosphere, or into oxygen gas. But the reverse is the case, when the oxygen of the atmospheric air has been separated by *intense* combustion; however much the phosphorus has been in excess, and though it has been a second time sublimed in the azote, it has not acquired the power of shining on admixture with common air, although from its smell there was no reason to suppose that the gas did not contain phosphorus in solution.

Mr Graham has pointed out the remarkable effect of different varieties of carburetted hydrogen in extinguishing the light of phosphorus. The results of my experiments with these gases perfectly agreed with his. I have also found that hydrogen gas obtained from iron-filings and dilute sulphuric acid (the former from the blacksmith's shop) has had a similar extinguishing effect, though in a less degree. One volume of it, mixed with fifty-nine of common air, has prevented phosphorus immersed from shining; diluted more than this, it lost its preventive power. This result is probably owing either to the presence of a little vapour somewhat analogous to that of naphtha, on which the odour of hydrogen gas thus procured depends (and the odour of this gas was strong); or, on the presence of a little carburetted hydrogen formed by the union of the nascent hydrogen and the carbon of the cast-iron or steel at the instant of separation. The result of the analysis of the gas by the explosion with oxygen by means of the electric spark, has been rather favourable to the first supposition; but the quantity of carbonic acid gas formed was so extremely small, that it was impossible to decide positively. The fact that hydrogen gas procured by means of very pure steel, such as piano-forte wire, does not, when mixed with atmospheric air, extinguish the light of phosphorus, is favourable to the same conclusion.

Some of the results described are not without interest in relation to practical chemistry. Mr Graham has pointed out the applicability of phosphorus to detect in mixed gases the presence of very minute quantities of carburetted hydrogen. It is equally applicable as a test of the purity of muriatic acid gas and carbonic acid, and hydrogen gas. If they contain the slightest trace of common air, phosphorus will shine in these gases, provided they are otherwise unadulterated. It has been shewn how it is capable of detecting an adulteration of hydrogen, which had hitherto, I believe, escaped detection; and, it may also be employed to detect similar impurities in other gases, in which, with an admixture of common air, phosphorus usually shines. I need not point out the caution that is required in deciding on the absence of oxygen, in any mixed gas in which phosphorus does not become luminous.

In relation to the results in general, they are not without some interest theoretically considered, as belonging to the more obscure phenomena of chemistry, somewhat analogous to what we witness in the animal and vegetable kingdoms, in which notable changes during life and after death are taking place, owing to the action of causes which we are not able to appreciate, or perhaps of substances which have hitherto eluded detection.

MALTA, *March* 1833.

ON THE CHARACTERS AND AFFINITIES OF THE GENUS *CODON*. *By* DAVID DON, *Esq. Libr. L. S. Communicated by the Author.*

THE present genus is one of those whose characters are concealed under a peculiar habit, which renders it often difficult, if not impossible, to determine with certainty their natural affinities. I was at first inclined to consider *Codon* as belonging to the *Solaneæ*, and indeed the curved embryo, and the striking resemblance in habit, appeared strongly to favour that arrangement; but a more intimate examination has shewn these views to be untenable, and that its affinities must be looked for among other families. In *Codon* the flowers are symmetrical, the stamens epipetalous, the anthers incumbent, with parallel cells, the style duplicate, and the capsule composed of two valves, with the septum formed by the approximation of the two prominent placentæ, the ovula erect, and the seeds albuminous, with the embryo about equal its length. On comparing these characters with those of the *Hydroleaceæ,* we shall find that they accord in a very remarkable degree; and although in *Codon* the stamens and divisions of the calyx and corolla are doubled in number, the symmetry of the flower is preserved, and the mere increase of those parts are of comparatively little importance, when the number of points of agreement are taken into account. In *Codon,* and in some of the *Hydroleaceæ*, particularly in *Wigandia,* the leaves have a lobed margin, and are clothed with bristly points, which, in the former genus, are developed into prickles. The stamina and pistilla entirely coincide in both genera, but the albumen is more copious, and the stigmata less developed in *Codon*, whose affinity, however, to the *Hydroleaceæ*, may be considered as completely established. *Cordia decandra* may be instanced as an example of increase in the number of stamina in a family very nearly related to *Hydroleaceæ*. The *Cordiaceæ* appear to constitute a group intermediate between that family, *Convolvulaceæ*, and *Boragineæ;* and, by means of the small group of *Hydrophylleæ*, which is distinguished by a completely unilocular ovarium, and by a minute embryo placed at the extremity of a copious albumen, these families are connected with *Polemoniaceæ* and *Primulaceæ.*

CODON, *L.*

Syst. Linn. DECANDRIA MONOGYNIA.

Ord. Nat. HYDROLEACEÆ, *Nobis.*

Calyx multi (10–12)- partitus: *laciniis* subulatis, erectis; *alternis* minoribus. *Corolla* tubulosa, calyce longior, basi torulosa, costis lobis numero æqualibus peragrata: *limbo* 10 v. 12-fido: *lobis* oblongis, obtusis, carinatis, æstivatione imbricatis; *alternis* parùm minoribus. *Stamina* 10 v. 12, laciniis corollæ alternantia, fornicibus totidem compresso-tetragonis è fundo ortum ducentibus inserta: *filamenta* subulata, glabra: *antheræ* medio adnatæ, incumbentes, biloculares: *loculis* parallelis, longitudinaliter dehiscentibus, nisi ad utramque extremitatem, omninò connatis. *Pollen* farinaceum. *Pistillum* 1: *ovarium* biloculare: *ovulis* erectis: *stylus* semibifidus, basi pilosus: *stigmata* simplicia, obtusa. *Capsula* ovata, acuminata, bilocularis, valvis 2, apice dehiscens, polysperma. *Dissepimentum* duplicatum, marginibus revolutis, seminiferis. *Semina* numerosa, angulata, copiosè papillosa: *testâ* simplici, cartilagineâ: *albumen* copiosum, carnosum. *Embryo* erectus, axilis, modicè arcuatus: *cotyledones* brevissimæ: *radiculâ* longissimâ, filiformi, obtusâ, umbilicum spectanti.

Herba (Capensis) *annua, aculeis subulatis, rectis, albis undique copiosè ornata.* Radix *fusiformis?* Caulis *erectus, ramosus, teres, flexuosus, robustus, calamo scriptorio vix crassior, pedalis v. sesquipedalis.* Folia *alterna, petiolata, ovato-oblonga, apicem versus parùm attenuata, sed obtusa, substantiâ crassiusculâ carnosa, subtùs costata, margine recurva et subrepanda, pilis setosis brevissimis utrinque copiosè vestita, scabra, 2–3-pollicaria, ad marginem et infrà ad costam præcipuè aculeata.* Petioli *sesqui v. bipollicares, suprà planiusculi, leviter canaliculati, subtùs convexi.* Flores *magni, solitarii, pedunculati, extra-alares, in caulis apice subracemosi, basi foliis 2 angustioribus sæpè bracteati.* Corolla *alba, purpureo-variegata.*

1. C. Royeni.

Codon Royeni, *Linn. Syst. Nat.* ed. 13. p. 292.—*Thunb. Prodr.* p. 80.—*Willd. Sp. Pl.* 2. p. 540.—*Andr. Rep.* t. 325.—*Persoon, Synops.* p. 466.

Hab. ad Promontorium Bonæ Spei. *Thunberg. Niven.* ⊙. (V. s. sp. in Herb. Linn. et Lamb.)

The *Sibthorpiaceæ* may be adduced as affording also an example of increase in the number of the parts of the flower, in the genus *Disandra,* whose flowers are most frequently 7-cleft and heptandrous. This small group is very nearly related to the *Primulaceæ,* with which it agrees in its symmetrical flowers, capitate stigma, and large, globular, central placenta, but differs in having the stamina alternating with the lobes of the corolla, and a bilocular ovarium.

ON AMERICAN STEAM-BOATS. *By Mr C. Redfield of New York.*

"The increase in the number of steam-boats in the waters of the United States within the last fifteen years, which has not failed to excite both surprise and gratulation, is hardly greater than the improvements which have been made in their structure and efficiency. Before the commencement of the period alluded to, the steam-engine had been brought nearly to the maximum of its efficiency as a moving power, and the adaptation of its energies to the purposes of navigation, though less advanced, was supposed to have nearly reached the same stage of perfection. About ten years since, the steam-boats which navigated the river Hudson, and which were doubtless superior to any others of that period, performed the passage between New York and Albany in from eighteen to thirty hours, according to the favour of circumstances: five years later, and from one to four deeply laden vessels, each of more than two hundred tons' burthen, were *towed* through the same route, by a single steam-boat, in an equal range of time.

The power and speed of the Hudson River steam-boats, as well as those employed on the Mississippi and elsewhere, have continued to be annually increased up to the present time. In the year 1827, the passage between New York and Albany, which is supposed to be equal to 150 statute miles *, had been performed under favourable circumstances, in about twelve hours. In 1829 this passage had been accomplished in ten hours and thirty minutes, and in 1831 in ten hours and fifteen minutes, all the stoppages on the river being included in these statements. But the giant offspring of science and the arts had not yet attained its full strength and maturity, and during the present season (1832) the passage has been performed in *nine hours and eighteen minutes*, including the time spent at the different landings. Claims to this rate of speed have also been set up by more than one competitor. It appears highly

* The distance between the two points by the river-road is reputed to be equal to 162 miles. The direction or course of the channel of the river, though generally favourable, ranges between south-west and north-east.

probable, that, with the means now possessed or in preparation, the passage may yet be performed in something less than nine hours, notwithstanding the obstacles presented by the shallowness of the river, and the intricacies of the navigation, in the thirty miles nearest to Albany. It may be remarked here, that the length of the route, as above given, is not supposed to be overrated, as is usually the fact with inland navigable routes; nor can the assistance of the tides in ascending the river be fairly estimated at more than one mile per hour, on an average of the whole distance; while, in the descending passage, little or no advantage can be derived from this source, because the ebb and flood are then made to alternate in three hours, or even in a shorter period. Twelve landings are usually made on each passage, and at six of these places the steam-boats are commonly brought to, and fastened to the wharfs.

Those who are conversant with the difficulties which attend the attainment of high velocities in navigating a medium whose resistance accumulates in a ratio exceeding the squares of the velocities, by means of an artificial power, the reaction for which is obtained from the medium itself, will justly consider the above rates of speed as extraordinary. Nor will this view of the subject be weakened by statements, which may chance to gain currency of the attainment of greater speed in more open waters, by steam-vessels, possessing less comparative efficiency, on routes either overrated in their extent, or affording greater occasional advantages, from the strength and rapidity of the tides. It sometimes happens, that, owing to the inadvertence of a compositor, or some other cause, a mistake of an hour finds its way into the published accounts of the passage made by a favourite steam-boat.

In addition to twelve steam-boats which are employed on this river in the various lines of transportation, and on short routes, there are ten boats of the first class, which have been employed in daily trips for the conveyance of passengers between New York and Albany, viz. the North America, Albany, Novelty, Erie, Champlain, Ohio, New Philadelphia, De Wit Clinton, Constitution, and Constellation. Of these the five first named depart in the morning at seven o'clock, and perform the passage in nine and a quarter to thirteen hours; the latter five depart usually at five in the evening, and accomplish the passage in nearly the same time. Passengers in the former may enjoy airy accommodations, and the interesting scenery of the Hudson, together with their accustomed repose at night; and by means of the latter, men of active and provident habits are able to transact their daily business at will, either in our commercial metropolis, or in one of the flourishing cities at the head of navigation; the intervening space of 150 miles being passed over during the hours of relaxation and repose, with no other discomfort than attends the occupation of a good mattrass with clean linen, in a steam-boat usually loaded with passengers. The price of passage is commonly fixed at three dollars.

Most of these boats have undergone a material change in their size, form, and general outfit, since their first construction, in order to maintain a successful competition for the business of this noble river. It will not be necessary to give an account of the various efforts of professional skill, by means of which these boats have attained to their present degree of perfection and efficiency, but a general, and somewhat definite description of one of the number may prove acceptable to the readers of the Journal.

The *De Wit Clinton* having been twice enlarged, is now of the following dimensions, viz. entire length on deck 233 feet, breadth of the hull at the water-line 28 feet; projection of the deck or wheel-guards on each side, 18 feet; maximum width of deck, including guards, 64 feet; depth of hold 10 feet, height of the upper deck 11 feet; length of the great cabin 175 feet; draft of water, not exceeding 4 feet 6 inches; diameter of the water-wheels 22 feet; length of the same, measured on the buckets, each wheel 15 feet; depth of the bucket or paddles 37 inches; diameter of the iron water-wheel shafts 14 inches; length of the crank 5 feet; length of the stroke made by the piston 10 feet; diameter of the piston 66 inches, its superficies being equal to 3421 square inches. The gross length of the working cylinder, which is placed in a vertical position, is 11 feet 10 inches; its lateral apertures, by which the steam is received and discharged, are 42 by 10 and $\frac{3}{4}$th inches. The engine is worked by means of four circular receiving-valves, each of 17 inches diameter (two at either end of the cylinder), and four exhausting valves of the same dimensions. The diameter of the main steam-pipe and side-pipes is 25 inches.

The entire capacity of the cylinder, deducting the space occupied by the piston, and including one of the side apertures extending to the valves, is equal to 252 cubic feet, which is equal to 1890 standard wine gallons, or sixty-three barrels of thirty gallons each. Should the engine perform twenty-six revolutions or double strokes per minute *, there will be exhausted 13,104 cubic feet = 3276 barrels per minute, and 786,240 cubic feet of steam, or 196,560 barrels will be exhausted every hour, during the time in which the engine is in full motion! But the steam is allowed to enter freely from the boiler, only during a part of each stroke, the throttle-valve being then closed, and the steam which has previously entered the cylinder is allowed to expand during the remainder of the stroke. If the pressure of steam maintained in the boilers be equal to twenty pounds per square inch above the mean pressure of the atmosphere (and greater pressure is frequently employed in these boats), the average effective pressure on the piston may be safely estimated, even with less pressure, at about ten pounds for each square inch of its superficies. To this must be added the *net* pressure of the atmosphere, obtained by the use of the condenser and air-pump, which is fully equal to ten pounds to the inch, the vacuum in the condenser varying generally from twelve and a half to thirteen and a half pounds to the inch, by the barometrical guage. This estimate, which is obtained by near approximations, will give an average pressure on the piston equal to twenty pounds to the square inch; but, lest we should be charged with overrating, we will reduce it to sixteen pounds effective pressure to the square inch, or 3421 inches of piston, running fifty-two single strokes of ten feet each per minute. Estimating now the full powers of a horse as equal to 150 pounds, moving at two and a half miles an hour, or to raising 33,000 pounds 1 foot per minute, we have the following formula:

$$\frac{3421 \times 16 \times 52 \times 10}{33.000} = \frac{28462720}{33.000} = 862$$

* The engines of some of the Hudson River boats are often seen running at the rate of twenty-eight double strokes per minute, the velocity of the piston being 560 feet per minute.

showing a force exerted upon the engine which is equal to the power of eight hundred and sixty-two horses. From this result we are to deduct the power necessary for moving the engine, or that required for overcoming the friction and resistance of its parts, which is comparatively less in engines of this magnitude, working on such an extended crank, than in the average of smaller engines. We will estimate it, however, as equal to one-third of the force applied, which gives the effective working-power of the engine as equal to that of five hundred and seventy-five horses. An engineer with whom I have conferred, and under whose direction several of the engines in these boats have been constructed, estimates the net effective pressure, *exclusive of all deduction for friction*, &c. as equal to twelve pounds for every square inch of the piston. This may be nearer the truth, and gives the working-power of this engine as equal to six hundred and forty-six horses. Such results may at first view appear to be of a startling character, even to professional readers, but having been arrived at by gradual approximations, they seem hardly to have attracted the attention, either of men of science or practical engineers.

The following may be given as a summary statement of the principal dimensions of the other boats which have been named, and which, if not minutely correct in all its particulars, is sufficiently so for purposes of general information. The Champlain, a new boat, is 180 feet in length, 28 feet beam on the water line, and has two engines of 42 inches cylinder, and 10 feet stroke, which, with wheels of 22 feet, run from 26 to 28 revolutions per minute. The Erie, also a new boat, is of the same size, and somewhat greater power, her cylinders being of 44 inches diameter *. The North America is 218 feet in length, including a cut-water bow (which has also been affixed to most of the other boats), 30 feet beam, and has also two engines, with cylinders of 44 inches diameter, and 8 feet stroke.

* These two boats run to the City of Troy, a prosperous and beautiful town, situated six miles above Albany. A large lithographic drawing of these steam-boats, including also a sketch of the scenery in the Highlands of the Hudson, near the mountain called *Anthony's Nose*, has been published by the company owning the boats.

The Albany is 207 feet in length, 26 feet beam, and has one engine of 65 inches cylinder, and 9 feet stroke. The Ohio is 192 feet in length, 30 feet beam, and has one engine, with cylinder of 60 inches diameter, and 9 feet stroke. The New Philadelphia is 170 feet in length, 24 in breadth, and carries one engine of 55 inches cylinder, and 10 feet stroke. The Constitution is 145 feet in length, 27 feet beam, and has one engine of 42 inch cylinder, and 9 feet stroke. The Constellation is about 149 feet in length, 27 feet beam, and carries one engine of 44 inches cylinder, and 10 feet stroke. The Novelty is about 220 feet in length, 25 feet beam, and has two engines, with cylinders of 30 inches in diameter, and 6 feet stroke, working horizontally, using steam of higher elasticity, and dispensing also with the use of a condenser and air-pump. Most of the above steam-boats carry their boilers on the wheel-guards, entirely without the body of the boat. The Erie and Champlain carry each four boilers, and the same number of chimney pipes. The Novelty has four sets of boilers, of about forty inches in diameter, three in each set, and carries also four chimneys.

Little apprehension in regard to personal safety is now entertained by persons travelling in steam-boats. At a former period, two commodious safety barges were employed on the Hudson, which, in order to obviate all danger arising from this source, were devoted exclusively to passengers, and towed at the stern of a steam-boat. These barges, which were run during the summer season from 1825 to 1829, had attained to a speed of eight to nine miles per hour; but the increase which, during the same period, was given to the speed and size of the steam-boats, tended to discourage this mode of conveyance, and it has since been discontinued, to the regret of those who love quiet enjoyment, and whose nerves have not been inured to confusion by frequent proximity with the moving power.

It has been frequently remarked, that the exposure to fatal accidents on board of steam-boats, is much less than attends the use of the ordinary means of conveyance, either by land or water; and it has been suggested, that the average loss of life by steam-boat explosions, is even less than is annually occasioned by lightning. In order to test the accuracy of this suggestion, I have noted, during the present year, such accidents by lightning as were attended with fatal results, so far as the same have come to my knowledge. The whole number of cases thus ascertained is twenty-six, which were distributed as follows. In New Hampshire 1; Massachusetts 1; Rhode Island 1; Connecticut 2; New York 7; Pennsylvania 5; Delaware 3; Virginia 1; South Carolina 2; Louisiana 2; and Illinois 1. It is hardly to be supposed that this statement comprises one moiety of the whole number of fatal casualties of this kind, which have occurred in the United States during the past years, and it comprises but a single accident, in the four great States of Virginia, North Carolina, Kentucky, and Tenessee. In recurring to the list of steam-boat accidents, which was recently published in this Journal *, it will be seen, that the entire mortality from this cause, is estimated at three hundred in a period of twenty years, which amount to an average of fifteen for each year. The loss of lives by the bursting of steam-boat boilers, during the present year, I have recorded as follows: Steam-boat postboy, on the Mississippi, 1 killed; Ohio, on the Hudson, 5 killed and drowned; Adam Duncan, on the Connecticut, 1 drowned; Connecticut, in Boston Harbour, 1 killed; Monticello, on the Mississippi, 2 killed: Total 10. Of this last number, as far as I have been able to ascertain, three were passengers, and the remainder persons who were employed about the engine, showing that the risk to passengers is extremely small.

What further improvement in safety, or speed, are yet to be elicited in the art or science of locomotion, time only can shew us. The steam-boat, a short time ago, appeared to our view, as the *ne plus ultra* of human efforts, but the successful application of steam-power on rail-roads, has already rivalled, if not greatly surpassed, our achievements in steam-navigation. It is however probable, that the maximum of useful effect, has been nearly attained in both these departments, which, when practically considered, will be found auxiliaries rather than rivals to each other. The art of obtaining the full power of steam, and of applying it to the purpose of locomotion, on a fluid which

* Vol. xx. pp. 336—338.

sustains the load, and affords sufficient reaction for the moving-power, is now well understood; and in regard to rail-roads, it is doubtless true, that *a level metallic surface, not only sustains the vehicle, in the most perfect manner, but affords the least possible resistance, with the best possible reaction for the propelling power, and combines, therefore, the greater conceivable facilities for the transit of persons and property* *. Other expectations, which are often entertained without due consideration, will doubtless end in disappointment. It is to the establishment and extension of these unequalled means of conveyance, that the enterprise of our growing country should be directed. It has been truly said, that the career of improvement in our age is too impetuous to be stayed, were it wise to attempt it, and "though it would a futile attempt to oppose such an impulse, it may not be unworthy our ambition to guide its progress, and direct its course."—*Amer. Journ. of Science and Arts*, vol. xxiii. No. 2. Jan. 1833, p. 311.

LION-HUNTING IN SOUTH AFRICA. *By* LEWIS LESLIE, *Esq., 45th Regiment. Communicated by the Author.*

SOME years ago it was my fortune to be attached to a party of the Cape Cavalry encamped on the banks of Orange River in South Africa, for the protection of the boors on that extreme boundary, against a tribe of savages who were then supposed to threaten an invasion of the Colony. That portion of our African territory extending from the Fish River, formerly the north eastern limit to the banks of the Gariep or Orange River, had been but a few years in our possesion, and then only a scanty population of Dutchmen was scattered over a space of some hundred miles. The occupation, I believe, was not

* It may be noticed, that the power employed for propelling a single steam-boat of the first class, is equal to that of fifty locomotive engines, of the power of twelve horses each. These would probably be adequate to the conveyance of all the passengers and property now transported upon the Hudson River, if the same were transferred to a level rail-way of equal extent.

recognised at that time by Government. The character of the scenery was somewhat peculiar: vast plains or flats extended in all directions, bare and sandy, rarely presenting a green blade of verdure to the weary eye; these plains were enriched or intersected by ranges of low table mountains, whose sides and summits were equally divested of all vegetation; and in passing over the country, as you crossed the lower ridge of some of these hills, a prospect of the same monotonous and barren extent was presented to the view. It was seldom we met with a human habitation, and nought enlivened the dreary scene, save the various species of antelope and quagga abounding in these plains, who, frightened at the appearance of man, ran widely off in every direction. At a distance they might have been sometimes taken for vast herds of sheep, and droves of cattle. If a boor's dwelling happened to be in the neighbourhood, these dwellings were always erected on the banks of some rivulet or spring, where there might be a sufficient supply of water for their flocks, and to irrigate a few limited roods of land to grow vegetables and tobacco for themselves. In the drier seasons, however, these almost pastoral farmers were obliged to forsake their more permanent abodes, and something like the Israelites in the desert, betake themselves to tents, and with their flocks, wander over the sandy waste in search of pasturage for their sheep and cattle. While encamped in these open plains, their craals or folds were frequently disturbed by the midnight visit of the lion; and their only escape from his attacks was in the discovery of his retreat and his destruction. His usual prey was the quagga or the antelope; but the fleetness of these animals, or their instinctive precautions perhaps, gave them more security than the feeble defences of a crowded craal.

It was on these occasions that I witnessed the mode in which the Boor discovered and rid himself of his troublesome neighbour, as the officer commanding was applied to, and most willingly granted the assistance of a few men, whom we were delighted to accompany. It has been frequently asserted that the lion is not the magnanimous and courageous animal that he was formerly described to be, and I see that Dr Philip, in his researches, has related the facility with which the Bosjesmans, (Bushmen) with their poisoned arrows, destroy the Monarch of these Wilds. From a tolerably long acquaintance and experience on the African Frontier, I am inclined positively to deny both these opinions. I have seen the Lion on several occasions hunted and slain, and heard the relations of many (on which I could place more credit, than on those of the credulous Boor), which bear ample testimony of his courage and noble bearing when at bay. The Bushmen I have frequently seen practise with their bows, but I have very little faith in the correctness of their aim or the strength of their poison. The most authentic relations I could obtain of their shooting even the smallest species of the antelope, prove that the poison is not at all immediate in its effect; the wounded animal, with the barbed and poisoned arrow in his side, will bound along the plain, where he is traced by the Bushman's eagle eye until he staggers and falls when the poison has been absorbed. If such is the case with a weak and timid animal, what would it be with the powerful, bold, and fiery lion? destruction of the daring Bushman who would attempt to meet him. I am well aware that they assert their being able to kill the lion, but am confident it is for the purpose of imposing on the credulous boor to magnify the power of their favourite weapon. In nine months that we were encamped within a mile of a numerous craal of Bushmen, they appeared to live almost wholly on roots, locusts, and ants, and what they obtained from the neighbouring farmers, or from our station.

Those who have denied the noble daring of the lion, have never seen him in his native desert. I have heard an individual who was engaged in the hunt, of which Mr Pringle gives so vivid a description, bear ample testimony of his high and fearless bearing in many a future encounter. My own experience is in every instance in his favour. He has nothing of the cunning, cowardice, or treachery ascribed to the tiger. In his conduct there appeared no pusillanimity. Before man he retreats with coolness and deliberation. He avoids because he hates, not because he fears him; once confront him, convince him that he is the object of your pursuit, and he retreats no longer. Whatever may be the number of his enemies he will no longer shun you. He seats himself on some ridge, which he will never leave, and from thence growls inimitable defiance till loss of blood or some well-aimed bullet lays him prostrate on the earth. Often have I seen him roll, when wounded, from the ridge where he was seated, but on his recovery, his sole object appeared to be to regain it, as if it alone was the object of the contest, and he would only yield it with his life.

The method by which the boors pursue the lion, will be shewn by describing the last hunt at which I was present. In every instance it was the same, and in three successful, without injury to any individual of the parties. The north-east bank of Orange River, opposite our encampment, was totally uninhabited save by a few wandering Bushmen. Vast numbers of antelopes and quaggas grazed upon the plains; and in the rugged and bare hills which intersect them, the lion dwelt during the day, and at night descended after considerable intervals in search of food. I have seldom seen him in the plain during the day, save when, in the extreme heat of the summer, he might be found on the wooded banks of the river; but often during the night, when we bivouacked in the open plain, and the terror of the cattle and horses bore evidence of his approach; at dawn he would be seen winding slowly his way to the loftier summit of some neighbouring mountain. One might hear the thunder of his voice at miles' distance, while every animal shook with fear. A lion of huge dimensions passed the river, which at that season was low, and carried off a horse, the property of a neighbouring boor. For some nights previous he had been heard in a hill close to the banks of the river, to which it was supposed he had again retreated on destroying his prey. The boors assert that the flesh of the horse is highly prized by the palate of the lion, but perhaps it is because that animal is their own most valuable property. It was proposed to cross the river the following morning and trace him to his den, with the few boors we could collect, and a party of our men. We mounted immediately after sunrise, and with a large number of dogs, proceeded to the mountain, every crevice and ravine of which we examined without finding him. Gorged with his late meal, he had, perhaps, we thought, remained in the thick cover on the steep banks of the river, to which we then returned, and in passing over a narrow plain, a spot of ground was pointed out to us by an eye-witness, where he had been seen to seize and devour a quagga some days before. The hard and arid soil was actually hollowed by the violence of the mortal struggle. The dogs had scarcely entered the thick bushy banks of the river ere they gave tongue, and they appeared to advance in the pursuit, as if the lion was slowly retreating. At times it would seem that he turned and rushed upon the dogs. We, however, could not dare to enter farther than the skirts of the jungle with a finger on the trigger, and the carbine half at the present. One single clutch of his tremendous paw unquestionably would have been fatal. For a considerable time the dogs remained silent, and we fancied we had irrecoverably lost him. With more and more confidence we examined the thicket, but without success, and were about giving up the pursuit in despair, when a Hottentot and boor observed his footsteps in the sand. The word was again to horse. The lion's course appeared to be towards the mountain, which we had left. R——, with a party of boors and soldiers, galloped strait up the nearest declivity, while I, with a smaller number, rode round a projecting edge of the hill, into a deep ravine, to which he might have retreated. With my party I had been too late; he had been just brought to bay, as he was commencing his descent on the opposite declivity of the hill, but R—— delayed the attack until we should arrive to witness the encounter; meanwhile the dogs amused him. The ascent by which we could reach the summit was steep and rugged, but our horses were accustomed to such, and with whip and spur we urged them on. Whoever has seen the African lion at bay, would assuredly say the sportsman could never behold a more stirring scene in the chase. There he was, seated on his hind quarters, his eye glaring on a swarm of curs yelping around him; his dark shaggy mane he shook around his gigantic shoulders, or with his paw tossed in the air the nearest dog, more apparently in sport than anger. We arranged preliminaries. The horses were tied together in a line, taking care to turn their heads from the direction where the lion was at bay, and likewise that they were to the windward of him, lest his very scent should scare them into flight. The retreat behind this *living* wall is the boors' last resource if he should advance upon them, that his indiscriminate fury may fall upon the horses. Some of the boors are excellent marksmen, and the Hottentot soldiers is far from being despicable: yet many a bullet was sent ere he was slain. Fired by the wounds he received, his claw was no longer harmless; one dog he almost tore to pieces, and two more were destroyed ere he fell. At each shot he rushed forward as if with the intent of singling out the man who fired, but his rage was always vented on the dogs, and he again retired to the station he had left. The ground appeared to be bathed with his blood. Every succeeding attempt to rush forward, displayed less vigour and fury, and at last, totally exhausted, he fell; but still the approach was dangerous. In the last struggle of his expiring agony, he might have inflicted a mortal wound; cautiously approaching, he was shot through the heart; twelve wounds were counted in his head, body, and limbs. He was of the largest size, and allied in appearance to the species which the boors call the black lion. We claimed the skin and skull; the Bushmen the carcass, which to them is a delicious morsel; and the boors were satisfied with knowing that he would commit no farther depredations on them.

On another occasion we roused two on the summit of a low stony hill. They were deliberately descending one side as we reached the top, and amid a shower of bullets, they quietly crossed a plain to ascend another. We followed, and they separated; we brought them to bay in succession, and slew both. It appears to me from what I have seen and heard, that a lion once wounded will immediately turn upon his pursuers; but I am of opinion that he seldom attacks man, generally shuns his vicinity, and that he has none of the reported partiality for human flesh. In the district I described, and of which a description was necessary to show that we encountered him upon clear and open ground, the various kinds of lion were originally very numerous. The boors enumerated three,—the yellow, grey, and black. Their numbers were much diminished, principally, perhaps, from their retreating beyond Orange River, to an unoccupied country, although many also were destroyed by the boors. It has been said that the lion dwells in the plains. The African hunters almost always seek him in the mountains, and occasionally one or two will not shun the encounter, if armed with their long and sure rifles, which on almost all occasions they carry. One instance more and I have done. A party of officers a few years previous, along with some boors, discovered a lion, lioness, and two cubs, within a short distance of Hernianus Craal on the frontier. The lion dashed forward to protect his mate and young ones, and attempted to defend them by shielding them with his body, until the officers, moved by his magnanimity of conduct, entreated that he might not be destroyed, but the Dutchmen were inexorable, and they killed him; the cubs fled and the lioness followed; but all were found dead of their wounds the succeeding day.

The above anecdote was related to me by an officer who was an eye-witness.

MOELMYNE TENNASSERIM,
25th December 1831.

ON THE CONNEXION WHICH SUBSISTS BETWEEN THE CALYX AND OVARIUM IN CERTAIN PLANTS OF THE ORDER *MELASTOMACEÆ*. *By* DAVID DON, *Esq. Libr. L. S., &c.*

IT is remarkable, that although the *Melastomaceæ* have been a frequent subject of investigation with botanists, no one, with the exception of Mr Brown, appears to have been aware of the peculiar nature of the union which subsists between the calyx and ovarium in most of the plants belonging to that family. The ovarium in these plants is connected with the tube of the calyx by thin, longitudinal plates of cellular tissue, disposed on each side of the depression formed by the insertion of the septa, leaving a tubular space free for the reception of the anthers in the early stage of the flower. The number of these plates, however, appears to depend more upon the number of the stamina than of the valves of the capsule. This curious arrangement of the stamina in æstivation, appears only to take place in those genera whose anthers terminate in a tubular process, as *Melastoma*, *Osbeckia*, *Rhexia*, *Arthrostemma*, &c. in which the cells of the anthers are attached along the inner surface of an elongated connectivum, and are plaited and wrinkled, so that when the anthers issue from their receptacle (being forced out by the development of the pollen swelling the cells), the pollen is thrown out with an elastic force, the transverse rugæ materially assisting in its discharge. In *Melastoma*, the alternate anthers, which are also the largest, and placed opposite the septa, are attached by means of the elongated base of the connectivum to the filaments, as it were to a pivot, which gives additional force to the emission of the pollen. In *Blakea*, *Cremanium*, and other genera, which have their anthers truncate, and opening by two terminal pores, the hollow spaces are entirely wanting, the tube of the calyx and ovarium being completely united, and the stamina in the unexpanded flower being arranged in the free space between the summit of the ovarium and limb of the calyx. The union of these two organs is still more complete in *Charianthus*, in which, as the dehiscence of the anthers is longitudinal, and no force is required for the emission of the pollen, the anthers are found to be merely bent downwards in æstivation, to prevent their being pressed upon by the sides of the petals.

I take this opportunity of correcting an error (first pointed out to me some years ago by Mr Brown) into which Ruiz, Pavon, and myself have fallen, in considering the two protuberances at the base of the leaves of *Axinæa glandulosa* as glands, while in fact they are merely callosities, originating in the folding backwards of a portion of the leaf.

EXPERIMENTS UPON THE SOLIDIFICATION OF RAW GYPSUM.

By JOHN P. EMMET, *Professor of Chemistry in the University of Virginia.*

THE facility with which burnt gypsum sets, when made into a paste with water, has rendered it not only conspicuous among minerals, but highly useful in the arts; hitherto, however, as far as I am aware, it has not been supposed that the raw or natural production is capable of exhibiting the same property. The following experiments, although resulting from an inquiry not confessedly connected with the subject of the present communication, and therefore not, perhaps, carried so far as they might have been with advantage, are considered of sufficient importance to receive a distinct notice. They satisfactorily show, that native gypsum may be rendered capable of perfect solidification, without having undergone the operation of burning, and may perhaps contribute to illustrate or render more available the setting property of this valuable natural production.

Raw gypsum, finely pulverized, is capable of undergoing immediate and perfect solidification, when mixed with certain solutions of the alkali potassa. Among those that answer best, may be enumerated caustic potassa, carbonate and bi-carbonate, sulphate and supersulphate, silicate and double tartrate or Rochelle salt.

In all these cases, the process may be easily rendered more expeditious than when burnt plaster alone is employed, and the resulting solid, after having been properly dried, does not seem to differ essentially from that usually obtained, except in composition. There does not appear to be any exact point of saturation; for the solid masses, when broken up and worked with fresh portions of the solutions, constantly recover their tendency to set, even when the saline matter is in very great excess; yet, no doubt, each case requires a specific amount, in order to produce the maximum of solidity. When water alone is employed, after the first mixture, the paste rarely exhibits any remarkable tendency to become hard; but a fresh application of one of the foregoing solutions never failed to develope it promptly.

There is also a marked difference as to the time required for the operation; solutions of carbonate and sulphate of potassa, if sufficiently dilute, produce their effects so slowly, as to admit of complete incorporation, whereas Rochelle salt acts as soon as the powder touches the fluid, and all subsequent motion necessarily weakens the cohesion. If crystals of Rochelle salt be triturated with raw gypsum and water, and then brought in contact with the mixture, there will be no apparent interval of time between contact and solidification. This extreme rapidity effectually prevents incorporation by the ordinary mode, and would induce one to imagine that Rochelle salt does not possess the power; for when the gypsum and solution are worked together with a spatula, although the particles feel hard and harsh, they readily crumble, and, by continuing the operation, actually assume a semi-fluid condition.

No other salts but those holding potassa were found to render raw gypsum capable of solidification. Those of soda, as far as they were examined, invariably produced a contrary effect, if we except Rochelle salt, which, however, seems to operate by its potassa. Yet it is remarkable, that several neutral salts of the latter alkali, as the nitrate and chlorate, did not occasion the slightest alteration. The bi-carbonate of potassa invariably produced a brisk effervescence, which considerably impaired, although it did not prevent, solidification. The same disadvantage characterizes the action of super-sulphate of potassa, whenever the mineral contains an admixture of carbonate of lime, as was found to be the case with the specimen of gypsum under examination. As the idea has been advanced that the setting property of ordinary burnt plaster, depends upon the presence of carbonate of lime, most of these experiments were repeated, with equal success, upon pure sulphate of lime obtained by precipitation.

The opinion, that carbonate of lime facilitates or causes solidification in the ordinary case, seems but little entitled to belief, when it is considered that the heat, necessary for the burning of plaster, falls far short of that required for bringing limestone to its caustic state, or even to that half-calcined condition which renders it capable of hardening under water; but, whatever may be its agency subsequent to the application of heat, the operation must be totally different in the present case, since the supersulphate of potassa completely decomposes all the carbonate of lime in the gypsum.

It is probable, as Gay-Lussac has observed, in his examination of this singular property of burnt plaster *, that we should refer the fact to an inherent property of the mineral; yet I can-

* Annales de Chimie et de Physique. tom. xi. p. 436.

not but think the foregoing experiment abundantly proves that it does not always depend upon the simple union with water, and subsequent aggregation of the saturated particles, as seems to be the fact with burnt plaster. These cases may not, indeed, be parallel, as some of the saline solutions, added *partially*, affect the composition of the gypsum ; yet I have satisfied myself that the alteration is neither uniform nor essential to the result, although it is extremely difficult to ascribe the solidification, in the foregoing instances, to the proper cause. Both potassa and its carbonate are extremely deliquescent, and do not, therefore, act by rapidity of crystallization; sulphate of potassa cannot effect the composition of sulphate of lime, and although the former salt may possibly be formed in all the cases of mixture enumerated, it does not seem to form any permanent combination with the gypsum, since the latter, in two experiments, was found to lose one-twelfth of its weight by the mixture of the substances, and subsequent washing with warm-water. The only uniformity observable in all the saline solutions capable of producing solidification, is the necessity of the presence of potassa, and the rapidity with which the operation takes place, seems greatly opposed to the supposition that the result depends upon double decomposition. If we take the pulverised gypsum, and saturate it by the solution of carbonate of potassa, all subsequent chemical action, from the same substances, should be prevented, and yet when the solidified mass thus formed, is worked up again with a fresh portion of the same saline solution, it sets with equal facility. This property appears but little diminished by three or four repetitions. As plain water does not answer until after the evaporation of the fluid, it seems more probable that the saline solutions exert a kind of repulsion towards the particles of gypsum, and thus tend to promote that solidification which is so very characteristic of it in the burnt state.

The experiment which first exhibited the solidifying property of raw gypsum, was well calculated to give the impression that chemical decomposition was necessary for the result. I wished to determine how far fresh precipitated carbonate of lime was capable of improving gypsum, (intending subsequently to burn the mixture). With this view, pulverised raw gypsum was placed on a filter, and a cold solution of carbonate of potassa poured over it. The result was the rapid solidification of the crude mineral, and an evident diminution of the alkali. Upon repeatedly returning the same solution through the filter, turmeric paper ceased to indicate the presence of potassa, and re-agents showed that sulphate of potassa had taken its place. In this manner, a saturated solution of the latter salt may be soon obtained, yet, as has been already stated, a further examination proves, that the sulphate of potassa is not capable of contracting a permanent union with the gypsum.

Further inquiry will, no doubt, lead to the detection of salts better adapted to the development of this property than those here noticed, but the cheapness of carbonate of potassa seems more likely to recommend its use for practical purposes, provided it shall be found that the solidification of raw or effete plaster, by the process here indicated, equals, in durability, that which has been recently burnt. Gypsum, it is well known, requires judicious treatment, in order to fit it for taking casts, and unless carefully defended from moisture, will soon lose its valuable property. The process of burning may, moreover, not always be convenient, and, in this case, a solution of carbonate of potassa, or, for common purposes, the ley from wood ashes, will always enable the operator to effect rapid solidification, and as far as I have observed, it is perfect.—*Amer. Journ. of Science & Arts*, vol. xxiii. No 2. p. 210,

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ON THE PHYSIOGNOMY OF SCANDINAVIA *. *By Professor HAUSMANN.*

THE united impression which the mountains and valleys, the woods and meadows, the river and lakes, and all other parts of a country, make upon our feelings, may be called its character or physiognomy. We feel a greater attraction for one country, and a less attraction for another, just as regards the physiognomy of men; and are equally unable to account for these sensations. As in the aspect of countenances, it is not the regularity and harmony among the several features which invariably

* Translated from the German original by George F. Hay, Esq.

make them pleasing; so a district in which there is a mountain, a rock, a solitary group of trees, or a waterfall in a prominent situation, often interests more than another in which the outline of mountain and wood is marked out by gently undulating lines. Inasmuch as the striking attachment of the inhabitants of mountains to their native homes, has assuredly various sources; so we can ascribe this, partly at least, to the form of the countries which surround them. But we can proceed still farther; we can even concede to the different shapes of countries no inconsiderable influence over the character and temperament of the inhabitants of entire regions and provinces. Must not the dweller amidst the heaths of Luneburg, who is obliged to plough up sand all day-long, and seldom sees any thing more than the heath plant and the sky, must he not have an usually sluggish gait, and heavy closing of his eye-lids? From the sameness of the external nature around him, can we suppose him to possess a rich store of ideas, and a lively interest in what is taking place around him? On the contrary, compare with him the native of the Hartz, who, now in deep valleys, and soon again on highly elevated lands, from which are stretched out before his view the low country; who, in the mines, surrounded with darkness and constant danger, raises to the surface the treasures which the earth conceals in its bosom; who is necessitated, by the form of the ground, to carry manure for his fields up the ridges of the steepest mountains, and then to carry back the produce of the sweat of his brow into the valley. We find that this person possesses a lively temperament, and a higher feeling of self-gratification; and that he partakes of these qualities with the inhabitants of mountains in general. Lastly, it might be shewn, that, in the above respects, the inhabitant of the hilly country occupies a place intermediate between that of the mountaineer, and the peasant of the heath land. May the above few remarks suffice to shew, that reflections upon the various forms of the earth's surface cannot fail to possess a varied and general interest.

The circumstances by which the physiognomy of a country is distinguished from that of other countries, constitute the character of the same. And as certain resemblances can be traced among the countenances of the individuals of a nation; so we derive the general character of the physiognomy of a country, out of the agreement among the features of its individual districts.

As the impression which the countenances of men make upon our feelings can frequently be modified, in no inconsiderable degree, by means of art, such as the arrangement of the hair, an ornamental head-dress, and many other circumstances; so undoubtedly works of art have a great influence on the impression which a country naturally makes upon us. Houses, bridges, fields, gardens and the like, are instances. Perhaps we would not know a land again, were these additions to it removed. By cutting down forests, or draining marshes, art destroys to a greater or less extent the impressions which nature has stamped upon individual regions, or entire countries. But Nature will never entirely lay aside the chissel, with which she shaped out the crust of the globe. When thousands of years have, by their lapse, occasioned a remarkable change in the construction of any feature of a land, we are not aware of the continual operation of the hand of Nature. Beds of shells situated high above the present level of the sea; eruptions and streams of lava from volcanoes; layers of soil upon solid rocks bearing luxuriant vegetation; debris at the foot of mountains; mounds of debris formed and carried along by the descent of the glaciers: the constant reforming of the surface of the earth by means of water; these are all eloquent proofs of the same activity of Nature. She guides her chissel slowly, but with firmness and constancy; and she seldom effaces, by means of any sudden or violent commotion, any feature which she has been at pains to express.

When a person travels from the southern mountainous part of lower Saxony towards the north, the hills of the northern boundary of the Hartz, which are characterized by gently waving lines, first sink out of view: Next, those mountains of the Hartz, which surround the foot of the venerable Brocken, and which are marked out by a more angular outline, disappear: At last the Brocken conceals his bald head beneath the horizon. And wherever the traveller turns his eye, he sees a boundless plain covered with sand, moor, and heath, upon which he sees at one place a miserable juniper bush, at another place a crooked fir tree, creeping into view. It is but seldom that the wearied gaze is enlivened by a friendly thicket of birch, still seldomer by a clear brook, accompanied with green meadows, or a village concealed by overshadowing oak trees. In the neighbourhood of the Elbe, the sandy heaths become more hilly; and this increases the farther we advance into Holstein and Schleswig. The sand now becomes more mixed with clay, and consequently more favourable for the growth of corn and large leaved timber, particularly the beech. The hills which, arranged in waving lines, wind through the country, here and there enclose lakes; these, surrounded by beautiful beech-woods, form the great charm of the districts of Plön and Eutin. In Jutland, particularly in its western and northern parts, sand and heath again obtain the superiority. On Fyen, Seeland, and the smaller Danish islands, vegetation succeeds wonderfully, and delights the eye, during the greater part of summer, with a fresh bright green, which may be ascribed to the greater humidity of the atmosphere and of the soil. The most beautiful beech-woods, together with fruitful fields and luxuriant meadows, vary the scene in this part of Denmark. Small lakes, likewise, as well as prospects of the sea, which burst on the sight, communicate variety and life to the landscape.

The southern part of Shonen, in its relation to the neighbouring countries, shows a great resemblance to Zealand, and with which it was probably at one time united. But when we reach the 56th degree of north latitude, behind an elevated land still covered with large-leaved timber, and which traverses Schonen from south-east towards north-west, the country then acquires an entirely new appearance, and assumes the character which it retains more or less throughout the whole of Sweden. We see solid rocks, clothed partly with innumerable lichens, and partly covered by a slight layer of earth, which permits the growth only of pine timber with horizontal roots, or of birch trees, which are in abundance. These rocks form either plains, hilly country, or high mountain ranges. The valleys situated between the rocky hills, are watered by numberless smaller and larger lakes, which are generally united with each other and with the sea, by means of rivers. The lakes are to be considered as expansions of the rivers; and some of them, as the lakes of Wener and Wetter, are fifty or more miles in length. They are hence, almost without exception, longer than they are broad. The principal direction of the inclined strata of the fundamental mountain-rock, which is here crystalline, in general corresponds to the length of the lakes; and the length of the lakes has a similar direction with the course of the rivers, of which the lakes are but a widening. Likewise the breadth of the lakes, as well as their frequency, increases in proportion to their distance from the principal mountain chains. Hence southern Sweden, as far as the 60th degree of latitude, is singularly full of lakes.

The solid rock, which so often bursts through the layer of vegetable soil, gives a character to the Swedish hilly plains very different from ours. The above characters prevail in the greater part of east and west Gothland, a part of Nerike, Westmanland, Sudermanland and Bleking. In the whole of the middle and southern part of Europe, solid bare rock and plain rarely occur together. But in the Swedish plains, on the contrary, we very often see a naked cliff arising amidst corn fields and meadows, a rock, too, which will not give sustenance to a blade of grass. While we see our plains intersected by streams, which run quietly on their course; we will be, on the contrary, frequently surprised by the noise of a foaming river, enclosed in a deep rocky bed, and making its way over fragments of rocks, in the countries above alluded to. In imagining to myself the celebrated cataract of Trollhatta in Westgothland, there was immediately associated with it in my mind the idea of a considerable mountain range. How much was I surprised, when an extensive plain, covered with corn fields, which bordered the seemingly boundless mirror of the Wener lake, brought me opposite to the thrice renewed fall of the broad Gotha Elbe, which, at a great distance, proclaimed its presence by its thundering noise. The above plain has some isolated hills which are more distinguished by their flattened form above, than by their height. Such contrasts, unfruitful rocks amidst rich corn fields; a raging, never resting waterfall, which swallows up what is within its reach, and gradually wastes away the firmest rocks;—such contrasts make the Swedish plains not only more beautiful than ours, but unquestionably much more interesting.

The mountainous country in Sweden, likewise, is remarkably distinguished from that in Northern Germany. In the former we do not see the beeches and oaks which so adorn our Elm *, our Deister †, and our Solling ‡; there we find no river, which, like our Weser, gives animation to a long, gently curved valley. The greatest part of the mountainous land in Sweden—and by far the greater part of Sweden is mountainous—is intersected by mountain chains in the most various directions, which at one time extend their branches around greater or less cauldron-shaped valleys, at another time they enclose narrow ravines. The bottom of the above broad valleys generally contains the reflecting surface of a lake; while, on the contrary, the ravines are watered by forest streams which tumble tumultuously over the rocky masses. Rugged walls of rock rise from their banks; while the more gentle acclivities of the mountains which enclose the broader valleys, are covered with dense pine forests, which pass over the mountain ridges, and extend into other valleys. Sometimes this gloomy forest is supplanted by more agreeable birch wood, or it retires and encloses a group of fields and meadows, which surround the neat cottage of a peasant. More rarely a small village, with its picturesque church spire, varies the scene.

The remarkable height and beauty of the *(Pinus Abies)* spruce fir, and of the *(Pinus sylvestris)* Scots fir, in most parts of Sweden, leads us very soon to the conviction,—that nature has appointed these two species of evergreen trees to flourish in the north as their peculiar country. Whether it is, that the care of the forests is there committed entirely to nature, their extent is in general far more remarkable than in our regions, where they are so much taken care of by art. The darker, but more pure green of the spruce fir, is varied in the forests by the lighter and more bluish green of the Scots fir. This latter tree, which in the sand plains of Northern Germany is generally found on-

* Elm, a mountain ridge in the neighbourhood of Brunswick.

† Deister, a mountain ridge in the neighbourhood of Hanover.

‡ Solling, a mountainous district between the Weser and the Leine.

ly in a crooked form, in the above countries surpasses the spruce fir by its height, straightness of its growth, as well as the firmness of the timber. It is hence the tree most highly prized in Sweden and Norway, and in the latter country is the most powerful support of its prosperity.

The meadows which are enclosed by the Swedish forests rival these latter in beauty. Although the meadows want the variety of flowers, and the height of the grass by which those of southern regions are distinguished, we find in them, on the contrary, the plants closer together. Among these the *Arnica montana* and *Linnea borealis* particularly delight the eye. The green, likewise, of the grass is brighter and fresher, and of more lasting duration.

The want of underwood and copse, which circumstance in Sweden is so new to the eye accustomed to German scenery, is as striking as the enclosures of fields, meadows, and kinds of barn-yards here in use. In no part of Sweden do we see live hedges, but only fences invariably formed of the stems of young pines placed together, and horizontal rows of wood to keep them firm. Where they know how to make a better use of their timber, these fences are supplanted by stone walls.

Although nearly all Sweden is, in a peculiar sense, a great rocky mass, still, even in the towns, with the exception of Stockholm and Gottenburg, it is but seldom that we find houses built of stone. The greater warmth of the wooden houses, scarcity of clay for bricks, and of good mortar, are the principal causes of this. Most of the Swedish houses, as well the cottages of poor peasants as the dwellings of the rich, are constructed of the trunks of trees, laid lengthwise over one another, and dove-tailed together at their extremities. The interstices are stopped up with moss; the roofing is various, but is generally of wood, and covered over with earth. It is not only by the above style of architecture, which at most permits only one method of construction, but likewise from the brownish-red colour * which they almost universally give them, that the houses have quite a singular appearance; and this is not without its

* This colouring matter, which conduces very much to preserve the wood, is prepared from the washed residue of roasted alum-slate, which contains much iron-pyrites scattered through it; or it is prepared by burning weathered pyrites.

influence upon the peculiar character of the Swedish landscapes. The uniformity which these acquire from the widely spread pine forests, is varied by the numerous lakes which these enclose. But sincere and happy tranquillity reigns in those valleys, in which the deep blue lakes are surrounded by dark green woods, out of which there occasionally rises a pillar of smoke from some solitary cottage: And amidst the hollow forest murmurs, we hear the harmonious tinkling of the distant bells of the cattle grazing upon the mountain meadows.

Journeying in the swift rolling karra,* along the excellently formed roads which lead down the declivities of the mountains, and then along the winding margin of a lake, the traveller finds himself transported into a quite different scene. The lake, which before had a considerable breadth, gradually contracts itself. The lately gentle declivities become more steep. Out of thick woods we see rocky masses burst into view; always increasing in height, and overhanging the way, which they confine more and more. At last the lake withdraws itself entirely from view; and a narrow rocky valley, in which a forest stream foams along, guides the traveller on his course. Now, at intervals, the hollow sound of a large hammer, moved by water-power for working iron, reaches his ear. Soon after this the fire of a forge shines through the dark fir boughs; and, amidst the rushing sound of the water, which moves the wheel, is heard the thundering blow of the hammer, which works the iron. In this workshop of Tubalcain, all is life, activity, and restlessness; the impression of which contrasts powerfully with that produced by the scene which had shortly preceded it.

Sweden so abounds in similar contrasts, that a journey through this country must necessarily be very interesting. Although nature there in individual scenes may appear uniform, and but seldom with lovely features; still, on the contrary, her general exterior is in the highest degree impressive and noble.† The beauty and sublimity of nature are found

* A light, two-wheeled carriage, in which it is usual to travel in Sweden.

† If the nature of the Equatorial Regions is distinguished by grandeur and variety of formation, the nature of the Polar Regions, on the contrary, unites greatness and simplicity. This uniformity does not appear, in an equal de-

more in union in the regions of Southern Norway. If the greater part of Sweden is represented as a hilly country; so again, nearly all Norway may be termed a high mountain-chain. The arms of this mountain land enclose valleys, which are long, and sometimes broad. Considerable rivers, sometimes expanded into lakes, water the deeper parts. Rich corn-fields and luxuriant meadows, occasionally varied with the houses and offices of substantial farmers, and the country-seats of rich merchants —extend themselves as far as the gentle acclivities of the chain of mountains. Where these acclivities become steeper, the bright green tapestry of the meadows is supplanted by the bluish-green leaves of the Scotch fir; this, with its golden-coloured stem, raises its proud head among the inaccessible cliffs, which, destitute of all vegetation, conceal their pointed summits among snow and clouds. The bays of the sea—which run far into the land, and unite the rivers with the ocean—are crowded with masts; and upon their shores are situated smiling towns, the abodes of wealth. The nearer the rivers are to the mountain-chain, to which they owe their origin, so much the more have they to struggle with the rocks through which they must force

gree, in the whole series of natural objects, but appears to diminish with their perfection. The north, in comparison with the regions near the equator, is astonishingly poor in quadrupeds. It is richer in birds as to their species; but it is proportionally richest in insects; although the Insect Fauna of the north, as to the number of species, is far inferior to that of our countries. In like manner, the north is poor in phænogamic plants; but very rich in the cryptogamic species; and, among these, plants of the nature of lichens are distinguished for variety of species, although they are among the lowest in the scale of organized bodies. Likewise, in inanimate nature we observe a similar relation. The north is, in general, poor in crystallizations; but, on the contrary, is rich in various uncrystallized mineral substances. But the simplicity of the nature of the north is expressed likewise in the forms, colours, and delineation of objects, which, as regards their variety and beauty of structure, are far behind those of the regions of the south.

The nature of the north shews its greatness, particularly in the multitude of individuals, which is far more considerable than what it is in our regions. Legions of rats and mice people Norway and Sweden. In Lapland the swarms of gnats are so great, that he who travels in that country during summer, must filter the air through a veil. Thick pine-forests cover the greater part of the habitable north. Rein-deer moss overspreads the largest flat districts of Lapland; and lichens are in such abundance, that Norway and Sweden send whole shiploads of some of the species to England, where they are used in dyeing.

their way. Where they are unable to overpower these, becoming impatient of their barriers, they throw themselves headlong, with a frightful crash, from a high precipice, and often still maintain their entire breadth. Upon the rocks which border these powerful waterfalls, a host of saw-mills are boldly placed, in order that their wheels may be driven more swiftly round, by the increased force which the water gains by its descent.

During the more severe season of the year, the regions of the north are clothed in a very different, but not for that reason less beautiful, vesture. Unmeasurable fields of ice, covered with crystals, are in the room of the lakes. Their margins are then contrasted by the dark-green colour of the never-fading pine trees. The snowy pinnacles of the higher mountain range glancing in the sun; and the aqua-marine tint of the icicles which fringe the glittering rocky masses,—and produce views of indescribable beauty, which are greatly enhanced by the almost constant serenity of the dark-blue sky. But the magnificent splendour of the north, when arrayed in its winter garb, appears to most advantage when, during the star-light night, the bright, or bluish, or fire-red rays of the aurora borealis, arise above the northern horizon, and shoot forth with the swiftness of an arrow towards the zenith. Then their incessantly varying brightness is reflected once more to the eye of the observer, by the bright phosphorescent fields of snow.

Hitherto this brief representation of the characteristics of the north of Europe, has entirely overlooked the regions which could leave only unpleasant impressions, and neither is Scandinavia entirely without such regions, any more than other large countries. There are in Norway, as well as in Sweden, very extensive tracts, nay entire provinces, which are marked with the stamp of the greatest wildness and unfruitfulness, in the midst of which a person may almost forget the agreeable impressions produced by the scenes before described. To the above regions belong the ridges and declivities of the principal mountain-chain of Scandinavia; this extends in its principal direction from south-southwest towards the north-north-east, and for about two-thirds of its extent forms the boundary between Sweden and Norway. The higher parts of this mountain-range—which, in Southern

Norway, according to Naumann, attain a height of about 8000 feet above the level of the sea—are covered with perpetual snow. On the western side, where the mountain-range becomes remarkably precipitous towards the sea, the snow extends downwards along the deep *fiords* which cut into the mountain-chain, the snow here and there terminating in glaciers. The lower parts of the range are no doubt, in mid-summer, free from snow. But their rocky foundations, deprived of earth, and their high situations, prevent the growth of the flowers of phænogamous plants *. It is only the numerous family of the lichens and mosses which are here in their place, among which the reindeer-moss (*Lichen rangiferinus*, Linn.) is particularly distinguished : this often clothes boundless plains, with a white elastic carpet. In somewhat lower regions, and particularly in marshy places, are found chiefly some dwarf-willows, also dwarf-birches (*Betula nana*), and we likewise see rugged dwarf juniper bushes. At a somewhat greater distance below the mountain heights, particularly in valleys which are somewhat sheltered, there grow white-stemmed birches, but of a humble, nearly shrub-like, growth. It is then that the Scots-fir first begins; and somewhat later, we find the spruce-fir appearing in crooked shapes. These appear in solitary trees, with distorted branches, which are often entirely deprived of leaves, and having suspended from them long pendulous parasitical lichens, and afford a sorry shelter to the rein-deer and elks upon the unmeasurable mountain plains, which, under the name of Kölen, form the boundaries of Dalekarlia and Norway. A person may travel for some days over these plains, without finding a single human habitation †.

* Among all the phænogamic plants of Norway, according to Wahlenberg, *Diapensia lapponica* flourishes the nearest to the limits of the snow.

† There is an error in most of the geographical works, even the latest of them with which I am acquainted, viz. that the Kölen mountains form the boundary between Sweden and Norway. No doubt, beginning from Jämtland, there is a mountain-chain which constitutes the boundary between Sweden and Norway, but which has no general name to denote it. And under the name of Kölen, as already mentioned, are implied large mountain plains, which are here and there marshy, or covered with forests. They are such as are termed platforms, plateaus, or table-lands, and extend along the limits between Dalekarlia and Norway. But after a person has passed these limits, he begins to ascend the greater heights of the mountain-range.

Some low-lying parts of Sweden are not much better than the above desert tracts, viz. certain districts in Smaland. This province, which is of pretty considerable extent, consists partly of hills formed of boulder stones; these no doubt have been borne along and heaped up there by means of floods, and perhaps with the aid of ice. They oppose vegetation in a great degree. Scots-firs, spruce-firs, and birches, of inconsiderable growth, press themselves forward, here and there, between the masses of rock. But not a blade of grass can thrive on account of the want of soil. When the industrious peasant of Smaland wishes to cultivate for himself a field, this often can only be done by means of the sacrifice which he makes of his timber. He cuts down the woods, and burns the branches, or even the trunks likewise, that he may afterwards sow among the ashes. This produces for him, twice in succession, a tolerably rich harvest, after which he resigns the desert spot to kind nature again, which gradually sows it with birches *.

If both Sweden and Norway, especially in their high northern latitudes, possess wide tracts, in which Nature loses all her charms, still, however, this want is much counterbalanced by the great attractions of the remaining parts of those countries. It can be justly asserted that northern Europe, no less than the southern parts of the same, affords us much occasion to admire the varied beauties with which the Creator has clothed our earth. The vesture of the north is in general indeed simple; but it is from this very circumstance that its peculiar physiognomy is given to it, the most prominent features of which are severity and dignity.

* This practice, so wasteful of timber, and which can be employed only in a land which is so blessed with forests, is found in other parts, especially in the more northern regions of Sweden, as well as here and there in Norway. A field which is thus cultivated—over which the corn does not grow equally, but rather in heaps, where the ashes have been collected between blocks of stone—is called in Sweden *Svedjeland*, and the operation by means of which this waste land is cultivated, is called *Svedjande*.

LIFE OF LINNÆUS *By A. L. A. Fee* *.

Much has been written concerning Linnæus, and the eminent station which he has occupied, the prodigious influence which he exercised over natural history, easily account for it: but of the many biographical accounts of this remarkable man, which are to be found in the French language, some were either so barren of details as to prevent us being thoroughly acquainted with his history, or were published too recently after his death to enable his influence to be impartially appreciated. Men in fact are like edifices: viewed near one cannot judge correctly except of the details, and even of those chiefly, if the structure be not very lofty; but as to temples and towering obelisks, a correct notion may be formed by surveying them at a distance;—it is the same with men who stand pre-eminent in their own age and impel it in a new direction. We cannot form a correct opinion of them till the fruits of their works have been reaped and prejudices have been overthrown. M. Fee has rendered a great service to the history of science by carefully collecting and arranging what is authentic, either in works that were published in Sweden and Germany, or in manuscripts that he procured, respecting the life of the reformer of natural history.

His work consists, 1*st*, of a translation of the life of Linnæus, written by himself, and published by his disciple Afzelius;† 2*d*, of extracts from his correspondence with the naturalists of his time; 3*d*, of a collection of anecdotes relating to him and his writings; 4*th*, of a bibliographical note of his works.

Linnæus himself has related his life on many occasions, and the account which forms the first part of the work of M. Fee is the most complete of these various autobiographies. The peculiar style of Linnæus is recognised even in the translation; it is a hasty yet concise recital pregnant with facts, and in which the flashes of a poetical imagination occasionally break forth.

* Vie de Linné, par A. L. A. Fee, 1 vol. 8vo. 1832.

† This interesting autobiography of Linnæus has been translated from the original Swedish into German, under the title "Linnes Eigenhandige Anzeichnungen über sich selbst, mit Anmerkungen und Zusätzen Von Afzelius." Berlin, 1826.

Charles Linnæus was born at Stenbrohult on the 1st of May 1707. His father was a country clergyman of a mild disposition and an equal temper. His mother, he said, had a great deal of wit, a sound judgment, and a very lively manner; he is an instance which tends to strengthen those who maintain the opinion that all distinguished men have had witty mothers, and who concluded from thence that the influence of early years on the intellectual development of children is considerable. Young Charles, however, having contracted a taste for botany, from looking at the flowers in his father's little garden, his mother, notwithstanding her intelligence, conceived such a dislike to the direction which his studies took, that she absolutely prohibited his brother Samuel from going among the flowers. The success of Charles in his college studies did not correspond with the expectations which his intelligence had predicated. Throughout his life he was by no means ready in the acquisition of languages, which were too exclusively made the test of success in the colleges, and he went to the University of Lund with the reputation of a very indifferent scholar. There he resolved to study medicine, and his poverty exposed him to great difficulties: Stobæus the naturalist received him into his house, which enabled him to see his little museum and strengthen his taste for natural history. He afterwards went to Upsal, where Olaus Celsus, having discovered his talents and his indigence, took him to live with him, that he might assist him in his work on biblical botany, and gave him access to a valuable library. By teaching a few students he procured a little money, and aspired to the place of Rosen, at that time professor extraordinary. As a guide in his study of plants he took Tournefort, whom he knew, especially by the abridgment published by Johrenius, under the title of *Hodegus Botanicus,* and shortly afterwards the treatise of Vaillant on the sexes of the plants opened his eyes to a new view. Rudbeck encouraged him to follow it, and it was at this period, when he was twenty-two years of age, that he commenced writing the *Bibliotheca Botanica,* the *Classes Plantarum,* and even the *Genera Plantarum.*

Incited by the advice of Rudbeck, he at that time undertook a journey to Lapland, a painful one, either owing to the climate and the rugged nature of the country, or because the scantiness of his means obliged him to travel alone, destitute of all the conveniences of life. He transmitted an account of his journey to the Royal Society of Science at Upsal, and with difficulty procured a trifling sum from that body; he was more successful in giving private lectures on mineralogy and botany; and when desirous of visiting Dalecarlia in 1734, he was accompanied by many pupils. One of them, Browall, afterwards bishop of Abo, advised him to endeavour to marry a lady whose wealth might render him independent: he paid his addresses to the daughter of Dr Moræus, who was considered rich, and, to his great astonishment, as he himself said, it was arranged that their marriage should take place in three years, and that he should spend the interval in travelling.

He then proceeded to Holland, where he received the degree of M. D., and became connected with the most distinguished naturalists of the age,—Gronovius, Van-Royen, Burman, and Boerhaave: he astonished them by his information, and the ease with which he named the plants which were laid before him. Clifort, who had the finest garden in Holland, induced him to live with him in order to procure his assistance in its management, and it was in that magnificent establishment that his ideas regarding vegetation were enlarged. He there published many important works, *Hortus Cliffortianus*, &c. Assisted by the generosity of his protector, he went to England, where he became acquainted with Dillenius. On his return to Holland, at the close of 1736, his reputation was already so great, that the *Academie des Curieux de la Nature*, on receiving him into their body, conferred on him the title of Dioscorides the Second. His method was already adopted by the botanists of Holland and publicly taught at Leyden. He afterwards travelled to Paris, and formed an acquaintance with the brothers Antony and Bernard Jussieu, where it appears that some attempts were made to induce him to settle; but he preferred returning to Sweden, and the great difficulty which he experienced in speaking foreign languages seems to have affected this resolution in no inconsiderable degree.

On his return home he was treated as a stranger, and the person who was already considered by one part of Europe as the Prince of Botanists, could not at first either find a chair in the university, or practice as a physician. He at last obtained, almost accidentally, a petty place in the school of Mines, and afterwards was appointed physician to the admiralty: his practice became so great, that it yielded him 9000 crowns per annum. He married; was appointed joint professor with Walerius, and, placed from that moment in a sphere which was worthy of him, prosecuted the study of natural history with renewed zeal. His *Systema Naturæ*, of which there were so many editions, attracted the attention of Europe. The academies wrangled about his name; his pupils traversed the world, and sent him their collections. The favours of his sovereign succeeded; he was ennobled, though it is said that this was owing to his discovery of the generation of pearls in the *Mya margaritifera*;* he received a pension and estates for himself and his posterity, and he who, in his youth, had been obliged, through poverty, to patch his shoes, found himself in his old age, in consequence of the eclat arising from his distinguished works, in a state of great comfort and high distinction in society.

The concluding years of his age were spent in publishing new editions of his works, and many frequent dissertations, in the form of theses, collected under the title of *Amœnitates*; in giving private lessons (often for eight hours a-day) to select pupils; in watching over the interests of the academy and public collections; and in arranging his own herbal. In 1773 he was attacked by a severe *angina;* in 1774 he was struck, while teaching in the Botanical Garden, with paralysis, which terminated in a tertian ague. He ceased writing his own life in 1776; his intellectual faculties fell into a state of decay—the more distressing as he was aware of it. His writing became illegible; he sometimes blended Greek and Latin characters in the same word. At last, he forgot his own name. In this state, the only thing which seemed to revive him was the sight of his collections in his country-house at Hammarby. He died on the 10th of January 1778, aged seventy years and seven months.

* It was at this period that he received the name of *Von Linné*, instead of *Linnæus*, which he had always borne, not with the view of latinizing it, as has been said, but in consequence of its being the correct family name. That of *Linnée*, which has often been given to him in French, is erroneous, and merely belongs to the plant which has been dedicated to him.

The second part of M. Fee's work contains extracts from the correspondence of Linnæus with the naturalists of his own time. It was unusually voluminous; and Linnæus himself told the Abbé Duvernoy, that ten persons could not have answered all the letters which were addressed to him. More than a thousand of his letters, to one hundred and sixty correspondents, are preserved, almost entirely written in Latin; the oldest in date is addressed to Rudbeck, his benefactor, 29th July 1731, and the last is to Masson, an English collector of plants, in 1776. They, of course, comprehend a period of forty-five years. It should be observed, that, notwithstanding the intellectual decay of his latter years, the literary life of Linnæus was longer than that of any other individual. His first work, *Hortus Uplandicus*,* bears date 1731, and the last, *Planta Aphyteia*, 1776, embraces a period of forty-five years, during which the publications of this indefatigable author rapidly succeeded each other. Of these M. Fee has given a very accurate chronological list. Shortly after the same epoch, Mr Wickström, a learned Swedish botanist, published in his *Conspectus Litteraturæ Botanicæ in Suecia* (one volume 8vo, Holunæ 1831), a list and review of the botanical manuscripts of Linnæus.

The portion of M. Fee's work relating to the correspondence of Linnæus being only of itself an extract, it is unnecessary to notice it; but we must pay more attention to the third part, which contains some curious anecdotes of this eminent person.

His connexion with Artedi exhibits him in the most amiable point of view. On arriving at Upsal in 1728, Linnæus made inquiries respecting the student who exhibited the greatest talents,—Artedi was his name; with whom he soon contracted a very intimate friendship: they laboured together in the different branches of natural history, and, after a trial of some months, each yielded to the other the departments in which he was superior; Linnæus to Artedi in Chemistry and Ichthyology, and Artedi to Linnæus in plants, birds, and insects; both the friends continued to study together on mineralogy and quadrupeds, in which departments their talents seemed to be equally powerful.

* This work is very rare, and is not mentioned either in the *Catalogue of Haller*, nor in the later, and very accurate, Tableau of Wikström. It is mentioned here on the authority of M. Fee.

This intimacy was interrupted by their travels; they met in Holland in 1735. Linnæus presented Artedi to Seba, to assist him in the publication of his large work, and their meeting re-established the practice of their early days, in trusting and consulting each other in their labours. Unfortunately Artedi fell into a canal in Amsterdam, and was drowned. Linnæus induced Mr Cliffort to purchase his manuscripts, and published, under the name of his friend, the remarkable works which he had left on the classification of fishes.

The connexion between Linnæus and Dillenius commenced in a manner which was by no means friendly. This botanist, who, at the appearance of Linnæus, was doubtless the most able of his age, was distinguished for great minuteness of details, but never seemed to have occupied himself seriously with classification on a great scale, and, accordingly, ill appreciated that which was truly eminent in the innovations of Linnæus; but, on the other hand, was particularly alive to the embarrassment which a new nomenclature introduced into the science. "*This is the person who will embroil the whole of botany*," said Dillenius to his friend Sherard, on seeing the debut of Linnæus. In many respects, however, his prejudices gave way. Linnæus, during the time he lived in England, and in the course of his correspondence, astonished him with his knowledge, and by his urbanity increased their intimacy

Another rival of Linnæus, who would have been the most dangerous of them all had he closely followed in the same pursuit, was Haller. This astonishing man, at once poet, physician, anatomist, physiologist and bibliopolist, had very peculiar ideas respecting the natural system, and would have made immense improvements had botany been the sole object of his researches. He applied his attention to a very limited subject, the Flora of Switzerland, and he affected the popularity of his work by not adopting the nomenclature of Linnæus in his classification, and rejecting the first part, which was excellent, on account of his antipathy to the second.

These celebrated men were on an intimate and confidential footing for a long time, and proved, that notwithstanding the diversity of their opinions, they mutually did justice to each other. A slight misunderstanding occurred occasionally, owing to some mutual criticisms: but a kind of quarrel unexpectedly happened between them, in some respects well founded, as Haller was so indiscreet as to publish a few old letters of Linnæus, containing some private details of his life, and especially of his marriage.

It must be said, in justice to Linnæus, that during his life he completely abstained from answering the critiques, often very caustic, on himself and his writings, either because he despised them, or conceived that he had a more extensive and brilliant object in view; he allowed Siegesbeck, Browall, &c. to pour out the vial of their wrath upon him, and enjoyed in peace the admiration of the age in which he lived. The only *petite* malice which has been noticed is against Browall, who in his youth was, as to poverty, on a level with himself: he dedicated to him a genus which only contained one species, *Browallia demissa.* Having succeeded to the Bishoprick of Abs, Browall behaved with great hauteur, and Linnæus named a second species which he had found, *Browallia exaltata.* The bishop, becoming exasperated, wrote some severe pamphlets against Linnæus; he presented him with a third species, not very closely connected with the genus, and called it *Browallia alienata.*

M. Fee has been at some trouble to vindicate Linnæus from a paltry act of which he has been accused towards Buffon. The genus which bears the name of that distinguished naturalist, is written in Linnæus with a single *f*, *Bufonia,* which was done, it is said, with the intention of calling it the *plante des crapauds.* Ventenat, desirous of exculpating Linnæus, says that he gave it this name because the plant grows in moist places, though, on the contrary, it exists on the most barren rocks. The fact is, that it was not Linnæus who made this fatal orthographical error. The genus had received this name from Sauvages, in his System of Leaves, and with a dedication so highly honourable to Buffon, that it is obvious it was purely a mistake. Linnæus admitted it without further examination, and was indignant that he could be supposed to condescend to such an aspersion.

The error of the public arose from the circumstance, that many of the names established by Linnæus bore allusions to the persons to whom the genera were dedicated. Thus he named a genus *Bauhinia*, in honour of the illustrious brothers Bauhin, *all the species of which* have leaves consisting of two foliola. Having received another genus from India, collected by surgeon Dalberg, sent by him to his brother, a banker in Copenhagen, and transmitted by him to Linnæus, he called it *Dalbergia.* One of the species having the fruit pointed, was named the *D. lanceolaris*, in honour of the surgeon; the other, having the fruit rounded, was the *D. monetaria*, in honour of the banker.

The collections of Linnæus were very considerable, considering the age in which he lived, and his herbarium was the peculiar object of his care and affection. He himself mentions, in one of his own notes, the origin of the plants which composed it, and which were obtained from the most distant countries, at a period when voyages were far from being so easily accomplished or so frequent as at present; and when the voyagers, too much swayed by the idea that the same plants were to be found in countries of various climates, frequently neglected to collect them. "My herbarium," says Linnæus, "is indisputably the greatest that has ever been seen;" but although this assertion may not have been very correct (as the herbariums of Vaillant and Tournefort of the same epoch seemed very considerable), if it is admitted to have been so, it is evident that this herbarium ought to contain about 8000 specimens, for the works of Linnæus contain in all a description of 7982 plants; and if he procured some after their publication, it is certain that there are also some mentioned in his works not to be found in his herbarium. The progress which botany made in half a century may be imagined, and chiefly owing to his influence, if we calculate the increase of the existing collections. There are many herbariums which contain 30,000 or 40,000 specimens, and at present there is one embracing no less than 55,000! Sir J. Smith has sometimes received more specimens in one year than Linnæus did during his whole life. The globe is explored with an activity which astonishes the imagination; and it may be justly supposed that, after fifty years, a thousand species will be discovered annually.

Although the herbarium of Linnæus is no longer one of the largest in existence, it is not the less valuable, whether on account of the feeling of admiration which is attached to its founder, or because it is the type and basis of the whole of the nomenclature. On the death of Linnæus, it came into the possession of his son; but he only survived him a couple of years. It is said that his mother, who was very wealthy, wished to dispose of it to advantage; afraid lest the Swedish Government might be desirous of retaining or purchasing it at a price unequal to its value. She offered it to Sir Joseph Banks. M. Fee states, that the baronet having no intention of purchasing it, mentioned the circumstance to Mr Smith. The anecdote, as I heard it from the lips of this gentleman, redounds to the honour of both, and deserves to be preserved. Mr J. Edward Smith, at that time very young, and a passionate admirer of Linnæus, showed, in a very lively manner at a public dinner, the value which he put on the herbarium of Linnæus, and his regret that his whole fortune did not permit him to set apart L. 1000 Sterling, which was demanded for it, the library, and the manuscripts, of this distinguished man. Banks being made aware of his enthusiasm, sent for Smith, engaged him to go over, and offered to lend him a sum of money which would enable him to procure them. The transaction was completed, and, thanks to this generous interference, and the attention of the English consul, the herbarium was sent to England. It is said that the Swedish Government, irritated at its removal, dispatched a frigate in pursuit of the vessel which contained it, and this fact has been mentioned as a mark of distinguished respect to his memory: there is even a portrait of Smith, with a vignette, which represents the frigate in pursuit of the vessel which bore away the precious herbarium. I regret throwing any doubts on an account so pleasing, and so honourable to science, but I am bound to add, that Sir J. E. Smith told me, that there was not the slightest grounds for it.

We may subjoin in this place, that this learned individual made use of these collections in a manner worthy of their origin. He has published many works in which, in consequence of having seen the original specimens, he has smoothed away difficulties, which the laconicism of Linnæus frequently created; he frequently had the complaisance to clear away the doubts which other naturalists might have had respecting the meaning of the writings of Linnæus; in short, he has allowed those who were engaged in certain departments to consult this herbarium, and heightened the obligation by the courtesy and kindness with which he conferred it. I cannot remember without emotion the hours which I spent with him, busied in surveying this precious depôt, or mention this fact without rendering homage to his memory. On the death of Smith, the Linnean Society of London, of which he was President, and whose foundation is dated from the acquisition of the herbarium of Linnæus, obtained the collections of Linnæus, increased by those of Smith; which herbariums being deposited in a place dedicated to science, are thus preserved for the future researches of botanists.

Having thus extracted both from the work of Mr Fee and our own recollections the most important facts in the life of Linnæus, this might perhaps be the place for appreciating his labours; but it would be too extensive an undertaking, and is worthy of a specific work. Let us confine ourselves to the remark, that the eminent and indisputable service which he has rendered to natural history, was the creation of a language peculiar to it, as well in terminology as in nomenclature. Before his appearance, the former had no precise meaning, and every person in describing animals, and vegetables especially, either employed vague terms or a circumlocution which rendered their writings tedious, obscure, and difficult of comparison. Linnæus fixed the meaning of the terms, and introduced many, especially in botany, which were clear and elegant; he employed this new language with remarkable skill and address, and thus entirely changed the form of every descriptive work. We must certainly admit, that in proportion to the progress made in the detailed knowledge of natural objects, it has become necessary to modify the meaning of some terms and to add others; but this has been done according to the principles of Linnæus, so that it is not without good reason, that, even at present, there is a disposition to attribute to him all the fortunate additions which have been made to the Linnean language, which has rendered natural history, so clear, so concise, and so popular.

The nomenclature of animals, and especially that of plants, was in a greater state of disorder and anarchy and embarrassment than even terminology. Each name consisted of a long phrase, so that the mere catalogue of a garden became a quarto volume; and as no individual knew them by heart, they were mentioned loosely and inaccurately. It was Linnæus's contrivance to apply to the nomenclature of natural productions the same system which is allowed in that of individuals of the human race; each animal, each plant, had a generic name which corresponds to our family name, and a specific one which resembles our baptismal one. Thus the names became short, clear and precise, they could be retained by the memory, which allows us to expect that they will one day be universally used.

These two great basis, the terminology and the nomenclature, being fixed, Linnæus had the courage to apply them to every department of natural history: he traced the tableau of the three kingdoms according to these principles, and astonished the world both by the variety and accuracy of his knowledge, and the care which he took in the introduction of a crowd of new objects and striking remarks into this vast picture; he mentioned under each article the ancient names which were not in use, the best figures, and the most certain localities which he could discover. He supported his general works by a mass of interesting and original memoirs, in which he explained such points as could not be satisfactorily unfolded in his usual concise manner, &c. Ought we, then, to wonder at the learned world being astonished at such immense works, and at the same time that changes so complete as to forms and terms should embarrass those who had spent their lives in teaching others, and thus divided naturalists into enthusiastic admirers, and sometimes unjust detractors of Linnæus?

Having thus considered the form of Linnæus's works, if we now cast a glance at his classification, we will, in analyzing it, meet with a curious exemplification of this twofold proposition; some writers admiring what Linnæus himself regarded as precarious and provisionary, and others blaming those parts of his works which are the most deserving of praise. I shall explain what I mean. Linnæus appears to have been the first naturalist who clearly comprehended the difference between the natural and the artificial systems; he was especially, notwithstanding the vivacity of his genius and his desire to sway the whole of science, he, I say, was perfectly aware that the number of objects known during his time, and the manner in which they were described, did not as yet admit of any attempt at a classification according to the natural system; he was satisfied with one purely artificial as to practice, and with a few small fractions of the former order for the purposes of study. He has said very plainly, and on many occasions, that the artificial system was temporary, and only useful in finding out the names of plants, &c.; but the natural one was the legitimate object of science, and that thither all the labours of the natural historian should be directed. He gave private lessons to select pupils, on the natural system, and allowed no opportunity to escape of enabling them to appreciate it. But the learned world has, in this respect, committed two blunders, which are singular on account of their inconsistency; some, like Buffon, have censured him severely, because in his sexual system, objects very unlike are often brought together, as if this juxtaposition was not inherent in every artificial method, which can only be compared to a mere dictionary, and as if Linnæus had not corrected these casual juxtapositions in his fragments on the natural system: others, who are exclusively termed Linnæans, have considered the artificial system as comprehending the whole of the science; they have taken for a permanent arrangement what their master laid down as temporary, and have abandoned with contempt the examination of the natural system, which Linnæus declared to be the true end of science: thus, as it were, depreciating their great leader, in order to accommodate their narrow conceptions, they are opposed to the principles which he professed, and, in retaining the external form of his writings, they have misconceived their meaning. Linnæus is a far greater man than these pretended Linnæans would induce us to believe, and I doubt not, that, were he again to appear, he would be their strongest opponent. Truth, moreover, pierces the clouds on all sides; the artificial methods are reduced to their real value, their true sphere, the art of finding names; and every one is sensible at present, that the natural system, properly understood, is the true expression of the whole science.

D. C.

TABLES OF THE SUN'S MEAN RIGHT ASCENSION. *By* WILLIAM GALBRAITH, *A.M. Communicated by the Author.*

THE following Tables, adapted to the meridian of Greenwich, have been computed by me, for the purpose of performing a problem, of frequent occurrence in practical astronomy.

They are founded on late investigations, are more accurate than any with which I am acquainted, and are applied in the following manner.

Let m be the mean solar time at the place of observation,

s the corresponding sidereal time,

r the mean right ascension of the meridian, equivalent to the mean longitude of the sun, converted into time for the preceding mean noon at the place of observation.

a the acceleration of the fixed stars for the sidereal time $s-r$, from a table for converting sidereal into mean solar time. See XXXI. of my Mathematical Tables.

α the acceleration for the mean solar time m, by a table for converting mean solar into sidereal time. Table XXX. of my Mathematical Tables.

Then $m = (s - r) - a$ . . . . (1)

And $s = r + m + \alpha$ . . . . (2)

Now, by Tables I. and II. for years, months, and days, find the mean right ascension of the meridian at *mean* noon on the given day of any proposed year, reckoned from the mean equinox. To this apply the equations from Tables III. and IV., of which the arguments are ☊, ☉, and ☽, and the result will be the right ascension reckoned from the apparent equinox. In the Nautical Almanac for 1834, and succeeding years, the sun's right ascension at mean noon will be given, which will facilitate this problem.

Example 1.—An eclipse of the first satellite of Jupiter was observed at Greenwich on the 17th January 1825, at $2^h\ 19^m\ 49.0^s$ sidereal time by a clock, which was $59^s.14$ fast. Required the corresponding mean solar time ?

	h	m	s
Sidereal time by the clock, ...	2	19	49.00
The error of the clock fast, ...	—		59.14
Correct sidereal time, .	2	18	49.86

			h m	s		
Year, 1825,	Table I.	...	0 3	24.502	Table I. ☊	251
Month, Jan. 10.	Table II.	...	19 15	25.553	...... II.	1
Day, 7.	...... II.	...	27	35.887	...... II.	1
☊, Lunar Nutation III.		...		1.058	Sum,	253
☉, Solar Nutation IV.		...		0.062	☉	= 297°.5
☽, Lunar Equation IV.		...		0.005	☽	= 281 .6
$r =$			19 46	27.067		
$s =$			2 18	49.860		
$s - r =$			6 32	22.793		

By my Mathematical Tables, XXXI.

h	m	s		m	s			
6	0	0	give	0	58.977			
	32	0	...		5.242			
		23	...		0·063			
$s - r =$ 6	32	23	give $a =$	1	4.282	—	1	4.282
			$m =$ mean solar time,			6	31	18.511

Example 2.—Suppose the observation had been made at 6ʰ 31ᵐ 18ˢ.511 mean solar time, and the corresponding sidereal time were required, the operation would have been performed as follows:

	h	m	s		h	m	s
$m =$					6	31	18.511
$r =$					19	46	27.067
By Mathematical Tables XXX.	6	0	0				59.139
		31	0				5.092
			18.5				0.051
$s =$ sidereal time,					2	18	49.860

Since the tables of the sun's mean right ascension are adapted to the meridian of Greenwich, a correction must be applied when the computations are made for any other meridian. This correction may be conveniently taken from Table XXX. of my Tables.

Example 3.—Required the correction necessary to adapt these tables to the meridian of Paramatta, in longitude 10ʰ 4ᵐ 5ˢ E.

	h	m	s			m	s
By Table XXX.	10	0	0	give		1	38.565
		4	0	...			0.658
			5	...			0.014
Total correction for	10	4	5	=	—	1	39.237

which is negative or — because the longitude is east.

Ex. 4.—Required the correction for Edinburgh, in longitude 12ᵐ 42 .5 W.

	m	s			
By Table XXX.	12	0	gives		1.972
		42.5	...		0.118
Total correction for	12	42.5	=	+	2.090

which is additive, because the longitude is west.

Example 5.—August 14. 1830. On the meridian of Paris, in longitude $9^m\ 21^s.34$ E., at $22^h\ 22^m\ 13^s.4$ mean solar time, what was the sidereal time?

	h	m	s		
Year, 1830, Table I. ...	0	2	34.569	☊ . .	519
Month, Aug. 10. ... II. ...	9	11	15.287	. . . . .	33
Day, 4. ...		15	46.221	. . . . .	1
Long. $9^m\ 21^s.34$ E. cor. ...	—		1.538		553
☊ Lunar Nutation, ...	—		0.338	☉ =	142°
☉ Solar Nutation, ...	+		0.076	☽ =	105
☽ Lunar Equation, ...	+		0.006		
r = ...	9	29	34.283		
m = ...	22	22	13.400		
$22^h\ 0^m\ 0^s$ Table XXX.		3	36.844		
22 0 . . .			3.614		
13.4 . . .			0.037		
s = sidereal time, . . .	7	55	28.178		

Example 6.—July 20. 1830. On the meridian of Paris, the sidereal time was $16^h\ 15^m\ 40^s.8$ by a clock $19^s.7$ slow,—required the corresponding mean solar time?

	h	m	s
Sidereal time by clock, ...	16	15	40.8
Error of clock slow, ...	+		19.7
Correct sidereal time, ...	16	16	0.5

	h	m	s		
Year, 1830. Table I. . . .	0	2	34.569	☊	519
Month, July 20. ... II. . .	7	48	27.625	. .	30
Sum = ...	7	51	2.194		549
Correction for longitude $9^m\ 21^s$ E. .	—		1.538	☉ =	117°
Difference, ...	7	51	0.656	☽ =	129
☊ Lunar Nutation, ...	—		0.319		
☉ Solar Nutation, ...	+		0.062		
☽ Lunar Equation	+		0.013		
r = ...	7	51	0.412		
s = sidereal time, ...	16	16	0.500		
$s-r$ = ...	8	25	0.088		

h	m	s		m	s		h	m	s
8	0	0	Table XXXI.						
			gives	1	18.636				
	25	0	...		4.096				
$s-r$ = 8	25	0	...	1	22.732	—		1	22.732
m = Mean solar time, . . .						=	8	23	37.356

These examples are sufficient to show the general method of making the necessary computations, which are frequently required in an active observatory where a sidereal clock is indispensable.

Note.—In the months of January and February of bissextile years, take the day preceding that given.

Right Ascension of the Mean Sun at Mean Noon on the Meridian of Greenwich.

TABLE I.

Year.	R. A. M.	R. A. S.	☊
C 1800	3	37.627	908
1801	2	40.329	961
1802	1	43.031	15
1803	0	45.732	69
B 1804	3	44 989	123
1805	2	47.691	176
1806	1	50.392	230
1807	0	53.094	284
B 1808	3	52.351	338
1809	2	55.052	391
1810	1	57.755	445
1811	1	0.456	499
B 1812	3	59.713	552
1813	3	2.415	606
1814	2	5.116	660
1815	1	7.818	713
B 1816	4	7.075	767
1817	3	9.776	821
1818	2	12.478	875
1819	1	15.181	928
B 1820	4	14·439	982
1821	3	17.140	37
1822	2	19.842	90
1823	1	22·543	144
B 1824	4	21·800	198
1825	3	24·502	251
1826	2	27·203	305
1827	1	29·905	359
B 1828	4	29·162	413
1829	3	31 866	466
1830	2	34·569	519
1831	1	37.270	573
B 1832	4	36.527	627
1833	3	39.229	681
1834	2	41.930	734
1835	1	44.632	788
B 1836	4	43.889	842
1837	3	46.592	895
1838	2	49.296	949
1839	1	51.999	3
B 1840	4	51.256	56
1841	3	53.958	110
1842	2	56.659	164
1843	1	59.362	218
B 1844	4	58.620	272
1845	4	1.323	325
1846	3	4.025	379
1847	2	6.727	433
B 1848	5	5.985	487
1849	4	8.687	540
1850	3	11.390	594
1851	2	14.092	648
B 1852	5	13.350	701
1853	4	16.052	755
1854	3	18.755	809

TABLE II.

Month.	Day.	R. A. H.	R. A. M.	R. A. S.	☊
Jan.	0	18	36	0.000	0
	10	19	15	25.553	1
	20	19	54	51.107	3
	30	20	34	16.660	5
Feb.	0	20	38	13.216	5
	10	21	17	38.769	6
	20	21	57	4.323	7
Mar.	0	22	28	36.766	9
	10	23	8	2.319	11
	20	23	47	27.872	12
	30	0	26	53.426	13
April	0	0	30	49.981	13
	10	1	10	15.535	15
	20	1	49	41.088	16
May	0	2	29	6.642	18
	10	3	8	32.195	19
	20	3	47	57.749	21
	30	4	27	23.302	22
June	0	4	31	19.858	22
	10	5	10	45.411	24
	20	5	50	10.965	25
July	0	6	29	36.518	27
	10	7	9	2.071	28
	20	7	48	27.625	30
	30	8	27	53.178	31
Aug.	0	8	31	49.734	32
	10	9	11	15.287	33
	20	9	50	40.841	34
	30	10	30	6.394	35
Sept.	0	10	34	2.950	36
	10	11	13	28.503	37
	20	11	52	54 057	39
Oct.	0	12	32	19.610	40
	10	13	11	45.163	42
	20	13	51	10.717	43
	30	14	30	36.270	44
Nov.	0	14	34	32·826	45
	10	15	13	58.379	46
	20	15	53	23·933	48
Dec.	0	16	32	49.486	49
	10	17	12	15·040	51
	20	17	51	40.593	52
	30	18	31	6·147	53

Day.	M.	S.	☊
1	3	56.555	0
2	7	53.111	0
3	11	49.666	0
4	15	46.221	1
5	19	42.777	1
6	23	39.332	1
7	27	35.887	1
8	31	32.443	1
9	35	28.998	1
10	39	25.55348	1

TABLE III.

☊	Equa. + (s.)	☊	Equa. − (s.)
0	0.000	500	0.000
10	0.068	510	0.065
20	0.136	520	0.129
30	0.203	530	0.193
40	0.269	540	0.257
50	0.334	550	0.319
60	0.398	560	0.381
70	0.460	570	0.441
80	0.520	580	0.499
90	0.578	590	0.555
100	0.634	600	0.610
110	0.687	610	0.662
120	0.737	620	0.711
130	0.784	630	0.758
140	0.828	640	0.803
150	0.868	650	0.844
160	0.905	660	0.882
170	0.938	670	0.916
180	0.967	680	0.947
190	0.992	690	0 975
200	1.014	700	0.999
210	1.031	710	1.019
220	1.044	720	1.034
230	1.053	730	1.046
240	1.057	740	1.054
250	1.058	750	1.058
260	1.057	760	1.054
270	1.053	770	1.046
280	1.044	780	1.034
290	1.031	790	1.019
300	1.014	800	0.999
310	0.992	810	0.975
320	0.967	820	0.947
330	0.938	830	0.916
340	0.905	840	0.882
350	0.868	850	0.844
360	0.828	860	0.803
370	0.784	870	0.758
380	0.737	880	0.711
390	0.687	890	0.662
400	0.634	900	0.610
410	0.578	910	0.555
420	0.520	920	0.499
430	0.460	930	0.441
440	0.398	940	0.381
450	0.334	950	0.319
460	0.269	960	0.257
470	0.203	970	0.193
480	0.136	980	0.129
490	0.068	990	0.065
500	0.000	1000	0.000
	+		—

TABLE IV.

Arg.	☉	☽	Arg.	Arg.	☉	☽	Arg.
°	s.	s.	°	°	s.	s.	°
0	—0.000+	—0.000+	360	100	+0.026—	+0.004—	260
10	0.026	0.004	350	110	0.049	0.008	250
20	0.049	0.008	340	120	0.067	0.011	240
30	0.067	0.011	330	130	0.076	0.013	230
40	0.076	0.013	320	140	0.076	0.013	220
50	0.076	0.013	310	150	0.067	0.011	210
60	0.067	0.011	300	160	0.049	0.008	200
70	0.049	0.008	290	170	0.026	0.004	190
80	—0.026+	—0.004+	280	180	+0.000—	+0.000—	180
90	0.000	0.000	270				

SUMMARY OF THE RAIN, &C. AT GENEVA, AND AT THE ELEVATED STATION OF THE PASS OF GREAT ST BERNARD, FOR A SERIES OF YEARS. *From the Bibliotheque Universelle for March* 1828. WITH OBSERVATIONS ON THE SAME. *By JOHN DALTON, F.R.S.*

GENEVA is situated in latitude 46° 12′ N. and about 6° E. longitude from London; its elevation is 450 yards above the sea; its distance from the Atlantic is 360 miles, and from the Mediterranean 160 miles. The high mountains of the Alps form an immense amphitheatre from Geneva, extending more than 100 miles to the eastward. The mountain Great St Bernard is one of the higher Alps, over which is a public road or pass into Italy. It is about sixty miles to the south-east of Geneva. There is an inn or convent at the pass for the convenience of travellers; in summer the road is practicable without much danger; in winter it is impassible; in spring and autumn the traveller is often in danger, and sometimes perishes by the sudden and unexpected falls of snow, by the descent of masses of ice and snow from the sides of the mountains, or by extreme cold. The height of the pass above the level of the sea is 2720 yards, which is between two and three times the height of Snowdon.

The scientific gentlemen of Geneva have very laudably availed themselves of the opportunity which the situation at St Bernard afforded them, of ascertaining the meteorological phenomena at the latter place. A series of daily observations of the barometer, thermometer, hygrometer, quantity of rain, &c. at the convent, has been made for the last ten years; and a summary of the observations was given in the Bibliotheque Universelle for March last, together with those of the like kind made at Geneva for thirty-two years.

The observations at Geneva do not appear to present any thing of peculiar interest. The *annual means* and the *general means* for the period of thirty-two years are all that are given in the summary; the mean temperature is $49\frac{2}{3}°$: this is low considering the latitude, but the elevation of the place, its inland situation, and its proximity to the Alps, conspire to reduce the temperature. The annual rain is 30.7 inches (English measure).

The observations on St Bernard are given much more in detail. The monthly means for each year are given, and the averages for each month, for the barometer, thermometer, hygrometer, and rain; from which general averages for the whole ten years are obtained.

It appears that the mean height of the barometer at St Bernard is nearly 22 English inches; the mean temperature is $30\frac{1}{4}°$ Fahrenheit; the mean quantity of rain and snow is 60 inches annually; and the mean state of the hygrometer (Saussure's) is $83\frac{1}{2}°$, only half of a degree more moist than at Geneva.

From the accounts furnished, I have calculated the mean monthly averages of rain at St Bernard for twelve years *, and find them as under:

	Rain, inches.	
January,	5.95	Wet period.
February,	6.85	
March,	6.98	
April	5.65	
May,	2.76	Dry period.
June,	3.20	
July,	4.16	
August,	4.31	
September,	4.79	Average period.
October,	5.47	
November,	4.51	
December,	5.42	
	60.05	

* Since the paper was read, I have incorporated two more years' rain, namely 1828 and 1829, into the averages for St Bernard; so that the table here presented is for twelve years.

The most striking circumstance with regard to the rain is the great excess of it, compared with that at Geneva. Though the average rain at Geneva for the thirty-two years was 30 inches annually, yet the average quantity for the same ten years as those which were observed at St Bernard was only 26 inches annually; so that the rain at St Bernard is nearly two and a half times as much as that at Geneva. From the observations made in great Britain, it appears to be an established fact that more rain falls in the hilly parts of the country than the plains; but it also appears, that the quantity of rain in a low situation, is greater than that in an elevated situation in the vicinity. Hence it might have been imagined, that the great elevation of St Bernard would reduce the quantity of rain below that of the plain of Geneva. The fact, however, appears to be far otherwise; and it may demand a little consideration. High mountains produce rain, I think, unquestionably from their obstructing the horizontal currents of the air, and causing them to ascend into the higher regions of the atmosphere, by which airs of different temperatures are mixed together. Now, it is well known, that two portions of air, saturated with vapour at their respective temperatures, when mixed together, are incapable of retaining the whole of the vapour; a part of it is precipitated in the form of a cloud or rain. This is the case, too, if the portions of air be *under* saturation, within certain limits.

The physical principles on which the above statement is supported, are, 1*st*, When two portions of air of different temperatures are mixed, the temperature of the mixture is the *arithmetical* mean of the two temperatures. 2*d*, When two portions of air saturated with vapour are mixed together, the quantity of the vapour found in the mixture must also be the *arithmetical* mean of the quantities found in each; but it is only a quantity proportional to the *geometrical* mean that can be supported in the state of vapour, by the mean temperature; and as the geometrical mean is always less than the arithmetical mean, the excess must needs be precipitated.

This accounts for more rain falling in mountainous countries than in plains; but the question at present is, How does it happen that more falls on great elevations amongst the Alps than on the plains below?

To this it may be answered, that the pass on St Bernard is not the *highest* point of land in the vicinity, but rather the *lowest*, at least of the ridge over which the road passes. Hence the fall of rain, even in that elevated station, is still under the influence of superior currents of air over the higher summits, and may still exceed in quantity what falls on the distant plains. The quantity of rain which falls at the *foot* of the mountain, either on the Swiss or Italian side, I have little doubt, will be found to be still greater than that which falls at the Hospital, as related above. It would be very desirable, however, to ascertain the fact; and more especially on the side of Italy, where the greatest quantity may be expected from the west winds.

How far a ridge of hills extends its influence over a plain, in regard to the weight of water precipitated, it is not easy to form a decided opinion. It can scarcely be doubted, that the greatest influence will be confined to two or three miles from the ridge; but some influence may be found, in all probability, at the distance of ten or even twenty miles or more, according to the greater or less elevation of the mountains.

It is a matter of curious observation, that the falls at St Bernard for the four first months of the year, are all greater than for any other months, and that the falls for the next four months are all less than for any other, thus leaving the four last months to yield about the average monthly quantity. A series of twelve years can scarcely leave a doubt as to the general accuracy of the fact. Possibly there may be some uncertainty as to the quantity in regard to the snow; the observers estimate one foot in depth to be equal to one inch in depth of rain; and the weight of the falls for six or eight months in the year is snow.

Remark on the Barometrical Observations at St Bernard.

The author of the summary in the Bibliotheque Universelle, remarks, with *surprise*, that the barometer at St Bernard gives the *highest* mean for August, and the hottest months, and the *lowest* in the coldest months. This observation must have been made without due reflection, as the cause is evident; the stratum of air from the height of St Bernard to the surface of the earth must be lighter in summer than winter, on account of the higher temperature; consequently, the superior atmosphere must then be heavier, the sum of both being considered a constant quantity in summer and winter.—*Manchester Memoirs*, vol. v. p. 233.

OBSERVATIONS ON COMPETITIONS AMONG WORKING TRADESMEN. *By* WILLIAM GRIERSON, *Esq. of Garrock, W. S. Member of the Society of Arts. Abridged from a Paper read before the Society* 10*th April* 1833, *and by their Committee recommended to be printed.*

All of the useful arts admit of two distinct kinds of improvement. The one is by new inventions, the other by rendering workmen more expert.

The encouragement of invention has long been a favourite object with the public, and every one is also sensible of the importance of having operative tradesmen properly instructed; yet hardly any thing has ever been done towards attaining this last end, however desirable. Indeed, if we except the case of ploughmen, scarcely one class of the members who are employed in providing us with the necessaries of life, have ever had the stimulus of a prize for superior excellence held out to them, though there is not one among them to whom it might not be applied with perfect ease, and with incalculable effect.

However varied and complicated a man's employment may be, a very few simple operations will suffice to shew his merits. Thus from the formation of a mortice and tenon, from the construction of a pannelled door, from the fitting of a drawer, the jointing of the leaf of a table, and one or two other such works, a perfect idea may be formed of the qualifications of all the various denominations of square-men, in every stage of their progress. Each of these works might accordingly be assigned to a separate class of competitors, as the test of their advancement; and in every other trade a similar selection might be made, adapted to the various degrees of proficiency of its members. By these means some object of ambition might be placed within the reach of the youngest apprentice, while the most expert workman would not find himself without rivals; and to preserve his pre-eminence, would be compelled to continue his exertions.

The details of such a system must of course be left to practical men; but there are one or two general principles which appear to apply universally, and which, indeed, seem quite necessary to the success of any attempt of the kind. 1. No class should be so large as not to afford a fair chance of success to every individual comprised in it; but, that superior merit may obtain a corresponding distinction, the successful competitors in the first class should be brought again into competition with one another for an additional prize, just as in a coursing match. 2. That every one may know with whom he is to contend, the name of each competitor should be entered in a public list, a considerable time before the day of trial. 3. The work by which the merit of each class is to be ascertained, should, as far as possible, be executed in the same place, and at the same time, both to insure that no one shall produce any thing but what he has himself executed, and also for the purpose of comparing the different modes of doing the same thing, practised by different workmen. 4. That the competitors may have complete assurance of perfect impartiality, they ought, in every case, to have the choice of their own judges. 5. It may be mentioned, in the last place, that books appear by far the best prizes that can be given, both on account of the valuable information which may be thus communicated, and also because a suitable inscription can be put upon them at no expense.

These principles of competition have already been tried with great success by the Glenkens Society, an institution which was formed about two years ago in a retired district of the stewartry of Kirkcudbright, for a similar purpose with that now under consideration; and there can be no doubt that competitions thus conducted, would be still more beneficial under the influence of the condensed population of a large town.

It has long been a very general complaint among masters, that they find it next to impossible to fix the attention of their apprentices: that even their journeymen can hardly be prevailed upon to take an interest in their work beyond what is necessary to provide themselves with bread, and that the idle hours of both are grossly misspent. Indeed, so long as their utmost dexterity and skill can do so little towards raising them into public notice, we can hardly wonder that their work should hang heavy on their hands, and that their relaxations should be of a kind of which we cannot approve. But were a ladder afforded to a working tradesman, by which he might raise himself step by step from his obscurity, to such a station as his talents and acquirements enable him to fill with credit to himself and benefit to the public; and were it made plain to him that, whatever step he may at present occupy on this ladder, no great exertion would be required to gain one step higher, there cannot be a doubt that the emulation which has, by similar means, been excited among ploughmen, would be excited in him also, and in a much greater degree. The ordinary occupations of the workshop would become interesting to him as preparations for his public exhibitions; and the time during which he is not thus engaged, would be employed by him in gaining some acquaintance with such branches of science as may be connected with his trade. This would unquestionably be the effect of these competitions on all the ablest men among these classes; and as it is from them that the whole take their tone, their example would be speedily followed. The community at large would become industrious and economical, and men who now sink through all the gradations of idleness and want, till they end in crime, would become active and useful members of society.

This would necessarily produce no inconsiderable diminution on the number of paupers, while it would at the same time tend to lessen the expense of all the necessaries of life. Every hand being improved to the utmost, and employed in the best possible way, would be rendered proportionally more productive, and as the most important inventions have almost all been made by working tradesmen, a very rapid addition to them might be confidently anticipated, from the prodigious force of talent thus brought into operation, which is at present altogether dormant.

To these considerations it must be added, that the proposed competitions would do much towards re-establishing the connection between the higher and lower classes, which, of late years, has been almost entirely done away, very much to the injury of both. Indeed, however anxious a rich man may now be to make himself useful to his poorer neighbours, he has it not in his power. He comes seldom into contact with any of them, but such as have already reduced themselves to beggary by idleness and dissipation, and, finding any thing he may give them to be worse than thrown away, he either abstains from charity altogether, or commits his contributions to some of the benevolent societies with which this country abounds. By them he is sure that his donations will be judiciously administered; but, when thus made, they will do nothing towards securing him a place in the affections of the persons relieved, who, being unacquainted with their benefactor, cannot, of course, make to him any return of gratitude. But were the stamp of merit fixed on the really deserving by these competitions, a class of persons would be offered to the notice of the higher ranks, who would be every way deserving of their countenance. To them it would be given willingly and liberally. It would not fail to produce corresponding feelings of attachment and respect, and the various ranks would thus gradually become bound together by all those sympathies which enhance the joys and soothe the sorrows of life.

SOME ACCOUNT OF THE NORTHERN LIGHT-HOUSES.

" *Pharos loquitur.*

" Far in the bosom of the deep
O'er these wild shelves my watch I keep,
A ruddy gem of changeful light,
Bound in the dusky brow of night.
The seaman bids my lustre hail,
And scorns to strike his timorous sail *."

From the important nature of the experiments and trials lately made with various lights at Gullan Hill, 12 miles east from Edinburgh, by order of the Commissioners of the Northern Light-houses, which we saw from the Calton-Hill, we have been led to a perusal of Stevenson's splendid and interesting work, entitled " Account of the Bell Rock Light-house," for informa-

* Lines written by Sir Walter Scott in the Album of the Bell Rock Light-house, when he visited it in 1814.

tion with regard to the Light-house Board, and its extensive operations; and we have also sought information from other authentic sources.

After adverting to the early state of navigation, the voyage of James V. round the north of Scotland, and the early charts of the coast, the subject of a Scottish Light-house Board is mentioned by Mr Stevenson as having originated with the Convention of Royal Burghs, and its constitution by act of Parliament he refers to the year 1786. The Board consists of his Majesty's Advocate and Solicitor-General, the Chief Magistrates of the principal burghs, Edinburgh, Glasgow, Aberdeen, Inverness and Campbelton, and the Sheriffs or Judges Ordinary of maritime counties.

When we look at the extent to which the operations of this Board have been carried, it is not a little surprising to remark, that the preamble of the original act states, "that it would conduce greatly to the security of navigation and the fisheries, if *four* light-houses were erected in the north part of Great Britain." Such, it would seem, was the limited state of trade about fifty years ago in Scotland, that the erection of *four* light-houses was all that was contemplated at that time, although the coast, extending to about 2000 miles of circuit, is perhaps the most dangerous of any in Europe. But no sooner were these four lights exhibited to the mariner, than the facilities which they afforded to navigation were cheerfully acknowledged, and applications were received from the shipping interest of the country for the erection of others; and now, in 1833, there are twenty-five lights on our coast, including double or leading lights. The funds of this Board arise from a duty of 2d. per register ton on all vessels passing any of them. In addition to this, the trade of the Frith of Forth formerly paid three halfpence per ton for the Isle of May light, by a *Scotch act*, to the family of Scotstarvit; but when this light, by act of Parliament, became one of the Board's lights, the additional duty of three halfpence was reduced to one halfpenny per ton, and the odious distinction of making English and Irish vessels pay double, as foreigners, ceased. Vessels also may now pass the three lights of the Isle of Man, belonging to the Scotch Board, by paying the small sum of one farthing per ton, which was considered to be sufficient by the Board, on account of the great traffic in the Irish sea with Liverpool and Dublin, &c.; but if, from the nature of their voyage, they incur the general duty of the Northern Lights, they pay nothing exclusively for the Isle of Man. These we believe to be all the peculiarities of the duties payable for the Northern Lights, and they are certainly of a very liberal description. After making allowance for some change in the rate of the duties, the sum annually collected for these lights forms a striking proof of the advanced state of the trade of the country. In 1790, it was L. 1477 : 5 : 1; in the year 1802, L. 4386 : 7 : 5; and, in 1824, it amounted to L. 24,000: the debt of the Board at this time being L. 60,000, and the yearly expence of management about L. 900.

Having noticed these particulars, we now proceed to detail the operations of the Northern Lights Board, and our narrative will convincingly shew, that the country was never more fortunate in the appointment of a public board. At the first meeting of the Commissioners, held in the month of August 1786, Sir James Hunter Blair, then Lord Provost of Edinburgh, and Member of Parliament for the city, was elected Chairman *. At this period, the chief lights on the coast of Scotland were the Isle of May in the Frith of Forth, and the Cumbrae Isle in the Frith of Clyde; and at both of these stations open coal fires, placed in elevated choffers, were exhibited to the mariner. Sir James stated to the meeting, that after corresponding with the Port of Liverpool, where reflectors with oil had been substituted for the open coal fire, he recommended that this system should at once be adopted by the Board. The plan brought forward by the late Mr Thomas Smith, engineer to the Board, being approved of, the works were ordered to be proceeded with, by the erection of the four light-houses referred to in the act. "These works," we are told, were "necessarily executed on the smallest, plainest, and most simple plan that could be devised, and with such materials as could be easily transported, and most speedily erected, so as to meet the urgent calls of shipping, and answer the very limited state of the funds." By the year 1794, in addition to the four original northern lighthouses, two had been erected on the island of Pladda in the Clyde, and two on the Pentland

* The only Member present at the first Board who still survives, is Sir William Macleod Bannatyne, lately one of the Lords of Session, and then Sheriff of Bute.

Skerries in Orkney; being additional to the four sanctioned by the Act. About the year 1800, the funds of the Board were getting into a more flourishing state, its operations were conducted upon a more extended scale, and other two light-houses were erected, one upon Inchkeith in the Frith of Forth, and another on the Start Point of Sanday in Orkney. The Commissioners were now also in a condition to listen to applications for a light upon the fatal reef called the Bell Rock, which lies twelve miles off the shore, in the direct track of navigation, and was much dreaded by the mariner as the source of the greatest danger on the eastern coast of Scotland. It has been calculated, that not a year passed without the loss of several vessels, either upon the Bell Rock or in consequence of the dread of it; but since the light-house was erected, not a single wreck has occurred on the rock, and comparatively few upon that line of coast.

Hitherto the accommodation at the light-houses was only calculated for one family, but it was now resolved to have two effective light-keepers. The change of the watch, and other assistance for the light-keepers, had heretofore depended upon the family of the light-keeper. Over these, however, the Board could have no control. The keeper might be single or married; his wife, children or servant might be unfit for the duty; and in case of sickness or death in these insular and remote situations, the consequences to a fleet of ships whose course depended upon the regular appearance of the light might be dreadful. On the whole, the Board properly resolved that there should be two responsible persons, a principal and an assistant keeper, at each station, who should mount guard throughout the night, as on ship-board. So specially is this now attended to, that the keeper is liable to immediate dismissal if he leave the light-room before being regularly relieved by his colleague; and for securing order and regularity in this respect, a time-piece is placed in each light-room, and bells are hung in the bed-rooms of the dwelling-houses. At some of the stations, instead of slender wires, these bells are connected by tubes leading down the walls of those lofty towers, with a mouth-piece in the light-room, into which the man on watch blows, and immediately the alarm-bell is sounded, which arouses the keeper below to mount guard. We have been more particular in noticing this, both on account of the science displayed in the apparatus, and also as a proof of the importance attached by the Board to the unremitting constancy of the watch, and of its regard for that punctuality which we believe regulates all the details of this establishment.

The dwelling-houses now constructed are calculated for the accommodation of two families. The walls are lined with brick instead of laths, and a space of two and a-half inches is left between to render them water-tight. They are covered with a leaden-platform, defended by a parapet-wall, instead of a slated roof with garrets. The slated roof was found constantly liable to injury from high winds, in situations exposed, as the Light-houses generally are, to the rage of every storm, and not unfrequently to the sprays of the sea, even in situations much above its level. Formerly, when the attic apartments were occupied, the premises became liable to accident by fire. The early light-rooms were chiefly constructed of timber, lined with fire-proof plates; now they are built wholly of incombustible materials. The dormant sides, should there be any in the light-room, are made double, with a space between, to prevent the effects of condensation and moisture. For the same reason, its cupola-roof consists of two shells of copper. The windows are now glazed with polished plate-glass, each pane measuring about 18 by 30 inches, and a quarter of an inch in thickness, instead of the common sash-panes of crown glass, formerly in use, which, from the number of interposing astragals, obstructed the passage of the light.

The reflectors originally employed were casts in plaster of Paris, from a mould formed to the parabolic curve, upon principles susceptible of considerable accuracy, and were lined with facettes of mirror-glass. The power of these reflectors, however, was comparatively small, from the reflecting surface being composed of numerous pieces, in each of which only one point coincided with the curve of the parabola. This description of reflector was, at the time of its introduction, brought under the notice of the late eminent Professor Robison, who expressed a doubt that, from the nature of the parabola, the beam of light from the reflector would be too direct to be generally useful to the mariner. But in practice they were found to be sufficiently dispersive.

The Trinity House having been at great pains to improve the reflecting apparatus on the coast of England, with the advice and assistance of persons eminent in science, adopted parabolic reflectors made of silvered copper; and these, from their superior effects, have ultimately been introduced into all the light-houses of the United Kingdom. The reflectors which have for many years been employed in the Northern Light-houses consist of copper coated with silver, in the proportion of six ounces of silver to one pound avoirdupois of copper, which are rolled at the mills of Messrs Bolton and Watt, and, with much labour and great nicety, by a process of hammering and polishing, formed to the parabolic curve of a mould made with mathematical precision. The diagram for the Bell Rock reflectors was drawn by Professor Leslie, and the mould was made by Mr Adie the optician. The powers of this elegant production of the mechanical art are quite astonishing; and when these reflectors were examined by the late Professor Playfair, he expressed his unqualified admiration of the accuracy with which the curve was formed. If, for a moment, we compare the highly polished and regularly curved surface of the silvered copper reflector with the few corresponding points of the parabola formed by *facettes* of glass, the superiority of the former seems to be quite infinite. But what can be more authoritative than the fact that their influence completely extends to the horizon formed by the height of the light-house tower and the earth's curvature? The lights, for example, of Sumburgh Head and Cape Wrath are seen from a ship's deck at the distance of nine leagues at sea. Both the light of the natural appearance and that which is coloured red at the Bell Rock are seen at the distance of thirty-five miles from an elevated situation. Observations have also been made across the Frith of Clyde from Wigtonshire to the Mull of Kintyre, a distance of thirty miles, from which Corsewell light is seen, though it presents only three reflectors to the eye of the observer; and Inchkeith light, with only one reflector upon a face, is seen as a good sea-light at the distance of twelve or fourteen miles.

In the early state of the Northern Light-houses, whale-oil and the common lamp were in use; but, in their improved condition, spermaceti oil and the Argand lamp have been introduced. We believe it has been proposed by some to introduce oil-gas in a portable form for light-house purposes; but we take leave to say that there is no mode of *producing* oil-gas either so effective or so economical as by means of the Argand burner. The same arguments which hold good for the use of gas for domestic purposes do not apply to light-houses. Here there is a complete arrangement,—the keepers are professionally adepts in the management of lamps, and should a drop of oil be spilt, the floor is covered with painted floor-cloth to receive it. Nor must we omit to notice the great attention paid to the construction of the Argand light-house burners: they are tipped with silver, to prevent the waste and imperfection to which copper is subject from the excessive heat of the burner *.

In speaking of the humane and proper arrangements of the Light-house Board, we may notice that a pilots' guard-room is provided at the several light-house stations, where these useful men have their rendezvous. In the event also of shipwreck near any of the light-house stations, the unfortunate seamen are not only lodged, but have been supplied with clothes and money to carry them to their respective homes. In this way it has occasionally fallen to the lot of the keepers of the Northern Light-houses to save the lives of perishing seamen, and not unfrequently to succour exhausted fishermen and pilots when driven by stress of weather to these lone places of abode for safety and shelter. In these varied forms, it will not be too much to suppose that the practice of protecting the navigator in distress, which is said to have formed a chief part of the design of the Fire Towers and Nautical Colleges of the Ancients, is thus in some measure restored.

In our account of the progress of improvements upon the lights of the Scotch coast, it is not perhaps necessary for us to do more than simply to have mentioned the great undertaking of the Bell Rock Light-house, the details of which occupy the large volume now before us. This is a structure, the erection of which should ever be coupled with the highest eulogium on the Commissioners of the Northern Light-houses, for their public spirit and patriotic energies, and which will be a lasting monument of fame to all who were in any way engaged in its execution. Like the Eddystone, it is built upon a sunk rock twelve miles at sea; but it may be noticed as a difference in the situa-

* May we not hence conclude, that the silver lamps of the Jewish Temple were substantially for use as well as ornament?

tion of these celebrated edifices, that while the water rises in spring-tides about twelve feet over the Bell Rock, the top of the Eddystone rock is never entirely covered by the tide. Mr Stevenson, however, taking a liberal view of the subject, concludes, that, from the smallness of the Eddystone rock, the difficulties experienced by Mr Smeaton were even greater than his own in the erection of the Bell Rock Light-house. The execution of this last work occupied about four years; but such were the difficulties anticipated, that the arrangements of the work-yard, &c. were made upon a scale of seven years' duration. The cost was L. 61,331 : 9 : 2, toward which Government, at five per cent interest, lent the sum of L. 30,000. But the Board did not yet rest upon its oars; it completed an important transaction with the heirs of the Scotstarvit family, and, under the sanction of Government, paid L. 60,000 as a compensation for the light-duties of the Isle of May, by which (as already mentioned), the trade was relieved of the heavy duty of three-halfpence per ton, and the toll reduced to one halfpenny. Upon completing this transaction, measures were immediately taken for the erection of a new light-house, with all the modern improvements, and the old tower was converted into a pilot's guard-room. The new light was exhibited upon the 1st of February 1816, and upon the same night the open coal fire was extinguished, after having been continued one hundred and eighty-one years.

From the celebrity of the works of the Northern Lights' Commission, and the confidence reposed in that Board, the trade of Liverpool applied to it to erect light-houses upon the Isle of Man for the protection of their shipping in the Irish sea. An act of Parliament was accordingly procured; and three light-houses were erected, two upon the Calf of Man and one at the Point of Ayre.

The attention of the Board was next directed to the Shetland Islands, where a light-house was placed upon the lofty pinnacle of Sumburgh Head, forming the southern extremity of that group of islands. It may here be proper to notice, that no additional duty is levied for any new light-houses erected by the Board on the coast of Scotland, the whole being now maintained from the surplus duties. Since 1821, when the light of Sumburgh was exhibited, lights have been erected upon the Island of

Islay, Buchanness, Tarbetness, Mull of Galloway, Cape Wrath, Dunnet Head, Bara Head, Girdleness, and Lismore. Some of these stations form the principal forelands of the coast, and their erection has been attended with very considerable expense, from the difficulties of access both by sea and land. At Cape Wrath, for example, landing-places had to be formed, and 10 miles of road to be made, chiefly through a deep morass. Till of late when this district became the property of the Duke of Sutherland, the light-house was about 70 miles from a post-office; but there is now a post established at the small hamlet of Durness, about 12 miles from Cape Wrath. Bara-head station, however, forming the southern termination of the Lewis, Harris, and Bara Isles, is exposed to still greater difficulties in this respect than Cape Wrath, even in its former state. The light-house stores and coal, where peat-fuel cannot be had, for the use of the light-keepers, are carried by the general Light-house Tender of 140 tons, assisted by the Pharos Bell Rock Tender of 50 tons, belonging to the Board. In these vessels the visiting officers and artificers for repairs are also transported to the several stations; and the engineer makes his inspection in the former vessel, accompanied occasionally by some of the members of the Board. It is part of the arrangement in conducting this system, that the light-keepers, agreeably to printed forms, make monthly returns, containing in particular the quantity of oil nightly used, the precise moment of lighting and extinguishing the lights, the order in which the respective keepers mount watch, the prevailing state of the weather, the height of the barometer and thermometer, and state of the rain-gauge, with which instruments each station is supplied. As the keepers at the Bell Rock have rations of provisions, their returns, which will be seen at page 433 of the Account of the Bell Rock Light-house, are necessarily more complicated than at ordinary stations. The keepers are also furnished with Shipwreck-returns, as at page 436, which are filled up and dispatched to the engineer in case of shipwreck in the neighbourhood. They state the circumstances attending any shipwreck, and have been occasionally called for at Lloyd's. The Light-house Board has also a report from the coast-guard, and the cruisers, in the event of any defect being observed in the appearance of the lights as seen at sea. Upon the whole, the completely effective state of the Northern Lights, and the regular system of the Board, are most satisfactorily established.

With regard to the characteristic appearance of the Northern Lights, they may be classed as *stationary*, *revolving*, *flashing*, and *intermittent* lights. In the first, as its name implies, the light has a steady and uniform appearance, and the reflectors are ranged in circular zones upon a chandelier or piece of iron frame-work, which is either supported upon a pedestal, or suspended by truss-work from the roof of the light-room. The *revolving* light consists of a frame built upon a perpendicular shaft, and the reflectors are ranged on perpendicular planes or faces, which are made to revolve in periodic times, by means of a train of machinery kept in motion by a weight. When one of those illuminated planes or faces is brought round toward the eye of the observer, the light gradually increases to full strength, and again diminishes in the same gradual manner. When, on the contrary, the angle between two of these faces comes round, the observer is in darkness. By these alternate changes, the characteristic of the light-house is as distinctly marked to the eye of the mariner as the opposite extremes of light and darkness can make it. The *flashing* light is a modification of the revolving light, and is practically a beautiful example of the infinite celerity of the passage of light. The reflectors are here also ranged upon a frame, with faces which are made to revolve with considerable rapidity; and the light thus emerging from a partial state of darkness, exhibits a momentary flash, resembling a star of the first magnitude, and thereby produces a very striking effect. The King of the Netherlands having applied to the Light-house Board for a description of this light, as applicable to some part of the coast of Holland, was graciously pleased, on receiving it, along with a copy of the book now before us, to present the Engineer of the Board with a massive gold medal, bearing his Majesty's effigy, with a suitable inscription upon the reverse. Similar applications with regard to the *flashing* light have been more recently made from other quarters. The *intermittent* light suddenly appears like a star of the first magnitude, and continues as a *stationary* light a minute and a half, when it is as suddenly eclipsed for half a minute, and, by this simple arrangement, a strongly marked distinction in the lights of the coast is introduced. This is accomplished by the perpendicular motion of shades before the lights. A variety of all these lights is introduced by interposing before the reflectors plates of red glass, which produce the beautiful red light alluded to in the lines of Sir Walter Scott, when he notices the "ruddy gem of changeful light."

Nothing, in our opinion, can exceed the marked and characteristic description of the appearance of the several lights alluded to. It would be most hazardous to tamper with such a system, or to adopt speculative alterations. The French, it is believed, are attempting to distinguish their lights by classing them in orders according to the intensity and duration of the light, as described by M. De Rossel, *Amiral de France.* But we confess we are at a loss to conceive how such a system can be modified to the various atmospheric changes to which a French or even an Italian sky is subject; and still less is it possible that the distinctions can be sufficiently obvious to observers at different distances. We fear there is more of theory than practice in this projected system.

In concluding the notice of the works of the Northern Lights' Board, we cannot help observing the proof which they afford of the rapid extent and importance of the shipping interest of the united kingdom. According to the circumscribed scale of the original light-house act for Scotland, only four stations were contemplated, leaving an immense hiatus between each, and it is surprising to think that in half a century there are now twenty-two stations, the distances between which are so modified, that, with the erection of two or three additional light-houses, vessels may go round the mainland of Scotland, from the Frith of Forth to the Frith of Clyde, with a light always in view. One of the lights still wanted, and which is recognised in the act of Parliament, is for the rock Skerry-vore, which lies far at sea, between the Islands of Tyree and Iona, in the direct line between Bara Head and Islay, and forms the seaward termination of a great mass of foul ground on the coast of Argyleshire; which is highly dangerous to West Indiamen falling in with the land. Two or three lights on a small scale are also wanted for the Sounds of Islay, Mull, and Skye; and the Shetland Islands require at least another light, to complete the entire district of the Commissioners of the Northern Light-houses. The clause in the Light-house Act will then come into operation, which provides, that when a sufficient number of lights shall have been erected on the coast, and an adequate sum provided for their maintenance, the duty is ultimately to cease.

There is perhaps nothing which more strongly marks that elevation of mind and character which one would expect from the Northern Lights Board, constituted as it is of men of education and habits of business, than its assiduous attention to the improvement of the lights of the coast. This, we think, is sufficiently manifest in the change made from open coal-fires to glazed light-rooms, with reflectors. Nor do they seem to be at all stationary in this respect: their engineer has lately visited the coast of France, and brought with him a new lens apparatus from Paris. The Board has farther procured an apparatus from London, for the exhibition of the lime-ball light, with oxygen and hydrogen gases, as employed by Lieutenant Drummond. In order to enable the engineer to try these and other experiments which he has in view more fully than could be done at his temporary observatory near Inchkeith Lighthouse, the Board have not only extended his apparatus, but also the means of applying it, by the erection of three light-room cabins on Gullan Hill, a place admirably adapted for such a purpose, and affording such practical opportunities of trial as to prevent all danger of being misled by theoretical hypotheses.

This splendid apparatus, after much detention from various causes, to which it would here be out of place to allude, was ready for exhibition in the month of February last, and its exhibition was continued till the day had lengthened out too much for such observations. We shall, however, mention the results as far as the experiments have been proceeded in, and we hope hereafter to be able to give further details, as we understand they will again be resumed next winter.

We have already noticed that the light-houses are now furnished with reflectors of silvered copper, raised to moulds made with accuracy to a parabolic curve, whose focal distance is 4 inches. These reflectors measure over the tips 21 inches as applicable to *stationary*, and 25 inches for *revolving* lights, and are illuminated by means of Argand burners, with an effect, which we may safely say is not surpassed on any coast in Europe. In the much neglected state of the coast of France during the long *night of terror*, when its commerce was ruined, and its ships were disabled, even if we did not know the fact, we should conclude that it was unlikely that any attention would be paid to the improvement of the French light-houses. Accordingly, only about ten or twelve years since, when the *Corps Royal des Ponts et Chaussées, et des Mines*, under which the light-houses and harbours of France are placed, began to improve their lights, they resolved upon laying aside the very imperfect and insignificant reflectors then in use. They adopted a modification of the famous Buffon's burning-glass, as prepared by the late celebrated M. Fresnel, and which we believe to be similar or identical with the burning-glass of Dr (now Sir David) Brewster, who, in 1811 or 1812, had described a lens of this description, in the Edinburgh Encyclopædia. In the application of this instrument to light-houses, Fresnel, with that liberality of character which greatly endeared him to all who knew him, disclaims any merit as the first who had suggested its application to light-house purposes. Such a proposal had been made by an optician of London to Mr Smeaton in 1759, as mentioned in his Narrative, page 156, for illuminating the Eddystone light-house, but was not adopted by that eminent engineer. M. Fresnel mentions that lenses had been used in England so far back as 1789, in the lower light-room at Portland Island, but, from whatever cause, they have since been laid aside. In the year 1820, in the course of some investigations connected with the Trigonometrical Survey of Great Britain, and conducted by a deputation of persons eminent in science from London and Paris, M. Fresnel, from the French side of the Channel, exhibited, by means of his lens and a large lamp, a powerful light, which was observed by the English across the Channel.

The brilliancy of this light so struck Lieut.-Colonel Colby of the Royal Engineers, who was engaged in these observations, that, with his usual kindness, and zeal for the advancement of science, he immediately corresponded with Mr Stevenson, engineer for the Northern Light-houses, as to its probable use upon the Scottish coast. Mr Stevenson, no less zealous for improvement, communicated with Mr Adie, the principal optician in Edinburgh, and with Dr Brewster, then engaged in optical researches, but without coming to any practical result. In

1824, however, in consequence of Colonel Colby's having informed him that the Tour de Corduan was just fitted up with lenses, he visited that light-house; and in 1825, two of the lenses, and the lamp employed for illuminating them, were received from Paris, where they had been ordered by Mr Stevenson. In 1826, Colonel Colby made arrangements for exhibiting the lens and reflector, and Lieutenant Drummond's apparatus, in one of the long rooms of the Tower of London. To this exhibition the Master, and Elder Brethren of the Trinity-house, Sir William Rae the Lord Advocate of Scotland, and other members of the Northern Lights Board then attending Parliament, were invited, together with a number of the members of the Royal Society, including Sir William Herschel, Dr Olinthus Gregory and Mr Barlow, as also Messrs Gilbert, the opticians, and other artists of eminence. On this occasion a train of very interesting experiments were made. From London the lens was sent to Messrs Bolton and Watt of Soho, where Mr Stevenson had a consultation with some of the members of that scientific and highly respectable house, regarding the construction of lenses for light-house purposes; but it appeared that Sheffield was rather the place for that manufacture.

The French lens was considered by Sir David Brewster as of an inferior quality, from its being made of greenish glass, and he stated to the Light-house Board, that if a lens were prepared under his direction by Messrs Gilbert of London, its effect would be much more powerful in penetrating fogs than that of the French lens. The Light-house Board, therefore, though they considered their lights adequate for every purpose, excepting penetrating fogs, upon the recommendation of Sir David Brewster, readily gave him a *carte blanche* to prepare a lens. The comparative trial of this lens with the French lens, the reflected light at present in use and the lime-ball light, and the ascertaining of their respective powers in penetrating fog, were the primary objects of the late experiments at Gullan Hill.

In the comparison of the French and British lenses, the first of which is of greenish glass, and that prepared under the directions of Sir David Brewster of flint glass, there was no perceptible advantage on either side, as observed from the Calton Hill, which is distant about 12 miles from Gullan. This result, though contrary to the expectation of some, is yet easily accounted for, by considering that the quantity of light absorbed by glass of a greenish colour, is too trifling to make any appreciable difference in the intensity of the refracted beam. In regard to the comparative trial of the lens light with the reflectors at present in use on the coast, it appeared that the lens, illuminated with a lamp consuming the oil of 14 Argand burners, was fully equal in appearance to the light of 6 or 7 reflectors, each having an Argand burner; but it is to be noticed, that the French lamp consuming the oil of 14 Argand burners if placed in the centre of a system of lenses, would give a light in every direction equal to that of 6 or 7 reflectors. This, however, is chiefly applicable to *revolving* lights, in some of which only 7 reflectors are employed, in others 12, or at most 20, according to their situation. When the Bell Rock light was first exhibited, 24 reflectors were in use.

The light produced by the flame of oxygen and hydrogen gases passing over a lime-ball when exhibited in the focus of a single reflector, was much more powerful than either the lens or reflector when illuminated by lamps. But it also deserves notice, that a single reflector very far surpassed the lens in brilliancy and effect when the lime-ball light was exhibited at the same time in the face of both.

It had farther been suggested that distinguishing lights, similar to those used by the Bengal pilots, might be introduced with good effect into light-houses. Bengal-lights were accordingly procured from his Majesty's stores at Woolwich, on the application of the Light-house Board. At the same time, Mr Stevenson commissioned from London a supply of the nitrates of strontia and baryta, by the combustion of which red and green lights were produced. These were also exhibited from Gullan Hill; but the red light, in so far as the experiments have yet been carried, was chiefly worthy of notice. When this substance was burned in great quantity, it afforded a beautiful flash of light resembling the red light of the Bell Rock light. It is to be regretted, that during these trials, the weather did not afford an opportunity of making observations during fog; but, as before noticed, the experiments are again to be resumed, when we hope to give precise information as to the anomalies of some of these appearances.

ON THE GROUND-ICE OR THE PIECES OF FLOATING ICE OBSERVED IN RIVERS DURING WINTER. BY M. ARAGO.

The severe winter of 1829–30 has attracted the attention of natural philosophers to the phenomena of congelation in *running waters*. They have examined how, and in what manner, immense quantities of ice are formed which some rivers carry down to the sea, and which, on being piled up against the arches of a bridge, often cause fatal accidents. I confess that, in a theoretical point of view, the question does not yet seem, in my opinion, to be exhausted. Is it not a strong reason, then, for my presenting as complete an analysis as possible of the observations to which it has given rise? For want of a definitive solution of so curious a problem, I shall at least have placed before the eyes of meteorologists a complete tabular view of all the data with which it is indispensable that the explanation shall agree.

Every one knows that in a lake, a pond, in every sheet of stagnant water, congelation proceeds from the exterior to the interior. It is the upper part of the surface of the water which is primarily affected. The thickness of the ice afterwards increases in proceeding from above downwards.

Is this the case with *running waters?* Natural philosophers are of this opinion. On the other hand, millers, fishermen, and watermen, maintain that the masses of ice with which rivers are crowded in the winter season, proceed from the bottom. They pretend that they have seen them rise, and have often borne them up with their hooks. They say, in order to strengthen their opinion, that the inferior surfaces of large flakes of ice is impregnated with mud; that it is encrusted with gravel; that, in short, it bears the most unequivocal marks of the ground on which it rested; that, in Germany, the sailors have a peculiar and characteristic term to designate floating ice which they call *grundeis*, *i. e.* ground-ice. Such arguments make little impression on prejudiced minds. It would require nothing less than the evidence of many experienced philosophers to cause a belief in the reality of a phenomenon which seems directly opposed to the laws of the propagation of heat. But it is so. This evidence is not awanting; and if the phenomenon of ice in the bottom of water has only appeared recently as an established fact in treatises on physics and meteorology, the reason is, because their authors generally copy from each other, because every one neglects what his predecessor neglected, and because academical collections, in which many treasures remain concealed, are very seldom consulted.

In 1730, at an atmospherical temperature of —9° centigr. (15°8 Fahr.), Hales *saw* at Teddington, the surface of the Thames, near the banks, covered with a layer of ice one-third of an inch in thickness. There was also at the same time a second layer below, of greater thickness, which followed the depth of the river, as it adhered to the bottom. This sheet was united to the upper one even on the water-side; but it was gradually separated in proportion, as, in proceeding into the river, the depth of the water increased. It was not so solid as the first, and was mixed with sand, and even stones, which the flakes sometimes carry with them in their movement upwards.

This observation is defective, inasmuch as it was made too near the bank. Those who do not know how imperfectly every kind of soil transmits heat, might suppose that the cold was communicated from the dry ground of the bank to that which formed the bed of the river by means of conductibility. It is unnecessary to discuss this difficult point, as it has no connexion with many of the cases which are about to occupy our attention.

It is really surprising that those writers who have lately considered the subject of floating ice in a historical point of view, have not alluded to some observations which were made in France a good many years ago.

At the close of December 1780, the temperature was very suddenly increased in the southern parts of France by a very strong northerly wind. The thermometer sunk to 8° or 7° centigr. below zero. Desmarest, member of the Academie des Sciences, who, at that time, happened to be at Annonay, *saw* the bed of the *Dèome* covered with spongy ice. The frost commenced at first on the margin of the river, where there was a depth of water to the extent of two or three feet. The cold continuing, the ice soon shewed itself in the deepest parts.

In places where the water flowed over the *bare rocks*, Desmarest saw no vestige of ice. On the contrary, it was rapidly formed in great abundance, especially where there was any quantity of gravel: in some parts it was two feet thick.

According to Desmarest, " it was from the lower part which touched the bottom, that the flakes of ice successively increased. . . . . . The ice already formed was continually raised up by the expansive force of that which was in the act of formation. . . . . . In watching its motion, I have seen," said he, " that certain flakes of ice *were raised up* five or six inches in a single night. Some of them were, in consequence of the daily and tolerably equal *under-additions*, believed to form, in this manner, islands of ice, which appeared above the running water."

No one has hitherto corroborated this mode of increase of ice under water. It is to be regretted that Desmarest did not explain the nature of the observation which induced him to come to such a singular result. Had he, for example, deposited on the flakes of the ice at the bottom objects which always remained visible, while, in rising, all the twenty-four hours, the flakes actually approached the surface of the water, it certainly would have been worth while giving an explanation.

When, in consequence of a cloudy sky, the atmospherical temperature experiences little variation throughout the day and night, the ice at the bottom of the water, according to Desmarest, uniformly increases every twenty-four hours. On the contrary, when the sun shews itself, the ice does not increase during the day. The different layers which are produced during the night after an interval of five or six hours of repose, form distinct beds, which are easily disunited. The current then detaches each layer of ice from the lower one, to which it adheres but feebly, and the river begins to carry it along.

M. Beaun, a bailiff at Weld Wilhelmsbourg, on the Elbe, published many dissertations in 1788, in which the existence of ice on the bottom of a river is established, either by his own observations or the unanimous declarations of fishermen, procured after a most anxious investigation.

The fishermen asserted that, during the cold days in autumn, long before the appearance of ice on the surface of the river, the nets which were at the bottom of the water were covered with such a quantity of *grundeis* that they drew them up with great difficulty; that the baskets which were used for catching eels also often on being brought to the surface were encrusted with ice; that anchors which had been lost during the summer again appeared in the following winter, being raised up by the ascending force of the ice at the bottom which had covered them; that this ice raised up the large stones to which the buoys were attached by chains, and occasioned the greatest inconvenience by displacing these useful signals, &c. &c.

These various observations were confirmed by Beaun on his own authority. He says that he discovered, by means of experiment, that hemp, wool, hair, the boiled hair of horses, moss in particular and the bark of trees, are bodies which, on being placed at the bottom of water, are very speedily covered with ice. He declares that various metals do not possess this property in the same degree. According to him, tin occupies the first rank,—iron the last.

Mr Knight, the celebrated botanist, has related an observation in the 106th volume of the Philosophical Transactions, which is the more valuable, as it seems in some respects to afford a clue to the secret of the formation of ice on the bottom of rivers.

" In a morning which succeeded an intensely cold night, the stones in the rocky bed of the river appeared to be covered with frozen matter, which reflected a kind of silvery whiteness, and which, upon examination, I found to consist of numerous frozen spicula crossing each other in every direction, as in snow, but not having anywhere except very near the shore assumed the state of firm compact ice. The river was not at this time frozen over in any part; but the temperature of the water was obviously at the freezing point, for small pieces of ice had everywhere formed upon it in its more stagnant parts near the shores; and upon a mill-pond, just above the shallow streams (in the bottom of which I had observed the ice), I noticed millions of little frozen spicula floating upon the water. At the end of this mill-pond the water fell over a low weir and entered a narrow channel, where its course was obstructed by points of rock and large stones. By these, numerous eddies and gyrations were occasioned, which apparently drew the floating spicula under water; and I found the frozen matter to accumulate much more abundantly upon such parts of the stones as stood opposed to the current, where that was not very rapid below the little falls or very rapid parts of the river. I have reason to believe that it would have accumulated in very large quantities if the weather had continued sufficiently cold; for I had been informed on good evidence, that, some years before, the whole bed of the river in the part above mentioned had been covered over with a thick coat of ice.

"On some large stones near the shore, of which parts were out of the water, and upon pieces of native rock, under similar circumstances, the ice beneath the water had acquired a firmer texture, but appeared from its whiteness to have been first formed of congregated spicula, and to have subsequently frozen into a firm mass, owing to the lower extremity of the stone or rock. Ice of this kind extended in a few places eighteen inches from the shore, and lay three or four inches below the level of the surface of the water, and did not dissolve so rapidly as that which was deposited upon stones more distant from the shores."

On the 11th of February 1816, the engineers of bridges and roads residing at Strasburg, *saw* above the bridge of Kehl that many parts of the channel of the Rhine were covered with ice. About ten o'clock A. M. this ice became loose, rose to the surface, and floated.

The thermometer in the open air stood at — 12° centigr. The water in the river at every depth was at zero cent. The ice at the bottom was only formed in places, however, where there were stones and angular stuff. It was spongy, and formed of icy spicula.

The overseers of the bridge stated that it never appeared on the surface until after 10 or 11 o'clock in the morning.

The canal of Saint-Alban conveys the waters of the Birse through the town of Bale. It is very limpid, and flows with great rapidity. During the winter of 1823, Professor Merian carefully examined the bed of the canal, which, in general, is covered with pebbles, and *saw* that wherever the bottom exhibited any projection, there was a small piece of ice, which might have been supposed, at a distance, to be a reuniting of tufts of cotton. This ice became disengaged from the bottom from time to time, and floated on the surface. It had all the appearance of the *grund-eis* of the German watermen.

M. Hugi, president of the Société d'Histoire Naturelle de Soleure, is the philosopher who, in my opinion, has *seen* the phenomena of the formation of ice at the bottom of water displayed on the greatest scale. His first observations were made in 1827.

From the 2d to the 3d February of that year, the river Aar, at Soleure, was breaking up the ice; on the 15th it was completely open. It flowed slowly on the 16th, and the water was perfectly pure. On this day, in consequence of a westerly wind, a multitude of large icy tables were continually rising from the bottom about 60 or 70 feet below the bridge, and over a surface of upwards of 450 square feet. I ought to add, as this circumstance confirms what Hales was told by the fishermen of the Thames, that the great proportion of the flakes of ice mounted vertically, till 5 or 6 decimetres above the surface of the water, and after remaining a few minutes in this position, they sunk down, and floated horizontally.

After a certain time, the flakes of ice became more scarce; but they had increased to such an extent, that many, though almost vertically raised above the water, still rested in the bed of the river on one of their sides, and in which position they remained stationary for a long time. The phenomenon lasted for about a couple of hours.

Below the bridge, the *Aar flows with rapidity* over an inclined channel of 20 or 30 degrees, and in many places is quite stony. Beyond the place where the flakes of ice arose, the water, already more tranquil, always exhibited *a sort of eddy.*

The temperature of the *air* was —5°.7 centig.; near the water —4°.9; close to the surface of the river, +2°.1. The water near the arches, where there was no ice, was at +3°.0; at the bottom, where the ice ascended, 0°.0.

There is one circumstance which lessens the importance of these observations as to the temperature; it is not established that the ice at the bottom of the river on the 16th February was formed on that day, and these ices might again cover the bed of the river for many days afterwards.

The second series of the observations of Mr Hugi were made in the month of February 1829.

On the 11th of this month, the Aar near Soleure was quite free from ice. For many days the temperature of the atmosphere was from +4° to +6° centigr. During the night of the 11th–12th, it suddenly fell to —14° centigr. On the 12th at sunrise, the river began to exhibit numerous floating pieces of ice. We must by no means omit to add, that the water, either near the banks, or in the shady places where it was perfectly calm, as yet bore no trace of congelation on its surface. It therefore could not be said that the floating masses were detached from the banks. It would have been as unfounded to have supposed that they had proceeded from any large sheet of ice situated farther up the river, as at Altrey, a league and a half above Soleure, the river hardly exhibited any ice. Besides, flakes of ice commenced soon to rise up above the bridge, in the place where they had been seen in 1827. Towards mid-day, islands of ice were seen forming in the centre of the river. On the 13th February these were 23 in number. The largest was upwards of 200 feet in diameter. They were surrounded with open water, resisted a current which almost ran at the rate of 200 feet in a minute, and extended over a space of one-eighth of a league. M. Hugi visited them in a small boat. He landed, examined them in every direction, and discovered that there was a layer of compact ice on their surface of 5 or 10 centimetres in thickness, resting on a mass having the shape of a cone reversed, of a vertical height of 3 or 4 metres, and fixed to the bottom of the bed of the river. These cones consisted of half-melted ice, gelatinous, and very like *the spawn of a frog*. It was softer at the bottom than at the top, and was easily pierced in all directions with poles. Exposed to the open air, the substance of the cones became quickly granulated like the ice that is formed at the bottom of rivers.

When these observations were being made, the temperature of *the air*, at 9 metres above the Aar, was, — 11°.2 centigr.; at

$1^{m}.3$, $-9^{\circ}.4$. That of the water, at 5 centimetres deep, $0^{\circ}.0$; at $1^{m}.8$, $+1^{\circ}.0$; at $0^{m}.5$ from the bottom, $+1^{\circ}.5$; at the bottom, $+2^{\circ}.4$; at 1^{m}. in the ground, $+8^{\circ}.0$.

These determinations of the temperature of the water were obtained in a part of the river which had no ice at the bottom.

M. Fargeau, a distinguished professor of natural philosophy in Strasbourgh, has made some observations on the Rhine, which have been communicated to the Academy. Notwithstanding what we have read, they are very deserving of notice.

On the 25th of January 1829, at 7 o'clock A. M., the temperature of the air, near the bridge of Kehl, was at $13^{\circ}.71$ centigr. At the same moment, in that part of the Rhine, which, owing to the situation of its sand-banks, formed, on the French side, a sort of lake *without currents*, the water of which was at *zero*, but at the depth of $\frac{2}{2}$ *metre* it was $+4^{\circ}.4$. This place had only a few plates of ice near the banks.

Beyond the banks of sand, in a little creek where the shallow water was *contiguous to a very rapid current*, all the pebbles seemed covered with a sort of transparent mass of from 3 to 4 centimetres in thickness, and which, on examination, was found to consist of icy spicula crossing each other in every direction. In this creek the thermometer stood at *zero* cent. both at the surface and at the bottom of the water. It was the same even in the most rapid part of the current. There was also seen, either in the channel of the Rhine, or on some pieces of wood on the side opposite to the current, at a depth of 2 metres, large masses of spongy ice, into which the pole of a waterman entered with ease. This ice, on being borne to the surface of the water, was found closely to resemble the innumerable flakes which were at that time floating on the surface. M. Fargeau states, that he saw ice on many occasions with his *own eyes*, in the greater Rhine, separate from the bottom, and rise to the surface.

M. Fargeau has added an important observation to his own remarks, which was communicated to him, and from whence the result is derived, that the nature of the bed of the river has the same influence on the phenomena of congelation in small and in large currents of water. In the Vosges, a superintendant of forges, informed him, that, to prevent the formation of ice at the bottom of the rivulet which supplied his establishment, he was obliged once a year to remove the stones and other foreign bodies with which the channel became accidentally covered.

In the beginning of February 1830, M. Duhamel, on breaking the ice which covered the surface of the Seine, a short way below the bridge at Grenelle, about 10 feet from the banks, found a layer of continuous ice 4 centimetres thick. He even procured many fragments. At this spot the water was upwards of one yard deep. At every depth the thermometer stood at zero centigr. The current was tolerably rapid.

The experiment of M. Duhamel had this defect, like that of Hales formerly mentioned, of having been made too close to the bank. I could not, however, omit quoting it, as I am not aware of any observation to be found elsewhere by a man of science respecting the congelation at the bottom of the Seine.

It has been mentioned already, that natural philosophers did not believe in the formation of floating ice at the bottom of water; they ought, therefore, not to expect that any thing very important will be found in the sketch I am about to present of the theoretical speculations to which this theory has given rise.

Sailors for the most part believe that the flakes of ice are formed at night on the bottom of rivers, by the action of the moon, and that it is the sun which attracts them to the surface on the following day. Popular prejudices are generally grounded on some imperfect observation. By recollecting what we said concerning the red moon *, we shall easily discover how the strange notion of which I have spoken arose.

The theory of the sailors was not succeeded by an explication in any degree better. It was said that heat arises from the rapid movement of the parts of bodies. The running water flows less rapidly at the bottom than at the top, the maximum of temperature is, of course, found at the surface; it is at the bottom, where there is the least agitation, that the congelation ought to begin. To complete this theory, the ascension of the flakes of ice was attributed to the elasticity which the air dissolved in the water resumes when it disengages itself during the process of congelation, and to the formation, in the midst of the icy mass, of bubbles of considerable size.

* In the Scientific Intelligence of this Number, the reader will find some account of the *red moon* mentioned above.

In 1742, when this strange theory saw the light (*Observations sur les Ecrits modernes*, t. xxxi.), the thermometer was in the hand of every person, and of course it could have been easily ascertained that, during a hard frost, river water is in general colder at the surface than at the bottom. But, as Montaigne says, even in the facts which are laid before them, men willingly amuse themselves in seeking for reasons rather than truth; they abandon things and fly to causes.

To reconcile the theoretical objection which Nollet has made to the popular opinion respecting ice at the bottom of water, with the observations which incontestibly establish that the greater part of the flakes which have been broken up have been immersed for a longer or shorter period, and that their inferior surface rests on a muddy bottom, it has been thought that the origin will be found in the small streams which run into large rivers. There, it is said, the water being shallow, the ice should soon find itself in contact with the ground or mud with which the bed is covered. As to the flakes of ice which rise beneath the water, which sailors bring up with their hooks from a depth of some feet, their existence is explained by remarking, that, after a sharp frost followed by the commencement of a thaw, there is sometimes a great increase, to which a new frost succeeds, so that there is in the river, but especially near the banks, *two layers of ice superimposed at a distance;* the one at the height of the first level of the water, the other at the height which this level has attained on the rise of the water. This theory, which refers to a peculiar case, does not explain, in any point of view, the observations just made, and in which natural philosophers have *actually* seen ice formed on the surface of pebbles placed at the bottom of the water in the beds of certain rivers.

We now come to Mr M'Keever, who, confining himself closely to the most subtle principles of the theory of heat, has not, on this account, been more fortunate than his predecessors.

According to this author, the rocks, stones, and gravel which generally cover the bottom of rivers, have powers of radiation superior to those of mud, perhaps on account of their peculiar nature, but chiefly because they have rough surfaces. Thus rocks, in large or small masses, will become much cooler in consequence of radiation: when the atmospherical temperature is very low, they will, of course, freeze the water which touches them.

It is unnecessary to examine here, whether heat radiates through a thick layer of water, as Mr M'Keever supposes, as the most simple observation is sufficient to overthrow it.

Where is the person who has not observed, that the strong radiation which the Irish philosopher admits, would be more plainly manifested, or as completely, in still water than in running water; but no one has seen a piece of still water frozen at the bottom?

Let us throw aside all these absurd explanations, and, for want of better, analyze perspicuously the physical condition of the question.

If liquids of different densities are thrown into a vessel, the heavy will sink to the bottom, the light keep at the top.

This principle in hydrostatics is general. It applies as well to liquids possessing different chemical properties, as to portions of one and the same liquid whose densities are dissimilar, in consequence of inequalities in the temperature.

Liquids, like all other bodies, solid or gaseous, increase in density as their temperature diminishes.

Water alone, in a *certain small extent of the thermometric scale*, presents a singular exception to this rule. Suppose water is taken at + 10° centigr. and gradually cooled, at 9° we shall find it denser than at 10°, at 8° more than 9°, at 7° more than 8°, and so on till 4°; at this point condensation will cease. In going from 4° to 3° for example, there is a manifest diminution of density. This diminution will go on till the temperature falls from 3 to 2, from 2 to 1, and from 1 to zero. To conclude, water has a maximum of density, which does not coincide with its term of congelation. At 4° above zero is the maximum of density.

There is nothing so simple as to point out in what manner the congelation of stagnant water takes place.

Let us suppose, as is always the case, that at the moment when the wind blowing from the north produces ice, the water throughout to be at + 10°. The cooling of the liquid, by coming in contact with the glacial air, will be affected from the exterior to the interior. The surface which, hypothetically speaking, was at 10° will soon be at 9°; but at 9° the water will possess more density than at 10°; then, in consequence of the principle of hydrostatics formerly mentioned, it will sink to the bottom of the mass, and be replaced by a layer not yet cooled, whose temperature is 10°. That, in its turn, will be affected like the first layer, and so on of the rest. In a greater or less time the whole mass will then be at + 9°.

Water at + 9° will become cool in the same way as at 10° by consecutive layers. Each in its turn, on coming to the surface, will lose one degreee of temperature. The same phenomenon will reappear, with similar circumstances, at 8°, 7°, 6°, and 5°; but, on sinking to 4°, every thing will be changed.

At + 4° (39°.2 Fahr.) water will actually reach its maximum of density. Should the action of the atmosphere take away a degree of heat from the superficial layer, or descend to 3°, the layer will be *less dense* than the portion of fluid which it covers; it will never sink into it. An additional diminution in the heat will not cause it to sink more, as water at + 2° is lighter than at + 3°, &c.

It is quite obvious, however, that the layer in question, by remaining always on the surface, incessantly exposed to the cooling influence of the atmosphere, will at length lose the first 4° of its heat. It will end by falling to zero, and freezing.

The superficial sheet of ice, however singular the phenomenon may be, is then found resting on a liquid mass, whose temperature, at least at the bottom, is 4° above zero.

The congelation of *stagnant water* could not evidently take place in any other manner. I repeat, that no person has ever seen the formation of ice beginning at the bottom of a lake or a pond.

Let us briefly examine the modifications which the motion of the liquid should produce.

The effect of this motion, when it is rather rapid, when it forms eddies, and flows over a rocky or unequal channel, is perpetually to mix all the layers. The hydrostatic order on which we have insisted so much is overthrown. The water, then, which is lightest does not always float on the surface. The currents are precipitated into the general mass, which is thereby cooled, and whose temperature soon becomes equal throughout.

To repeat, in a deep mass of stagnant water, the temperature of the bottom can never descend below + 4° cent. When this mass is in a state of agitation, the surface, the middle, and the bottom, may be found at zero simultaneously.

We have only now to examine, why, when this uniformity of temperature exists, and when the entire liquid mass is at zero, that congelation commences at the bottom, and not at the surface.

But where is the person who does not know, that to produce a speedy formation of crystals in a saline solution, it is merely necessary to introduce a pointed body, or an unequal surface into it; that it is around the asperities of such a body that crystals originate and are promptly increased? Be it so, every one may be assured that this is the case with crystals of ice; that if the mud in which the congelation occurs presents a rent or projection, or solution of continuity of any kind, it will become as so many centres, around which the filaments of frozen water will prefer to arrange themselves.

But is not what we have said exactly the history of the freezing of rivers? This cannot be doubted, if we recollect, that it never takes place in the channel, unless where there are rocks, stones, pebbles, pieces of wood, herbs, &c.

There is another circumstance which seems to have a certain share in this phenomenon, viz. the motion of the water. At the surface this motion is very rapid and irregular; it ought of course to put a stop to the symmetrical grouping of needles; to that polar arrangement, without which crystals, whatever be their nature, can neither acquire regularity of form, nor solidity; it should of course frequently break the crystalline groups, even in their rudimentary state.

This motion, which is the principal obstacle to crystallization, if it exists at the bottom as well as the surface of the water, is at least greatly diminished at the former. It may be supposed, therefore, that its action will merely oppose the formation of regular or compact ice, but will not eventually prevent a multitude of little filaments becoming irregularly blended, and thus produce that kind of spongy ice through which M. Hugi so easily drove the oars of his boat.

Having proceeded thus far, the reader may probably ask why I did not present what preceded, as a complete explanation of the formation of the *grund-eis* of Germany, of the *glaces de fond* of our sailors.—This is my answer.

We have no observations which *prove* that this kind of ice is seen, until the temperature of the whole of the water is at zero. It is not certain that the little icy particles floating on the water, mentioned by Mr Knight, and which may have acquired, by coming into contact with the air, at least on their upper surface, a temperature considerably below zero, do not play an important part in this phenomenon, which I have entirely overlooked; that, viz. of cooling the stones covering the bed of the river, when dragged thither by currents. Is it not possible that these floating filaments were the principal elements of the spongy ice which was afterwards to be formed?

Our theory does not explain in what manner this ice, once formed, only increases in a downward direction. If the remark of Desmarest be correct, there is something wanting to complete it.

During the congelation of the bottom of the Aar, at the place where the ice was formed, M. Hugi immersed pitchers filled with hot and cold water. The *first*, he says, on being brought up, was covered with a layer of ice of one inch thick, the other had no marks of congelation. Bullets covered with cloth, warm as well as cold, afforded similar results.

These remarkable experiments cannot be kept out of view. They ought to be repeated in a variety of ways: we should be sure whether these two bodies, on being immersed, do not differ but in temperature; that their surfaces are equally polished; and if, after all the minute precautions with which an able philosopher is sure to avail himself, it be found that the body, *originally hot at the moment of immersion*, is covered, as we are assured by M. Hugi, with more ice than the cold one, it will perhaps be necessary to attribute this singular phenomenon to the internal movement of the liquid; to currents which, being caused at first by the presence of a hot body, still continued after it became cold; to currents which incessantly continued to throw over this cold body filaments frozen on the surface.

Before coming to the conclusion, that the question which we have been discussing is completely solved, it would be necessary to subject the texture of the ices at the bottom to additional experiments; we must ascertain accurately whether the vesicular cavities, which traverse it in every direction, contain any air,—

or if they are completely empty,—for this circumstance is very necessary, in order to enlighten us as to the place where they originate.

I am expatiating, however, beyond my plan. I at first merely wished to examine, whether the floating ice was produced at the bottom or the surface of a river. This question can no longer be doubted. The theory is far from being so far advanced. I have pointed out the chasms which it still exhibits. If the recital of these cases can in any way contribute towards their being speedily filled up, I shall be amply recompensed for my trouble.—*Annuaire pour l'An* 1833.

ON THE ADVANTAGES OF A SHORT ARC OF VIBRATION FOR THE CLOCK PENDULUM. *By Mr EDWARD SANG. Read before the Society for the Encouragement of the Useful Arts in Scotland, 6th February* 1833.

A LONG intercourse with persons engaged in all the departments of machine-making has brought before me many erroneous ideas. At first I contented myself with exhibiting their fallacy as I met with them, but continued experience has convinced me that a systematic and public exposure of their nature would be of advantage to engine-makers. Following up that conviction, I have projected a series of papers, two of which are already before the Society of Arts. In this, the third one, it is intended to exhibit the impolicy of long sweeps for clock pendulums, and to correct that taste which renders such movements more saleable.

In these papers, of course, I do not offer my remarks to those who, with laudable zeal, have possessed themselves of a complete knowledge of the subjects. Intended for those only whose inattention, or whose want of opportunity, has prevented the acquisition of such knowledge, these remarks can hardly claim the notice of the initiated, unless, on the simple ground, that they tend to remove that barrier which separates scientific from practical men. Prevented from employing the refined and powerful methods of modern analysis, or even from adverting to the truths presented by the simple sciences, I am reluctantly compelled to combat error by assertion, and to attempt the removal of one prejudice through the agency of another.

In the present case, it would be vain to introduce an investigation of the law of motion in circular arcs, since no horologist who is able to follow that investigation can be partial to the long sweep. Among those who are unable to follow it, an indistinct belief prevails that the motions of the pendulum may be subjected to calculation: neither that calculation indeed, nor the principles on which it is founded, have they subjected to examination; but then the idea of applying the pendulum to the measurement of time was first entertained by one profoundly skilled in science,—the balance-spring, the fusee, and the compensations for thermal expansion, were all results of scientific research; and it may not be impossible, say they, that, from the same mysterious source, an exact knowledge of the influence of long and short arcs on the going of a clock, may be obtained. And thus, although they do not fully appreciate the force of theoretical results, they are yet not prepared to contradict them. Such is the kind of argument to which I must appeal in support of the statements I am about to make.

If, when the pendulum of a clock is making exceedingly minute vibrations, it be adjusted to true time, and if the arc be then lengthened, the duration of the beat will be increased also. At first, this increase will be exceedingly minute, but as the arc enlarges itself, the interval between two beats will augment more and more rapidly, until the slightest change on the arc of vibration will produce a sensible effect on the clock's going. I have computed and arranged, in the annexed tables, the exact amounts of the changes corresponding to each of the first twenty hundredth parts of the semicircle; by the help of these tables, we are enabled readily to compare the performances of pendulums with long or short sweeps.

Suppose that we had a clock regulated to true time when its pendulum swept an arc of twenty centesimal degrees on each side of the vertical line, and then let the maintaining power, on account of the thickening of the oil, or from any other cause, be reduced by one-twentieth part, the pendulum will, keeping no account of the resistance of the air, vibrate only 19 degrees on each side, and its daily rate will therefore be accelerated 52″235.

Conceive now, that, by an augmentation of the weight of the pendulum, and a consequent increase of friction on the knife edge, the maintaining power becomes sufficient for a sweep of only one degree on each side of the vertical line; and, having again adjusted the clock to go in true time, let the same diminution take place in the maintaining power, the arc of vibration will then be contracted to 19-20ths of a degree on each side, while the daily rate will experience an acceleration of 0″130, or rather less than the 400th part of the former.

When we consider, then, the mere action of gravity, the superiority of the heavy pendulum with the small arc of vibration, over the light pendulum with the long sweep, is obvious; the variation in the state of the oil, and the other inequalities of the escapement exerting less influence on the former in a ratio duplicate of that of the arcs of vibration.

That part of the error of a clock's going which arises from variations in the buoyancy of the air, attaches alike to all pendulums of the same material; but that part which arises from the variable resistance of the atmosphere is much less felt on the heavy pendulum. Returning to our former case, the velocity of the heavy pendulum will be twenty times less than that of the light one, so that the resistance of the air on a given extent of surface will be 400 times less; the quantity of surface, however, is 7368 times greater, while the distance through which the resistance acts is 20 times less, so that, in all, the influence which that resistance exerts in counteracting the maintaining power is lessened 1085 times; and hence that irregularity in the going of the clock, which arises from the variable resistance of the air, will be less 400 times 1085, or upwards of 400,000 times.

On account of the increased weight, the friction on the knife-edge is increased twenty times, while the distance through which it acts is diminished as often, so that, in the case of the heavy pendulum, the friction on the knife-edge interferes with the maintaining power just as much as in the case of the light one; variations, then, in this friction, will only produce the 400th part of the disturbance on the clock's rate when the heavy pendulum is used; the edge, however, will require to be somewhat strengthened, so that this circumstance will interfere a little with these proportions.

The retardation of a clock, when the arc of vibration of its pendulum is increased, is by no means so trifling as is generally imagined; the table, I am convinced, presents results much greater than were anticipated by many, even of those who are conversant with the subject. In the formation of the table, I have taken every precaution to insure accuracy, having carried the logarithms to ten decimal places, so long as I adhered to the decimal division, and employed the ordinary tables to seven places only, in passing from that to the ordinary division of time. These circumstances, joined to that of its being new, will render it acceptable to men of science.

These statements may be confirmed by a very simple but beautiful experiment. Having suspended a leaden ball by means of a slender thread, let this simple pendulum be put in motion, so that the ball may describe a curve known to bear a considerable resemblance to the ellipse. If the times of vibration along the two axes of this curve were exactly equal to each other, the ball would repeatedly retrace the same orbit; but these times of vibration are different, and, during the passage from end to end of the long axis, the ball has more than returned to its position in reference to the short one, so that the axes of the orbit are gradually displaced in the direction of the movement of the ball. This displacement will be found to be most rapid when the orbit is large; as that orbit gradually contracts, the displacement of the axes becomes more and more retarded, until, when the evagations do not exceed three or four degrees, it ceases to be perceptible.

To these remarks on the advantages of pendulums with short arcs of vibration, it must be added, that great practical objections lie against their being made very small; these objections, however, are founded on the peculiar natures of the escapements generally used, and, perhaps, derive additional strength from the reluctance to depart from long established, although arbitrary, rules. The beautiful escapement which lately gained the Society's highest prize, when applied, with proper precautions, low down on the pendulum rod, obviates all these objections, and offers the prospect of immense improvements in time-keeping. A movement on this plan is already in a state of forwardness, and I shall take pleasure in reporting to the Society the results of experiments made with it.

TABLES.

Half Arc.	Time of Vibration.	1st Difference.	2d Difference.	3d Diff.
.00	1.00000 00000	0154215	308455	080
.01	1.00001 54215	0462670	308535	129
.02	1.00006 16885	0771205	308664	185
.03	1.00013 88090	1079869	308849	235
.04	1.00024 67959	1388718	309084	289
.05	1.00038 56677	1697802	309373	341
.06	1.00055 54479	2007175	309714	394
.07	1.00075 61654	2316889	310108	447
.08	1.00098 78543	2626997	310555	501
.09	1.00125 05540	2937552	311056	554
.10	1.00154 43092	3248608	311610	611
.11	1.00186 91700	3560218	312221	658
.12	1.00222 51918	3872439	312879	720
.13	1.00261 24357	4185318	313599	769
.14	1.00303 09675	4498917	314368	830
.15	1.00348 08592	4813285	315198	879
.16	1.00396 21877	5128483	316077	942
.17	1.00447 50360	5444560	317019	992
.18	1.00501 94920	5761579	318011	
.19	1.00559 56499	6079590		
.20	1.00620 36089			

Half Arc.	Log. Time of Vibration.	1st Difference.	2d Difference.	3d Diff.
.00	.00000 00000	0066974	133953	017
.01	.00000 66974	0200927	133970	024
.02	.00002 67901	0334897	133994	036
.03	.00006 02798	0468891	134030	049
.04	.00010 71689	0602921	134079	055
.05	.00016 74610	0737000	134134	067
.06	.00024 11610	0871134	134201	079
.07	.00032 82744	1005335	134280	087
.08	.00042 88079	1139615	134367	100
.09	.00054 27694	1273982	134467	108
.10	.00067 01676	1408449	134575	122
.11	.00081 10125	1543024	134697	128
.12	.00096 53149	1677721	134825	143
.13	.00113 30870	1812546	134968	150
.14	.00131 43416	1947514	135118	166
.15	.00150 90930	2082632	135284	170
.16	.00171 73562	2217916	135454	188
.17	.00193 91478	2353370	135642	193
.18	.00217 44848	2489012	135835	
.19	.00242 33860	2624847		
.20	.00268 58707			

Half Arc.	Excess of Apparent above true Day.			Clock's daily Retardation.		
.00	000.000″	1.332	2.666	000.000″	1.332	2.666
.01	1.332	3.998	2.665	1.332	3.998	2.663
.02	5.330	6.663	2.667	5.330	6.661	2.666
.03	11.993	9.330	2.669	11.991	9.327	2.664
.04	21.323	11.999	2.670	21.318	11.991	2.664
.05	33.322	14.669	2.672	33.309	14.655	2.664
.06	47.991	17.341	2.678	47.964	17.319	2.664
.07	65.332	20.019	2.678	65.283	19.983	2.664
.08	85.351	22.697	2.682	85.266	22.647	2.663
.09	108.048	25.379	2.690	107.913	25.310	2.662
.10	133.427	28.069	2.691	133.223	27.972	2.663
.11	161.496	30.760	2.698	161.195	30.635	2.661
.12	192.256	33.458	2.704	191.830	33.296	2.662
.13	225.714	36.162	2.708	225.126	35.958	2.661
.14	261.876	38.870	2.717	261.084	38.619	2.660
.15	300.746	41.587	2.723	299.703	41.279	2.659
.16	342.333	44.310	2.731	340.982	43.938	2.660
.17	386.643	47.041	2.739	384.920	46.598	2.658
.18	433.684	49.780	2.748	431.518	49.256	2.657
.19	483.464	52.528		480.774	51.913	
.20	535.992			532.687		

32, St Andrew Square,
24th Jan. 1833.

ON DWARFS AND GIANTS. *By M. Geoffroy St Hilaire* *.

Let us examine the first class, of the vast group of hemiteries, or simple anomalies in the animal kingdom, viz. that which relates to the anomalies of size. They may be *general* or *partial*, consist either in a *diminution* or *augmentation*. Those by general diminution of size peculiarly constitute dwarfishness, which ought to be accurately distinguished from deviations in the spinal column, or deformations in the members. In the latter case it is disease, and not anomaly in the sense which is here attached to it. In truth, a pigmy is, in teratology, a being all of whose parts have undergone a general diminution, and whose height is also much inferior to the average height of its species or race.

M. Geoffroy finds dwarfs mentioned in the most ancient authors; he sees them every where exciting the curiosity of the learned, and serving as an amusement to the powerful. The practice was so general in the early ages of the Roman Empire, that merchants are said to have conceived the horrid idea of producing artificial dwarfs by means of boxes and bandages. The story of Jeffrey Hudson, who, at eight years of age, was served up in a pie to the Queen of England, Henrietta-Maria of France, wife of Charles I.; that of Nicolas Ferry, known by the name of Bébé, dwarf to Stanislaus, Duke of Lorraine; and of Polonais Borvilasky; and also many others, afford exceedingly curious details. What is important to be noticed here, is the great variety, in a moral as well as physical point of view, which exists among dwarfs. Some are almost idiots, pass from infancy to old age, and die prematurely—like Bébé, who died when twenty-two years and a half old; others, like Borvilasky and Hudson, have exhibited much intelligence, and reached a good old age. A young Austrian female, who died in England, was worthy of the following epitaph, in consequence of her abilities: "To the memory of Nannette Stocker, who quitted this life the 4th of May 1819, at the age of thirty-nine years, the smallest woman in this kingdom, and one of the most accomplished." She was an excellent musician, and not more than thirty-three inches high. There, however, exist traits common to dwarfs,

* *Vide* Histoire Generale et Particuliere des Anomalies de l'Organisation chez l'Homme et les Animaux, par M. J. G. St Hilaire.

which characterise them. Like men of small stature, they are generally irascible, lively, and impetuous, of which the following anecdote is an instance. A lady of the Court of Stanislaus was caressing a dog in the presence of Bébé; in a fit of frenzy he snatched it from her, and threw the animal over the window, crying out, "Why do you like it better than me?" The greater number of dwarfs have short legs, a large head, a disagreeable countenance, and a ricketty constitution. They are incapable of generating, either with those of their own size, or individuals of an ordinary stature. They are very often the offspring of mothers well shaped, of lofty stature, and very prolific. In the greatest number of instances, it has been observed that the same mother has produced two or more dwarfs. They are not more rare in nations of lofty stature, or of one sex, more than another. Dwarfishness with regard to age may present three cases. In the first, the individual exhibits at birth, or during infancy, a size inferior to that of his age, and afterwards grows up rapidly to the ordinary size of his species. In the second, he is born and developed normally at first, then, ceasing to increase, retains a stature for the remaining part of his life, inferior to that of the adult. In the third, he is born a dwarf, and presents, at every stage of his existence, a stature very inferior to that of his age. Dwarfishness, then, may be temporary or permanent.

Without dwelling on the hypothesis of the ancients, who attributed the production of dwarfs to a defect in the quality or quantity of the semen, M. Geoffroy considers the explanation of the moderns much more satisfactory, who regard it as the result of an obstacle opposed to the nourishment and development of the fœtus, either from a faulty conformation in the mother, or by a disease attacking the young subject in the course of its fœtal or embryo life. The stoppage in growth observed in infants or young animals, in consequence of a deficiency of nourishment, or bad health, seems to strengthen this opinion, which the ricketty constitution of dwarfs confirms in other points of view. Besides, it is observed that among animals, who rarely present any examples of being ricketty, dwarfishness is very rare.

After discussing dwarfishness and tardy growth, M. Geoffroy treats of general augmentations in size—of Giants, and the precocious increase of stature. Though works upon giants are very numerous, their history is not so far advanced as that of dwarfs. The reason is, because their existence has been discussed more than studied; because they were more rare than dwarfs, and been more seldom used as playthings. Antiquity and the middle ages concur in the existence of men of an extraordinary height. Many philosophers have even been of the opinion that great nations, nay, that the whole of mankind, were originally of a gigantic height, which has gradually diminished down to the present time. According to the calculations of Henrion, the Academician, in 1718, Adam was 123 feet 9 inches high, Noah a little more than 100 feet, Abraham 80, Moses 30, Hercules 10, Alexander 6, and Cæsar less than 5. It is well known that the mythologies of almost every nation are founded on this belief. As the principal evidence of these assertions, the discovery of human bones of large dimensions has been quoted: such as those found in Sicily, near Trapani, in the fourteenth century, and which belonged to a Cyclops of 300 feet high, evidently Polyphemus; those of Teutobochus, King of the Cimbri, found, during the reign of Louis XIII., in Dauphiny; besides a great many which are cited by ancient and modern writers. But the researches of Cuvier in ancient zoology, and the rapid progress of comparative anatomy, have established beyond doubt, that these gigantic bones are merely those of the elephant, mastodon, rhinoceros, or cetaceous animals, shells of tortoises, or hydrocephalous skulls.

The Bible has been finally adduced, where it is mentioned that giants were born in consequence of the intercourse of the sons of God with the daughters of men; many other passages have been brought forward, especially the history of Goliah. The Hebrew word, however, which is rendered *giant*, also signifies a *violent* or *cruel* man. As to Goliah who was vanquished by David, he was not, according to calculations which have been made, more than seven or eight feet high, a stature which is sometimes met among men. The other instances do not present any thing conclusive. It is even the same with those furnished by profane writers; all these are owing to exaggeration, folly, and credulity.

On the other hand, it seems established that human stature never exceeded eight or nine feet. These extreme examples are very rare, but men of six or seven feet are not.

Giants, like dwarfs, are almost always limited as to intellect; some of them are even idiots. They are, moreover, destitute of energy, activity, weak in body and mind, of a lymphatic temperament and delicate complexion, and of a bad conformation. Throughout their whole life they even retain a part of the exterior characteristics and traits of infancy. It is said, that at Vienna, where giants and dwarfs had been collected for the amusement of the Court, the latter incessantly ridiculed the former, and that, in a quarrel between two of them, the dwarf remained master of the field of battle. Giants, moreover, like dwarfs, are impotent, and equally so in both sexes, though less remarkable among females. Giants are still more uncommon among animals than dwarfs. The former, in general, die at an early age, worn out, as it were, by their enormous and rapid increase. They are found among nations of the most opposite characters, but generally among those of a considerable stature. They seem to be born of very prolific mothers, and are rarely the only tall individuals in a family. The causes of a gigantic stature are obvious: an abundant and enervating nourishment, a more flexible organization, a weak circulation, seem greatly to favour it. Berkeley, Bishop of Cloyne, made an experiment on an orphan, called Margrath, of whom it is only known that, on reaching the height of seven feet eight inches, he died—an old man at twenty years of age.

In those of a gigantic stature, there is a positive increase in the human stature; but this can only depend upon age and time. M. Geoffroy here insists with propriety on the distinction which ought to be established between growth and development. The first arises from the gradual augmentation of each of the parts of a body, independent of any change in their number, structure, and functions. Development, on the contrary, consists in a modification,—in a change more or less manifest. The appearance of the teeth of the first dentition, that of the permanent teeth, and lastly of puberty, indicates, in man and the upper animals, three principal epochs of development to proceed, from each of which the general increase commonly diminishes in a manner more or less marked. The connection between growth and development is very curious. If the first be precocious, the second also begins too soon. Thus, we have seen the appearance of teeth precede the birth in a large fœtus; we have also seen an infant of eighteen months old, remarkable for its appetite and rapidity of growth, afford at that age evident symptoms of puberty. If the latter development have commenced, that of the genital organs rapidly advances, and soon becomes complete; all general increase ceases; and the individual in which it takes place may remain of ordinary stature, or even very small, though not weak and impotent on that account. If, on the contrary, the development having begun, goes on slowly, and remains unfinished, those circumstances may take place: either the general increase stops, and the individual remains dwarfish and impotent; or this increase continues for a long time, and the individual becomes a giant, and equally impotent; or lastly, both the development and growth terminate at an age much more advanced. What has been said of the respective weakness of dwarfs and giants is quite in accordance with these considerations. They also apply to what has been seen in children remarkable for the precocity of their growth and of their puberty; their manly exterior, deep voice, their squat and robust forms, prove that the physical development is as complete in them as in the adult. It is different as to the moral development. These men of three, four, five, or six years of age, have the tastes and dispositions of infancy. Here, then, it is shewn that the general diminutions and augmentations of the stature are merely phases, more or less long, of the *loi d' alternative* between the growth and the development of the organs.

M. Geoffroy, to these considerations on the individual anomalies of stature, has given a sketch of the most striking facts which study presents of the variations of stature in the human race and in the lower animals. The normal stature of a race is necessarily the medium height of the individuals which compose it; and the normal stature of the species is the average height of the races which it comprehends. Races which are extremely high or low may be considered as anomalies produced, by the excess or deficiency of their development, as gigantic and dwarfish races. But we must now inquire, if the causes which have produced these races are of the same nature with those which produce individual giants and dwarfs, or rather, if the type of the species was not originally greater or smaller than the numerous races of the average height which exist at this moment. Inheritance is here a datum of the problem now first mentioned, and which renders the difficulty more complicated.

The species of savage animals, subjected to the action of modifying causes less numerous and powerful than those which affect domestic animals, do not ordinarily present very distinct or constant varieties in their sizes; each species only forms a single race, composed of individuals closely resembling each other. On this subject, M. Geoffroy recapitulates the researches which he has made into the general variations in the height of mammiferæ in a wild state. They have a reference to the medium in which they live, the food which they eat, and the places which they inhabit. The species which live in the bosom of the water reach a greater height than those of the same family who are terrestrial; and those, in particular, who live in trees, and are adapted for flight. Among the mammiferæ who live on land and on trees, the herbivorous are in general the largest; then the carnivorous; the frugivorous, who are all of an ordinary size; and the least are the insectivorous. Throughout, we behold an admirable harmony between the height, the size of these animals, and the food afforded them by nature. Similar relations appear in the winged mammiferæ. To the marine mammiferous animals, the law does not hold good. As to those which dwell in inhabited places, nature has on every occasion proportioned the size of the localities which should receive them; reserving the big species for the seas, the large islands, and continents, and the small ones for the rivers, lakes, and small islands. The greater part of the large mammiferæ inhabit the hottest countries; others in smaller numbers multiply in the cold regions; but no family has its large species in temperate climates.

It is a fault that some authors have drawn inferences from savage to domestic animals and man; and reciprocally. So far as height is concerned, domestic animals present many singular variations, which most frequently belong to many individuals, are transmitted in a regular manner, and being continued by means of generation, serve to characterise the races. These variations are often the more considerable, as the domesticity is the more ancient and complete. Climate, more or less care, nourishment, abundant or scarce, have, besides, a great influence. The dog, an old companion of man, infinitely less independent than the cat, also presents many more races of different sizes. The horse presents upwards of thirty races, all very different as to their height, shape, and nature of their skin. The ass also presents many varieties. In Arabia, Egypt, in Persia, where-ever it is as well fed and taken care of as the horse, it is almost its rival in size, beauty, and strength. It is well known why it is small and ill-made in the greater part of Europe, and especially in cold countries. What a striking proof of the power of man to ameliorate or degrade the animals whom he has reduced to a state of servitude! As to the sheep, though reduced from the earliest ages to the most complete state of domestication, it has, throughout the most numerous races, almost constantly preserved the same height. Domestic birds, with the exception of the cock, differ little from the wild species. As to the lower animals, especially fishes, the variations in size are not hereditary; they seem accidental, and to depend principally on the quantity and quality of their food. The numerous researches of M. Geoffroy on the variations of stature in domestic species, have led him to the following propositions.

The domestic species may be divided into two groups, those whose races have all the same height, or nearly so, and those which consist of very large and very small races.

In the first case, the height of the races or varieties cannot be different from that of the wild type; it may also present a difference of size, less or greater; this difference, however, is always very slight.

In the second case, there are some domestic races existing much larger, and others much smaller than the wild type; but the medium height of the domesticated races, a height which is found exact, or almost so, among many of them, hardly differs, or does not differ at all from the wild type.

In the human species, the relation as to height is not as in domesticated animals: individuals vary greatly, races very slightly. The length of the body of the smallest dwarfs, is to that of the greatest giants as one to a fourth; whilst the average height of the smallest race, and that of the greatest, is only as one to one and a half. In fact, the smallest dwarfs are little more than two feet high, and the tallest giants a little more than eight feet and a half. On the other hand, the average height of the Esquimaux, and mountaineer Boschmen, is a little more than four, whilst that of the Patagonians is about six feet. If travellers have differed much as to the height of these Patagonians, some calling them thirteen feet high, while others have attributed an ordinary height to them, it not only arises from a love of the marvellous, but a mistake, produced by a mixture which exists south of the La Plata, of many nomadic tribes, some of whom are very tall, and others of an ordinary stature.

It has been discovered, with a few exceptions, that all the people remarkable for their small stature inhabit the northern hemisphere, in the most northerly part of it, and that those who are of great stature generally live in the southern hemisphere, some on the continent of South America, others in the archipelagoes of the Pacific Ocean, from the eighth to the fiftieth degree of south latitude. On an attentive study, however, of the geographical distribution of the human race, we come to this curious result,—that people of small stature live almost always near the tallest nations, and, on the other hand, those of a high stature near nations peculiarly distinguished for their diminutive growth. Thus Terra del Fuego, near Patagonia, is inhabited by short and ill-made men; and the people of Sweden and Finland, which border on Lapland, are above the middle height. The influence of climate is without doubt incontestable; an acute cold is unfavourable to the development of height, whilst a moderate degree is favourable. The preceding example may tend to prove it.

Climate, however, is not the only active cause. Regard must be had to food, more or less abundant, to severe or easy labour. Misery and fatigue, not less than excessive cold, prevent the development of the body; on the other hand, ease and good living are favourable to it. It is also necessary to pay attention to the difference of the races, which connects itself with the conditions of the original type. Thus the Malayan is generally larger, and the Mongolian smaller, than the Caucasian and American races; each of them possesses a tendency constantly to reproduce with the same characters, a tendency so much the more evident, as the race is more ancient, which applies to man as well as the lower animals. But the unchangeableness and stability of the principal human races, lead one to draw inferences as to the high antiquity of their original formation. The learned and ingenious physiologist Mr Edwards, has shown what valuable assistance history may draw from such considerations, in establishing the genealogy of nations.

We have already spoken of the idea, so widely spread, of the decrease of the stature of the human races. This opinion, which is unanimously received, might easily have been propagated by one and the same people, and in that case unanimity proves nothing. Antiquity, besides, believes also in pygmies, and according to the principle of authority, it might be as reasonably maintained, that the stature of man has increased. Neither the remains of the human fossil bones recently discovered in many places, and which appear to be of very high antiquity, have belonged to men of other than an ordinary height, nor the ancient monuments, tombs, utensils, arms, paintings, nor the mummies of Egyptians, exhibit any sensible variation in the human stature for four thousand years. Beyond this remote epoch, monuments disappear, and we have only analogy to guide us. But if, as is quite certain, the changes produced on man by civilization, are completely analogous to those which domestication produces on animals, and if we recollect that the average of the height of the former is equal to that of their savage types, it will be admitted, which is confirmed in other respects by what we know of tribes which are not savage, that the average height of civilized men of the present times, differs very slightly, not only from those of the civilized men of ancient times, but also from those of men living in a savage state before any civilization.

M. Geoffroy afterwards proposes to show, as to races of giants and dwarfs, that there is a real analogy between their formation and that of the individual anomalies which they present.

Many travellers, Peron in particular, have mentioned a fact which is worthy of notice, viz. that savages, far from being stronger than civilized people, are weaker; an additional proof that civilization is beneficial to the destiny of human nature, and that the *state of nature*, of which Rousseau, in his disgust at a corrupt state of society, has formed an ideal felicity, is far from bringing us in contact with physical perfections. Every thing demonstrates, that man is sociable, and in a progressing state; but this progress is often shackled, his sociability rendered tortuous by individual egotism, and by the vitious nature of our institutions.

ON THE HOT SPRINGS OF THE CORDILLERAS OF THE ANDES.

At the meeting of the Academy of Sciences of France held on the 18th March 1833, M. Boussingault read a memoir on the temperature of the hot springs of the Cordilleras of the Andes. The theory originally proposed by Laplace to account for the heat of those springs, and which is grounded on the supposed existence of a high temperature in the interior of the earth, seems confirmed by a multitude of phenomena presented at various points of the Cordilleras. Thus, on the coast chain of Venezuela, the temperature of the hot springs diminishes as the absolute height increases. For instance, the hot spring of Las Trincheras, near Puerto Cabello, and which is situated nearly at the level of the sea, has a temperature of 97° cent.; that of Mariara, at a height of 476 metres, has only a temperature of 64° cent.; and that of Onato, which has an elevation of 702 metres, has only a temperature of 44°.5 cent.

But in the trachytic formation, especially in the vicinity of volcanoes, this regular decrease in the temperature of hot springs does not present itself; and it seems that in such cases the local cause producing the volcanic action has a marked influence on the temperature of the waters. It becomes, then, extremely interesting to determine if these hot springs have their origin near the seats of volcanic action. In order to solve this question, it is necessary to submit to chemical examination the hot waters occurring near volcanos, particular attention being paid to the nature of the gases they may contain. If these gases should prove to be the same which are recognised in active craters, we would obtain a strong argument for believing, that the water of hot springs has been in contact with the substances occurring in the sources of volcanic eruption. The determination of the saline substances contained in mineral waters would thus gain a new degree of importance, as these salts must then be considered as the soluble products which exist or are formed in the interior of volcanos. Such are the various considerations which induced M. Boussingault to undertake the analysis of the hot springs he has met with during his travels, and the memoir read to the Academy presents the results. The conclusion drawn from the numerous analyses performed is, that the gases accompanying the hot springs, which have their sources near volcanos, are identical with those of the craters of the same volcanos, viz. carbonic acid and sulphuretted hydrogen gases. It is then probable that the hot waters of the trachytic formation of the equator owe their elevated temperature to subterranean fire, and it is equally natural to believe, that the salts dissolved in these waters are derived from the interior of volcanos. Before terminating this memoir, the author examines the question as to the variation of temperature of the hot springs he investigated. In 1800, M. de Humboldt found the temperature of the *Mariara spring* to be 59°.3 cent. In 1823, M. Boussingault and M. Rivero found the thermometer in the same spring rise to 64° cent. A difference so considerable, viz. of 5°.3 cent., cannot be attributed to an error in the instrument, especially as the thermometrical observations made by those gentlemen at La Guayra and Caraccas accord perfectly with those made in the same towns by M. de Humboldt. It is more to be feared that as the spring of Mariara forms a considerable stream, the observations may not have been made precisely at the same point, although in general an observer who determines the temperature of a hot spring endeavours to find the spot where the hot water is hottest. But the objections which can be raised to the observations made at the Mariara spring are quite inapplicable to those made at the spring of *Las Trincheras*, near *Puerto Cabello.* At Las Trincheras, the water issues from two basins which lie close one to the other, and are hollowed in granite. The larger basin has a capacity of about two cubic feet. M. de Humboldt gives 90° cent. as the temperature of the water of Las Trincheras. Twenty-three years later, Messrs Boussingault and Rivero found the temperature of the water in one basin to be 92°.2 cent., and that of the water of the other 97° cent. Their observations, like those of M. de Humboldt, were made in the month of February. It appears, therefore, that in the short period of twenty-three years, the springs of *Mariara* and *Las Trincheras* have received an addition of several degrees to their temperature. It is remarkable that during the interval between the travels of M. de Humboldt and Messrs Boussingault and Rivero, Venezuela was visited by the earthquake of the 26th March 1812, which destroyed the town of Caraccas, and indeed all the towns situated on the eastern Cordillera, and caused the death of upwards of 30,000 individuals.

PROCEEDINGS OF THE LATE DR ALEXANDER TURNBULL CHRISTIE IN INDIA,—*as stated in a Letter dated Madras September* 1832.

I SHALL now give you an outline of my proceedings since I left Bombay. I went by sea down the coast to Mangalore, and thence by way of Cannanore, Tillicherry, and the Wynaad, to the Neilgherry Hills, through a most beautiful country, where I made a fine collection of birds, reptiles, and fishes, and observed some interesting geological phenomena. The Neilgherries between the latitudes of 11° and 12°, and rising to the height of nearly 9000 feet above the level of the sea, enjoy every variety of climate, from that of the plain of India to that of England. The climate of the higher parts resembles that of the great intertropical cities of America, which have become the centres of civilization in the new world; but is superior in one point of view, being never subject to those sudden changes and cold piercing winds, which are occasioned by the vicinity of lofty mountains, some of which are capped with snow. The mean temperature of Ootacamund, the principal station on the upper part of the hills, is rather more than that of London, but its annual range of temperature is very small. It may be said, that the season of spring reigns throughout the year, yet though there be no winter, the heat is never sufficiently great to bring the more delicate European fruits to perfection, and at this height we can only expect the successful cultivation of corn and of *vegetables*. The valleys, which have a height of from 5000 to 6000 feet, enjoy the climate of Italy, the climate of the vine, the orange and the mulberry. The tea tree is cultivated in China between the latitudes of 27° and 31°, generally in a hilly country, and consequently in a climate probably of 70° to 73° of mean temperature. Such is nearly the mean temperature of the valleys in the neighbourhood of Kotagherry, and of many others along the Eastern and Northern faces of the hills. The cultivation of this valuable plant might therefore be attempted here, and with a much better chance of success than in almost any country beyond the limits of China. A little lower down than this, coffee might be produced, its native habitation being on the sides of the lofty mountains of Yemen, and nearly in the same latitude as the Neilgherries. In these delightful regions I am going to establish my head quarters, and shall only make excursions to the low country during the cool and healthy season.

After having remained four or five weeks' on the Neilgherries, where I met with much attention from the Governor, I came to Madras by way of Trichinopoly, Tanjore, (where I saw my friend George Bell's brother), Cuddalore, and Pondicherry. The geology of that tract of country is not very interesting, and for some time I have been principally engaged with meteorology.

Since I came here, I have had an unpleasant attack of my old enemy the diarrhœa; I am now, however, quite well, and anxious to get out of this hot place, and back to the fine climate of the mountains. The Governor has offered me a grant of land there, and I believe I shall take a few acres, to be increased hereafter if I choose. I intend to try the cultivation of coffee, which is now produced equal to Mocha coffee, in considerable quantity in Mysore, and affords a very large return, notwithstanding it has to pay a duty, on account of being the produce of a foreign state. But do not suppose I am going to enter into any speculation, for I intend to run no risk, and my farming operations will be an *amusement* to me while on the hills. I intend to begin on a very small scale, and while my coffee trees are coming up, I intend to raise vegetables, and particularly potatoes, from the same ground, which I expect will prevent me sustaining any loss by those agricultural experiments. I may only mention, that the expenses of cultivation on the Neilgherries will not amount to 10 rupees per acre, carriage of potatoes to Madras or Bombay will cost about from 6 to 8 rupees a candy of 500 pounds; and at these places they sell for 2 rupees a maund of 25 ℔. An acre will produce, I suppose, from 15,000 to 20,000 ℔. A common gardener, who had a few acres of ground on the hills, went home a few years ago, after a residence there of six or eight years, with L. 6000.

I have written some instructions for making meteorological observations which the Government are now publishing, and intend to distribute at the principal stations throughout this presidency. They have also written home for twenty-five sets of meteorological instruments which I recommended, and I hope, that, in less than another year, an extensive series of observations will be instituted, according to my plan, over the whole of this vast country. The same thing will be done in the Bombay territories, and I intend to communicate my plan to the Society of Calcutta. A friend of mine, Mr Thorburn, will make similar observations, and with instruments of the same kind, at Alexandria in Egypt, and thus, in a few years, we may expect to obtain more extensive, complete, and precise, information than has ever yet been contributed to this interesting and useful branch of science. I will send you a copy of my instructions.

I lately sent a report to Government, giving an outline of my researches since I arrived in the Madras territories, to which I have had the following reply: "Extract from the Minutes of Consultation, dated 11th September 1832. Read the following letter from Dr Alexander Turnbull Christie, dated 5th September 1832.

"Ordered that the foregoing highly interesting paper be brought to the notice of the Honourable the Court of Directors, and that a specimen of the porcelain clay, procured by Dr Christie at Mangalore, be likewise transmitted to the Court."

The porcelain clay alluded to I discovered on the coast near Mangalore. It is very fine, and closely resembles that of which the beautiful Sevres ware is made, viz. the porcelain earth of Limoges in France. I also found it on the Neilgherries.

I am to have the allowance of an officer in charge of a survey, which, with my ordinary pay and allowances, will give me rather more than 700 rupees a month. This will do more than cover my expenses. I am also to have a subassistant surveyor, who draws tolerably well, and an apprentice, detached on my account from the survey department, &c.

I am sorry to say that the allowances granted to me by the Government must be sanctioned by the Court of Directors who may retrench them if they chuse. I shall therefore be in a state of suspense for at least a year. I intend to write immediately to some of my friends in London to plead my cause.

In the approaching cold season I intend to prosecute my geological researches as far south as Cape Comorin.

[We deeply regret to add, that our excellent and highly accomplished friend and pupil is now no more, having died on the 3d November last, of Jungle fever, caught on crossing to the Neilgherries, before he had well begun his natural history survey. Dr Christie's enthusiasm in the cause of science was of the purest and most disinterested nature; and his acquirements in Natural History were never surpassed by any British naturalist who visited India. He was master of the practical and theoretical details and views of Meteorology, Hydrology, Geology, Mineralogy, and Zoology; and, in Botany, had all that practical skill required for collecting the species, and tracing them with a view of their physical and geographical distribution and economical uses in the vast countries which we trusted would have been explored by him.

Dr Hardie *, an intelligent naturalist, now again in Europe from India, with the view of recovering his health, and adding to his stores of knowledge the *new views and facts* to be acquired by studying under the Professors in Edinburgh, Paris, and Berlin, and visiting the most important geological districts in Britain and the continent of Europe, will, we trust, be selected by the India Company (which has for so long a series of years munificently fostered and encouraged science), to take up and continue the investigations of Dr Christie.

Mere collectors of plants or rocks will no longer satisfy either the India Company or the demands of science: plants may be collected by a well instructed gardener, and rock specimens by a skilful lapidary. The naturalists sent to India ought to be of a different stamp: they should be armed at all points with the powers of general science—with a perfect knowledge of the use of those instruments employed in investigating the natural history of the atmosphere, the waters of the globe, and the gene-

* Dr Hardie is already well known by his geological memoirs published in this country and also in India.

ral physical constitution of the earth; with an extensive and accurate *practical* acquaintance with the present state of the most important of the natural sciences, both in a general and economical view, viz. Geology and Mineralogy. And it will be very desirable, indeed indispensable, that those entrusted with the natural history surveys in India, should be able to collect with judgment, and investigate with accuracy, the phenomena exhibited by the animal and vegetable kingdoms.—EDIT.]

RESULTS OF EXPERIMENTS ON THE ECONOMICAL AND MEDICAL USES OF THE OXIDES AND SALTS OF CHROME. *By Professor* JACOBSON *of Copenhagen. Communicated to the Editor.*

PROFESSOR JACOBSON has laid before the Medical Society of Copenhagen, the results of a series of experiments, relating to the oxides and salts of chrome, originally made by him with a view to physiology and therapeutics.

Chrome, which was discovered about thirty-five years ago by Vauquelin, has hitherto been employed solely in the preparation of pigments and enamels, in the dyeing of stuffs, and printing of calico. It is found at many places in Europe, in greater quantity in Siberia, but most abundantly in North America. It is, as is well known, susceptible of different degrees of oxidation, and is therefore capable of entering into combination, both in the state of acid and oxide.

Professor Jacobson has made the former of these the subject of particular investigation, and has discovered qualities in one of them, namely, the chromate of potash, which hitherto have been unobserved, and which may be useful as well in the science of medicine as in the arts.

He has found, to-wit, that this salt, which neither is, nor from its nature can be, inflammable, increases in a great degree the combustibility of animal and vegetable bodies. If, for example, hemp, flax, cotton, linen, or paper, be saturated with a solution of this salt, and suffered to dry, there is produced, whenever any part of it is ignited, an active, steady, and continued combustion, without flame, which spreads on every side, and consumes all that portion of the substance that has been saturated, This property the chromate of potash possesses in a higher degree than any other metallic salt, besides being still farther distinguished by its susceptibility of combination with an excess of alkali, as well as of combination with bodies of very different natures without losing said property.

Professor Jacobson has submitted the following theory of this process. He is of opinion, that the combustion above mentioned is not occasioned only by the decomposition of the chromic acid by the carbon, but that it is the result likewise of the decomposition of the alkali, which is produced by the mutual influence of the alkali and the chrome.

Among other useful purposes to which this property may be applied in medicine, may be mentioned the preparation of moxas. Prepared with this salt, they burn without being blown on, and their operation is rendered more certain.

Professor Jacobson is likewise of opinion, that it may be applied to pyrotechnic purposes.

The oxides of chrome in like manner possess this quality, particularly when combined with alkali. Among the chromates, of which they constitute the basis, are found some that possess it, but none in so high a degree as the chromate of potash.

Another important property which Professor Jacobson has found to be possessed by the salt is this, that notwithstanding its facility of reduction, it is susceptible of combination with most animal and vegetable substances without undergoing decomposition. This property, and the great affinity of the salt for water, by reason of which it is prevented from being imbibed by the organic substances, render the chromate of potash highly important as a means of resisting fermentation and putrefaction. Nor does it indeed only resist putrefaction, but also checks it when already commenced, and removes the effluvia thereby occasioned. It is, of consequence, a disinfecting agent.

Of this highly important quality many uses may be made, as well in medicine as in technology.

To the anatomist and naturalist it is important, inasmuch as in a weak solution of this salt one may preserve specimens intended for experiment, or for preservation in the cabinet.

The vegetation produced by fermentation and putrefaction, called mildew, may likewise, as Professor Jacobson has ascertained in his experiments, be prevented by means of this salt;

and he is further of opinion, that the dry-rot, so injurious and even destructive to buildings, may by means of it be wholly prevented or removed.

As to his physiological experiments connected with this agent, Professor Jacobson has communicated but this principal result, that chrome is one of those metals which in a particular manner acts on the nervous system, and that its topical action is partly resolvent, partly corrosive, though in a manner different from that of the action of the other metallic salts. The chrome salts are calculated, therefore, to become highly important as medicaments.

Professor Jacobson has tried them with success in the treatment of various sorts of ulcers, which application of them he has promised to make the subject of a future communication to the society.

ON THE SPECIFIC GRAVITY OF DIFFERENT SOLID PARTS OF THE HUMAN BODY.

Our attention has lately been directed to this subject, from receiving an inaugural dissertation by Dr Joseph Frick, published at Freiburg in the Breisgau, in 1832, in which a considerable number of original experiments are related.

Experiments of this kind, in order that they may be considered worthy of credit, must be performed upon a very great number of different bodies, as soon as possible after death, and as much as possible in a similar and healthy condition of the organs ; for it is obvious that putrefaction, for a very few hours, diseased alteration of any kind, and even a greater or less quantity of fluids, or of fat, in the healthy state, must cause a very considerable variation in the relative weights of the organs.

The specific gravity of a few parts of the body has been mentioned by Soemmering and Meckel, their information being probably derived from Musschenbroek. Some of the numbers assigned by these authorities are quoted by Dr Frick; but this author seems not to have known of the researches of Dr John Davy "On the Specific gravity of different parts of the Human Body," which appeared in 1829, in the 3d volume of the

Transactions of the Medico-Chirurgical Society of Edinburgh, and are the most complete of the kind with which we are acquainted.

Dr Davy's experiments were performed much sooner after death, and on a greater variety of bodies, than those of Dr Frick, and are on the whole more suitable for the establishment of the average natural result, as they were made principally on soldiers, or adult males between the ages of 20 and 40; while Dr Frick's experiments were performed on two males, one of 25, the other 56, on a female of 79, and on a child dying at birth.

A considerable part of Dr Frick's essay is occupied with a description of the kinds of balance he employed in weighing the parts, the specific gravity of which was to be ascertained, and with the construction of a formula for the reduction of the resulting specific weights to one temperature, viz. 16° R. or 68° F.

Many of his experiments were made with the view of ascertaining whether there exists any difference in the specific gravity of corresponding parts, taken from opposite sides of the same body. The results show that some such difference does exist, but they are by no means sufficiently constant to entitle us to found upon them any general conclusion.

We shall not at present follow the author through these details, but arrange in a Table, which we think may be interesting to general readers, the more important results obtained by Davy and Frick. In this Table, those results only which correspond most nearly are stated, and many are omitted in which the differences are such that they must be attributed to accidental circumstances, the consideration of which would be foreign to the immediate and important object of the investigation.

Author's Name.	Part weighed.	Body from which taken.	Specific Gravity.
	Teeth.		
Davy.	Front tooth, undecayed,	Male, aged 34	2.240
...	... Root, . . .	...	1.950
...	... Crown, . . .	...	2.380
...	First molar tooth, slightly carious, . .	Male, 40	2.142
...	... Roots, . . .	...	2.113
...	... Crown, . . .	...	2.313
...	... Enamel, . .	...	2.620
	Bones, Cartilages, and Ligaments.		
...	Petrous portion of temporal bone, . . .	Male, 41	1.852
...	Parietal bone, . .	Male, 34	1.772
Frick.	Frontal bone, . .	Female, 79	1.407
...	Fifth rib, . . .	...	1.164
...	Fourth rib, . .	Child at birth,	1.300
Davy.	Eighth rib, . .	Male, 34	1.383
Frick.	Os pubis, . . .	Female, 79	1.060
...	Clavicle, . . .	...	1.220
...	Ditto, . . .	Child,	1.284
...	Head of humerus, .	Female, 79	1.005
...	Body of humerus, .	...	1.238
...	Ditto, . . .	Child,	1.426
...	Second phal. of middle finger,	Female, 79	1.158
...	Ditto, . . .	Child,	1.100
...	Body of femur, . .	Female, 79	1.253
...	Ditto, . . .	Child,	1.420
...	Lower end of ditto, .	Female, 79	1.086
...	Body of tibia, . .	...	1.417
...	Ditto, . . .	Child,	1.416
...	Cartilaginous heads of femur and humerus,	...	1.043 to 1.051
Davy.	Cartilage of knee joint,	Adult male,	1.073
...	Intervertebral substance, outer part, . .	Male, 23	1.104
...	Central soft part, .	...	1.062
...	Ligament of patella, .	Male, 22	1.104
...	Tendo Achillis, . .	Male, 28	1.080
	Skin, Hair, Nails, Fat, &c.		
Davy.	Cuticle, sole of foot, .	Male, 39	1.190
...	Skin and cuticle, back of thumb, . .	...	1.100
...	Fat, abdom. integuments,	Male, 34	0.942
...	nail of thumb, .	Male, 39	1.197
...	Light and dark brown fine hair, ...	3 English females, 30 to 40	1.278 to 1.293
...	Grey fine hair, . .	Female, 66, Corfu,	1.290
...	... white fine, . .	Male, 77, do.	1.275
...	Ditto, bleached, . .	Male Ipsariot, exposed 2 years,	1.345
...	Ditto, black, coarse, and		
...	woolly, . . .	Hottentot fem-	1.323

Author's Name.	Part weighed.	Body from which taken.	Specific Gravity.
Davy.	Grey reddish-brown, exposed to sun,	Young fem. Pitcairn's Isl.	1.300
	Muscles.		
...	Left Ventricle of heart,	Male, 34	1 048
Frick.	Ventricles of heart,	Child,	1.028
Davy & Fr.	Biceps brach., Pectoral. maj., Sartorius, Soleus, Gastrocnem., Glut. max.	Child, and males of 20 and 34,	1.053 to 1.058
	Brain and Nerves.		
Soemmering.	Brain,	mean,	1.031
Frick.	Cerebrum,	Male, 25	1.031
Davy.	Do. cortical and medullary matter,	Male, 28, fluid in ventricles,	1.040
Frick.	Medullary matter,	Male, 25	1.030
...	Cortical substance,	...	1.021
...	Whole brain,	Calf,	1.016
...	Ditto,	Ox,	1.036
...	Corpus striatum,	Male, 25	1.036
...	Thalami nerv. opt.	...	1.037
...	Cerebellum,	...	1.037
Davy.	Ditto,	Male, 28	1.043
	Pons varolii,	Male, 34	1.033
Frick.	Ditto,	Male, 25	1.031
...	Medulla oblongata,	...	1.017
Davy.	Ditto,	Male, 34	1.037
...	Upper part of spinal cord,	Male, 27	1.035
...	Dura mater,	...	1.090
Frick.	Ditto,	Male, 25	1.069
...	Sciatic nerve and Crural do.	...	1.047
...	Ditto,	Child,	1.080
Davy.	Ditto,	Male, 22	1.111
	Arteries and Veins.		
Frick.	Ext. coat of abdom. aorta,	Male, 56	1.111
...	Fibrous coat,	...	1.078
Davy	Ditto,	Male, 20	1.077
...	Thoracic aorta,	Male, 34	1.086
Frick.	Ditto,	Male, 56	1.075
...	Arch of aorta,	...	1.078
Davy.	Ditto,	Male, 22	1.080
...	Abdominal aorta,	Male, 20	1.074
Frick.	Ditto,	Male, 56	1.081
Soemmering.	Arteries,	Mean,	1.080
Frick.	Iliac, popliteal, and ulnar,	Male, 56	1.048
...	Right femoral,	...	1.063
...	Left ditto,	...	1.080
Davy.	Upper part of ditto,	Male, 22	1.071
...	Middle part of ditto,	...	1.061
Soemmering.	Veins,	...	1.050 to 1.100
Davy.	Abdominal Vena cava,	Male, 26	1.061
Frick.	Superior Vena cava,	Male, 56	1.055 to 1.065
	Viscera, &c.		
Davy.	Lung, destitute of air,	Male, 29	1.054
...	Ditto, hepatized,	Male, 28	1.043

Author's Name.	Part weighed.	Body from which taken.	Specific Gravity.
Davy.	Pancreas, . . .	Male, 28	1.047
...	Thyroid gland, . . .	Male, 25	1.060
...	Liver, healthy, . .	Male, 27	1.069
...	Do. colour of yellow wax,	Male, 34	1.035
Frick.	Liver, healthy, . .	Child,	1.042
...	Ditto, surface, . .	...	1.065
...	Kidney, . . .	...	1.034
...	Ditto, cortical substance,	...	1.033
...	Ditto, medullary substance,	...	1.036
Davy.	Kidney, . . .	Male, 26	1.050
...	Supra-renal capsule, .	Male, 25	1.048
Frick.	Ditto, right, . .	Child,	1.022
...	Ditto, left, . .	...	1.034
...	Thymus, . .	...	1.036
...	Spleen, . .	...	1.052
Soemmering.	Ditto, . . .	Mean,	1.060
Davy.	Ditto, healthy, . .	Males, 25, 26, 34 and 41	1.060 to 1.070
...	Spleen, bright red and hard,	Males, 22 and 28	1.044 to 1.048
...	Do. very large, soft, and putrid, . . .	Male, 20	1.058
...	Œsophagus and intestine, inflamed and ulcerated,	Male, 39	1.040 to 1.044
...	Cardiac portion of stomach,	...	1.048
...	Pyloric ditto, . .	...	1.052
...	Duodenum, . .	...	1,047
...	Corpora cavernosa penis, cellular part, . .	Male, 26	1.086
...	Do. ligamentous covering,	...	1.097
...	Testicle, . . .	...	1.041
Frick.	Ditto, . . .	Child,	1.040
Davy.	Tunica albuginea, T.	Male, 26	1.088
	Eye. &c.		
Frick.	Whole eye, . .	Male, 25	1.021
...	Sclerotic coat of eye, .	Female, 79, and male, 25,	1.090
Davy.	Ditto, . . .	Male, 23	1.091
...	Cornea, . . .	...	1.076
Frick.	Ditto, . . .	Female, 79, and male, 25	1.049 to 1.103 1.140 to 1.176
...	Choroid, . .	...	1.047 to 1.049 1.110 to 1.174
...	Aqueous humour, .	...	1.005 to 1.024
...	Vitreous humour, .	...	1.002 to 1.006
Davy.	Lens, soft, . . .	Male, 23,	1.100
Frick.	Nucleus of lens, hard and yellow, . .	Female, 79	1.112
...	Aqueous humour, .	Calf, .	1.003 to 1.006
...	Ditto, . . .	Ox, .	1.006 to 1.008
...	Lens, . . .	Calf, .	1.002 to 1.005
...	Ditto, . . .	Ox, .	1.080

ELOGE OF BARON GEORGE CUVIER, *delivered in the Chamber of Peers on the 17th December 1832. By Baron PASQUIER, President of the Chamber of Peers. (Concluded from former Volume, p. 358.)*

As President of the Committee of the Interior, an office which he held during the last thirteen years of his life, the extent of the business which he transacted, and the number of cases examined, discussed, and despatched by his care and agency, startle the imagination. It is known that they sometimes amounted to 10,000 in the year. The art of dividing the work to be performed among his fellow-labourers—a talent for managing discussion—a memory always ready to bring former decisions seasonably to recollection—a profound knowledge of the principles requisite for determining every case, and of the just method of applying them,—such is a brief outline of the qualities which rendered him so valuable in this office, and which will perpetuate the remembrance of his labours in it, among all who have had for an instant the opportunity of knowing and reaping the advantages which flowed from them. To question the great utility resulting from the labours of the Committee of the Interior, would argue an entire ignorance of the form of government in France, as well as to what extent the Council of State proved to be the most valuable barrier against the encroachments of arbitrary power. This truth he often demonstrated during the discussions which took place in the Chambers on the existence of this Council, and the importance of its duties. The rules of government are not so determinate as those of the civil or criminal law, and the personal integrity of those who administer them is consequently of the first importance. But is not equity the truth in all things? And who was ever a greater or more devoted friend of truth than M. Cuvier? He could not be fully known unless seen and heard at one of the sittings of Council, or Committee, when business was transacting. Instead of showing any eagerness to deliver his opinion, he appeared somewhat absent, as if his mind was engaged with some other subject than that under consideration, and not unfrequently he was employed in writing out the result to which the discussions were intended to lead. His turn to speak did not arrive till reasons had been interchanged by both parties, and fruitless words were well nigh exhausted; then a new light broke upon the minds of all; facts resumed their proper places; ideas, previously confused, became distinct; the necessary deductions were made, and the discussion had terminated when he ceased to speak.

In what, then, consisted the power which M. Cuvier exercised? It cannot assuredly be ascribed to his style; for his expressions were simple, and occasionally negligent, unadorned with imagery, and destitute of every thing that addressed itself to the imagination. No recourse was had to the illusions of art, but all was order and perspicuity, those first of requisites, which are the sources of the purest pleasure to the mind. Let us regard him on a more extended theatre, as taking part in the preparation of the laws, and in the discussions to which they were subjected, either in private committees, in the councils of state, or in the councils of the cabinet, to which he was often called. I should reproach myself for not having spoken, in the first place, (for I know it is one of the services which he most congratulated himself for having performed), of the use which he made of his talents and influence, to obtain certain modifications in the constitution and jurisdiction of the *cours prévôtales*, which have principally contributed to diminish their dangerous effects. He took pleasure in recalling his success, but he never did so without mentioning at the same time the assistance which he had derived from the good sense and honourable character (I use his own expressions) of the Duc de Richelieu, as well as from M. Royer Collard, and M. de Serre, the one in the Council of State, the other in the Chamber of Deputies. If we pass on to other subjects, which, without being of a more important, are perhaps of a more elevated character, we will see him applying the same instinct of vigorous observation, which made him acquainted with the form and organization of beings emanating from the present and preceding creations, to the constitution of political bodies, and acquiring with equal facility a knowledge of their most secret springs, and the causes of their strength or weakness.

The extent of his historical knowledge supplied inexhaustible information on this vast subject; and his scrutinizing mind had treasured up a multitude of practical maxims, which were of value on all occasions. A very brief visit to London enabled him to obtain such an accurate knowledge of the mechanism of the English government, that he was able, on his return, to overthrow, by irresistible demonstration, the false notions which had been formed respecting it, by those who pretended to be best acquainted with it. With such an aptitude to acquire knowledge, and always founding his mode of proceeding on the most exact knowledge of facts, whose province it is so often to confirm or confute principles, he must needs be led occasionally to differ in opinion from those who shew less regard to facts and the results that flow from them, and who are often forced, sometimes in very opposite senses, to incline the balance of legislature towards the opinions with which their minds were preoccupied. If M. Cuvier's opinions were not at all times triumphant in the struggles in which he was so often engaged on many great and difficult questions, no one, at least, can deny that he brought to the discussion much useful knowledge, which had often the effect of improving even those plans which did not obtain his entire approbation. And you know how the brilliant and solid qualities of his mind were always displayed, in the speeches which he delivered before the Chambers in behalf of the schemes whose defence he had undertaken. Such of his auditors as were not convinced, did not fail to render homage to the suitableness, the elevation, and dignity of his address, and were always delighted to hear him, even when they opposed his suggestions.

Among the most remarkable of these discourses, I do not hesitate to mention that which he delivered in 1820, in the Chamber of Deputies, on the law of elections. I am greatly deceived if his powerful reasoning was not supported by eloquence of the noblest kind. And here, gentlemen, a reflection occurs to me: M. Cuvier, throughout the whole course of his political life, never appeared as a supporter of the governments under which he lived; and this, it must be confessed, would be a sufficient reason, in the eyes of some, to regard him with less consideration.

But this matter requires a short consideration. On entering into life, all men have not the same destination assigned them, and the diversified nature of their intellectual powers leads them into very different paths. There are some whose incessant exertions are directed to the improvement of society, and who prosecute their attempts in opposition to all the suggestions of experience. The good to which they aspire leads them to despise the advantages they possess, and to obtain this they willingly hazard all. We do not live in an age when this assertion can be treated as chimerical. Others, on the contrary, more struck with the danger of the evils which too often originate in great political commotions, never cease to contemplate the picture of misfortune which, in such cases, history presents; and having come to the conclusion, that the pursuit of the desired good, unless managed with prudence and caution, may lead to the diminution of the benefits positively enjoyed, they invariably resist any encroachments on the existing state of things, as a high degree of imprudence and rashness; under the impression that is requisite to preserve, at all risks, the conditions which afford protection even to their adversaries. The knowledge of history which he possessed, and the severe trials to which his youth had been subjected, would have sufficed to incline M. Cuvier to this line of opinion and conduct; and the habits of his mind, as well as the nature of the labours to which his life was devoted, connected this bias into strong and decided conviction.

The study of nature, and the incessant admiration of the order which prevails in her minutest parts,—of that order which produces, vivifies, and preserves all, had impressed him with the necessity of establishing and maintaining the same principle in political and social organization; and as governments are every where the natural guardians of order, they were on that account alone the objects of his particular interest. May I remind you, that the same dispositions in favour of established governments, were produced by similar causes in the mind of one of the most illustrious individuals of our age? The eminent author of the *Mécanique Celêste* had derived them from the study of the laws which regulate the movements of the planets, as M. Cuvier had done from those which regulate the organization of living beings. This explanation of his views and political conduct, has been often given, I am well assured, by M. Laplace himself, and especially by one of those individuals who occupies a high place in the empire of science, and whom the Chamber may now congratulate on reckoning among its members.

It will not be supposed that M. Cuvier, although influenced by the motives which I have mentioned to defend the proceedings of the governments under which he enjoyed the protection of the laws, was on that account hostile to the useful and progressive improvements which are necessary to the welfare of every institution; but it was his wish that these should result from patient and enlightened observation; that they should not be adopted in a state of passionate excitement, but undergo a calm and deliberate discussion, after a careful study of sound principles, and a conscientious inquiry into what was really needed. Need I mention, gentlemen, how valuable this disposition would have rendered him, in the rank to which he had been recently raised among you, joined as it was to such varied and profound knowledge, and such extensive experience in the affairs of Government? His name was necessary to complete the series of illustrious men whom I previously recalled to your recollection; and it was not possible that he could fail to be the choice of an enlightened prince, when occupied in filling up part of the void left in this Assembly, and seeking for names capable of maintaining the order of the peerage, in that degree of power and celebrity, of which it cannot be deprived without striking a blow at one of the strongest pillars of the state.

M. Cuvier was particularly sensible of the honour which had been conferred on him: he regarded it as a flattering reward of his labours and services; and he rejoiced at the same time to find himself in a situation which gave him the right of expressing his sentiments without restraint, in a place which secured to them a favourable hearing, and increased the respect which could not be withheld from their intrinsic worth. The discussions which took place in this Chamber, afforded him advantages on which he must have placed the highest value. He was certain of finding here the calmness and courtesy which are so favourable to the proper management of debate, when reasons are propounded and listened to on both sides, with that candour which belongs to men whose whole views are turned towards the public good, and who are in the habitual practice of mutually honouring the purity of each other's motives. On this tranquil arena, M. Cuvier found the parliamentary debates characterized by the same tone, and nearly the same methodical arrangement, as had been familiar to him in his scientific discussions, and his knowledge would not have been less available than it had been in the latter. Having been a member of many commissions during the few days he spent among us, his colleagues can bear testimony to his assiduity, and the scrupulous attention which he devoted to the business in which they were engaged. No record remains of his participating in our labours, except a report on a law relating to corn; the time was pressing, and the report was drawn up, I believe, in the course of a day. It is well known that the subject is arduous and delicate; yet the few hours which I have mentioned, were sufficient to enable him to bring forward an exact and sufficiently extensive statement of facts bearing upon the case, of the general principles which ought to regulate it, of the laws which had applied to it for a certain number of years, and finally of the considerations favourable to the measure proposed, and which was adopted by the Chamber. It would have been difficult for him to have done better, even had he been allowed a greater length of time. But for this little work, which to him was so easy, we should have had nothing belonging to him in our collections.

I am anxious before reaching the melancholy termination of my task, to which, gentlemen, you will perceive I am now approaching, to endeavour to make you acquainted in some degree with the private life of the illustrious individual, of whom I have hitherto spoken chiefly as a man of science and a politician;—to shew him to you in a situation where his many amiable qualities secured him the attachment of those who might otherwise have felt awe in the presence of one possessed of such vast capacity and universal knowledge. He has himself said, in speaking of the interest excited by the elogiums of Fontenelle and Condorcet, that it is not extracts from works of celebrated men, nor notices, almost always incomplete, of their discoveries; but it is the intimate knowledge of their individuality, the pleasure of being admitted, so to speak, into their society, of contemplating their qualities, their virtues, and even their defects, which render these elogiums the most interesting, and at the same time the most useful, kind of reading. These few lines point out to me a duty which I ought to endeavour to fulfil, although assured how far short I shall fall of the models which he cites, or those which he has himself supplied.

Let us contemplate him in the Jardin des Plantes, where he was established for nearly forty years, and to which he attached, so to speak, his very existence, near the Museum of Natural History, and the Cabinet of Comparative Anatomy, the latter of which owed its existence to his exertions; in the centre of this establishment, which is without its equal in the world, where the most enlightened and those most desirous to learn may find equal enjoyment and instruction; in the midst of a series of libraries arranged so as to facilitate the researches which the astonishing variety of his occupations obliged him to pursue; in this extensive cabinet, were to be found, on the Saturday of each week, during a period of so many years, not only the men whose works have done honour to France, but the most illustrious names which Europe possessed, as well as travellers from every quarter of the globe,—from the Indies, the Ohio, the banks of the Amazon, New Holland, and the icy seas—who never failed, even when on the most cursory visit to our capital, to visit the great naturalist, with whom for the most part they had previously been in terms of correspondence.

How much intellectual enjoyment must have resulted from such an assemblage, where the free interchange of sentiment among men of kindred inclinations, and who could appreciate each other's worth, formed a bond of connection which every one wished more strongly to confirm. In this meeting of celebrated men, which brought together young and old, masters and scholars, from every corner of the earth, how unaffectedly and becomingly did M. Cuvier fill the place he occupied? His grave, but not severe aspect,—his obliging attention in hearing those who would willingly have listened to him,—that incredible variety of knowledge, which not only enabled him to take part in conversations of the most different character, but even to open new views on every subject brought to his notice,—are qualities of which all of us have had opportunities of witnessing and admiring up to the close of his brilliant career.

But this part of M. Cuvier's private life still partakes a little of a public character. In following him into his more retired and familiar habits, we will find reason to admire, in the first instance, the equality of his temper, and unassuming deportment in all his social relations, combined with a gentleness which could be best appreciated by those who were continually in his company, and which was generally ascribed to a very remarkable and characteristic feature of his character,—the absence of all vanity, a commendation of the higher value, as it can so seldom be bestowed. Not only did he avoid the indulgence of hatred to any one, but he never felt the least displeasure towards his opponents, notwithstanding the obstacles which they threw in the way of his scientific and political pursuits. In general, it was his belief that ignorance is productive of greater evils than human passions, and he was accustomed to say of those whose words and actions, especially in political matters, he found reason to reprove ;—they are more to be pitied than blamed, for they know not what they do.

His disposition was so generous and charitable, that he could never refuse an application for pecuniary aid, even when his circumstances were such as to require rigid economy. Although his time was of such value, and so many different occupations claimed his attention, yet he never refused to receive persons who wished to consult him on their own affairs. When one remains, he said, in the Jardin des Plantes, at such a distance from solicitors, one has no right to shut the door against them. His time was distributed in such a manner that not a moment was left without its special object ; in this way he rendered it sufficient for all his avocations, and even found leisure to attend Societies, the proceedings of which were so familiar to him, and the duties devolved on him so much matters merely of form, that he might easily have been excused for neglecting them. For each of the works in which he was engaged, he allotted a department of his library, in which he arranged all the books which he might require to consult. He read and wrote even in the carriage which conveyed him from one place to another, and when he returned home, either from his lectures, or from a meeting of Council, or of the Academy, he crossed the apartment which was occupied by his family, and, after some words of courtesy and friendship, ran in haste to shut himself up in that particular cabinet set apart for the occupation he had at the time in view. This he did not leave till the hour of dinner, and generally entered the dining-room with the book he had been reading in his hand, which he seldom laid aside till he had finished the page or article begun. A few minutes after dinner he returned to his cabinet, and, if no other avocation interfered, he remained there till eleven o'clock. He then went to the apartment of Madame Cuvier, where he listened for an hour to the reading I have already mentioned,—of some work of ancient or modern literature, either of a light or serious kind. This relaxation he enjoyed much, as it afforded him the most refreshing repose after the labours of the day. During the last year of his life, he had in this way caused to be read to him nearly all the works of Cicero.

What, then, could be wanting to render such a man as happy as our nature admits of in this world ? His greatest distress, alas ! had its origin in what ought to have been the source of his greatest happiness. In the enjoyment of a companion whose qualities were most calculated to excite his esteem and love, he had become the father of four children. These he loved with the warmest affection, and they were successively taken from him. We witnessed the agony of his distress during the illness of the last that died, and have seen him under the pressure of his sore bereavement. It was a daughter, endowed with all the gifts which Nature could bestow ; worthy, in short, of such parents. She was on the point of forming an alliance which promised future happiness, when she was carried off by one of those diseases of the breast, whose ravages are so terrible. Two days after this event, he who has the honour to address you entered the gallery to which M. Cuvier had retired, and the spectacle which presented itself, was one of the most affecting which can be witnessed by any one, who is in a condition to understand and admire the scenes in which human nature reveals itself in all the energy of which it is susceptible. His whole appearance presented marks of the deepest grief which a father can feel, and so poignant had been his sufferings, that, as he himself confessed to me, he had come to seek, in the most assiduous labour which he could impose on himself, the means of distracting his attention, and rendering his sorrow more tolerable.

I can scarcely persuade myself but that I see him still, in that noble gallery, surrounded with monuments of human skill, and the wonders of nature, seeking to avoid the image of his beloved child, and perseveringly demanding of science, not to administer consolation, but to absorb his thoughts. Pascal attempted by energetic application to overcome only physical pain; but I had before me a struggle between the heart and the genius of man, between the powerful wish of the one, and the deepest suffering to which the other could be subjected. M. Cuvier could never be consoled, but he continued, notwithstanding, to prosecute with equal vigour of intellect, the various pursuits in which he never ceased to be engaged to the end of his life.

We now approach, gentlemen, the fatal moment to which I am to direct your thoughts. The scourge (*Cholera*) which afflicted our great city, and which made so many victims, had interrupted none of M. Cuvier's labours; it may even be imagined that it had incited him to additional exertion, for he is found to have written nearly two volumes of his Comparative Anatomy, a work which, as I have already mentioned, he wished entirely to remodel. Could he regard so great a calamity as a warning to terminate speedily all the undertakings which he had begun?

On the 18th of May he opened, in the College of France, the Course which he had continued for three years with so much success, on the History of the Natural Sciences. Those who were present at the last lecture of this great master, retain an impression which can never be imparted to such as have not experienced it, and of which I can convey but a very feeble notion. Seldom had he risen to such an elevation; but his auditors were particularly struck with the last phrases which he used, to express his intention of taking a view of the actual state of the study of creation—that sublime study, which, while it enlightens and strengthens the human mind, ought to preserve it from the deceptive habit of regarding things apart from their relation to each other, and distorting them, that they may be subjected to the laws of a system; which ought, in short, to lead the thoughts incessantly to that supreme Intelligence, who governs, enlightens, and vivifies all, who reveals all things, and whom all things reveal.

At this part of his lecture he displayed a calmness and justness of perception, combined with a depth and seriousness of thought, which led his auditors to think of that book which speaks of the creation to all mankind. This was the result of his ideas rather than his expressions, for every thing in the free exposition which he made, breathed the feeling of the omnipotence of a supreme cause, and of an infinite wisdom. He seemed, as it were, by the examination of the visible world, to be led to the precincts of that which is invisible, and the examination of the creature evoked the Creator. At last these words fell from him, in which it is easy to see a presentiment: "Such, gentlemen, will be the objects of our investigation, if time, my own strength, and the state of my health, permit me to continue and finish them." The closing scene of M. Cuvier's life, as a public teacher, appears to me to be impressed with peculiar beauty. Who could fail to be deeply affected at the last accents of so pure an intelligence, disengaged from the vanities and the interests of systems? Who could remain cold and insensible before the last look thrown on creation by him who had revealed so many of its mysteries? Who could resist the feelings excited by the view of science revealing eternal wisdom? How noble, now affecting, and how prophetic! So soon to appear before the supreme tribunal, what conviction could he express, what words could he pronounce, which would have formed a more suitable preparation? After this lecture the first symptoms appeared of the disorder, which, in less than eight days, brought him to the grave. He presided, notwithstanding, on the following day, in the Committee of the Interior. Soon, however, paralysis of a peculiar kind destroyed in succession the nerves which produce voluntary motion, leaving uninjured those which form the seat of sensation; the members affected thus became completely inert, and yet retained their sensibility. M. Cuvier had, a short time before, read to the Academy of Sciences, a memoir sent by an Italian anatomist on the existence of this little known affection of the nervous system. It may be supposed that the extent of his labours, during the latter years of his life, had contributed to produce it. All the assistance of art, lavished upon him by men of the greatest skill, was ineffectual, and it soon became apparent that his end was drawing near.

Every one knows with what courage and serenity he saw it approach. The unremitting care and attention which were bestowed on him affected him deeply, but did not diminish his courage. Even to the last he permitted those to approach who had been on terms of intimacy with him, and it was thus that I was a witness of his dying moments. Four hours before his death, I was in that memorable cabinet where the happiest hours of his life had been spent, and where I had seen him surrounded with so much homage, enjoying his well merited success; he caused himself to be carried thither, and wished that his last breath should be drawn there. His countenance was in a state of perfect repose, and never did his noble head appear to me more beautiful, or worthy of admiration; no alteration of a too sensible or painful kind had yet taken place, only a little weakness and difficulty in supporting himself were observable. I held the hand which he had extended to me, while he said in a voice scarcely articulate:—"You see what a difference there is between the man of Tuesday (we had met on that day), and the man of Sunday; yet so many things remain to be done! Three important works to be published, the materials of which are prepared, and nothing remains for me but to write them." I made an effort to find some words to express to him the general interest which he excited. "I love to believe it," he replied, "I have long endeavoured to render myself worthy of it."

It will be seen, that his last thoughts were towards the future, and aspiring after glory,—a noble desire of immortality! At nine o'clock on the evening of the 13th May, he had ceased to live, having reached only the age of sixty-two, although belonging to a family remarkable for longevity. Shall I mention the profound grief which immediately environed this vast sanctuary of science, in the bosom of which his mortal remains repose? shall I describe his funeral obsequies, which neither the increasing ravages of a frightful malady, nor any other cause, could prevent all ranks and all classes from attending, and carrying their last homage even to his tomb? But has not the most honourable homage which has been paid to him, arisen out of the void which was immediately felt in every situation where he was engaged?

I honour, as I ought, the indisputable merit of those who have been called upon to succeed him in the different stations which he filled, the number of which has astonished every one; but however well they may be filled, who would doubt, that if M. Cuvier could again appear, they would be restored to him with acclamation? In this acclamation, do you not recognise, gentlemen, the infallible voice of posterity, which has already caused itself to be heard? To it I leave the completion of the task which I have so imperfectly commenced, happy if your attention has hitherto followed me without fatigue, and if you have not found me too unequal for the task which has been assigned me.

CHARACTERS OF NEW OR LITTLE KNOWN GENERA OF PLANTS.

By ROBERT WIGHT, *Esq. M.D. F.L.S. Hon. E.I.C.S., and* G. A. WALKER ARNOTT, *Esq. A.M. F.R.S.E. and L.S. Communicated by the Authors.*

THE simple generic character of *Millingtonia* given by Roxburgh, in his Flora Ind. vol. i. p. 102., although sufficiently exact for the Linnean classification, in which those parts only are accounted stamens that have pollen, conveys little information as to the real structure of parts. The nectarial bodies opposite the petals, are of a very singular shape. The apex (which Roxburgh erroneously represents free) is incurved, and attached in front, similar to the petals of some umbelliferous plants, leaving two large hollows, one on each side, as if for the reception of the cells of an anther. Indeed, their whole appearance is that of abortive stamens, in which light we feel disposed to view them. The bifid scales, at the back of the fertile stamens, are of a very different texture, and these, we believe, are abortive petals. Thus, we have both stamens and petals heteromorphous; the imperfect forms of the one set of organs opposite to the perfect ones of the other. The calyx we have always found to consist of two interior sepals, and three exterior, one of which, and sometimes, but rarely all, are similar in size to the interior, and alternating with them: there are in some species in addition, small close-pressed bracteolæ. The mode in which the calyx is placed is well figured by De Candolle (Organ. Veg. t. 37. f. 12. *p.*) We have, then, a calyx, a corolla, and andrœcium, each of five parts, placed apparently in a double series; the one dissimilar to the other, and alternate with it; thus analogically shewing, that the hypogynous disk must be viewed as an outer series of the gymnœcium, the bidentate angles alternating with the two cells of the ovary. At first also, it would appear that the two outer parts of each organ alternate with the inner of the next, but this is only in appearance; for, if that were the case, the angles of the hypogynous scale would be opposite to the three larger petals, whereas they alternate with them. The real disposition of parts, therefore, will be better understood, if we suppose each organ to be of only one series, and of five parts; the petals alternating with the calyx, the stamens opposite to the petals, and the pistilla alternating with both stamens and petals. That this is the true explanation, is confirmed by the fact, that, in no known plant, where any organ consists of a double series of parts, do the component parts of one series differ in number from those of the other. The æstivation will thus be imbricate and quincuncial; and in such, two or three (as may happen) parts of the same organ are interior. It is, however, remarkable to find them of so very different a structure as occurs in this genus.

The affinities of *Millingtonia* have not, so far as we know, been pointed out. The habit is much that of *Semecarpus mangifera*, and *Buchanania;* and, like the *Terebinthaceæ*, the embryo is campulitropal. The genus *Sabia*, also, has the stamens opposite the petals, the ovarium bilocular, two ovules in each cell, the one placed above the other; but the petals are likewise opposite to the sepals, and the habit is different: moreover, it is by no means certain that *Sabia* ought to be referred to the *Terebinthaceæ;* and the characters of all the other genera of the order present little in common with *Millingtonia.* Our friend Dr Hooker has suggested an affinity with *Sapindaceæ;* and with different genera of that order, it has several points in common,—as the fleshy disk, the two superposed ovules in each cell, the indehiscent fruit, with part of it abortive; the absence of albumen, and the curved embryo; but that order has usually stamens twice as numerous as the petals, and, in addition, scales or tufts of hair at the base of the petals; so that if, as in *Millingtonia,* these scales were to be viewed as abortive stamens, the whole number of stamens would much exceed that of the petals. In *Sapindaceæ,* too, the hypogynous disk is fleshy, and is, we believe, the torus: here it is quite free from the receptacle, except at the point of attachment, and appears to be formed by the union of an outer series of styles. Although, therefore, we cannot agree to place it among the true *Sapindaceæ,* we can see but little objection to its forming the type of a new order next them.

Gen. 5. MILLINGTONIA, *Roxb.*

Linn. Syst. DIANDRIA MONOGYNIA.

Ord. Nat. SAPINDACEIS *affinis.*

Calyx persistens, quandoque 1–3-bracteatus, 6-sepalus; sepala inæqualia; 2 interiora, æqualia; 3 exteriora, sæpe inæqualia: *æstivatio* imbricata. *Petala* 5, ad marginem receptaculi inserta, decidua, sepalis alternantia, heteromorpha; tria exteriora, orbicularia, integra, sepalis interioribus alternantia; *æstivatio* imbricata: duo (spuria) interiora, staminibus fertilibus opposita, minora, acute bifida. *Stamina* 5, petalis opposita, iisdemque ima basi subunita; tria sterilia ante petala majora; duo fertilia ante petala minora: *filamenta* (fertilium) plana: *connectivum* terminale, transverse ellipticum, antrorsum patelliforme, carnosum, margine membranaceum, antheram loculis juxta positis globosis transverse dehiscentibus in patellula continens. *Pollen* globosum, lævissimum. *Ovarium* ovatum, supra discum planum, tenue, liberum, triangulatum, angulis bidentatis, cum petalis majoribus alternantibus, insidens, triloculare; loculis biovulatis: *ovula* dissepimento affixa, superposita. *Stylus* simplex, brevis, crassus. *Stigma* subbilobatum. *Drupa* unilocularis, monosperma; loculo altero abortiente; dissepimento supra evanido, ad basin indurato persistente. *Semen* subrotundum, hinc prope basin, ad hilum, intrusum; integumentum membranaceum. *Albumen* nullum, (vel parcissimum, *Roxb.*) *Embryo* campulitropus, curvatus, conduplicatus. *Cotyledones* oblongæ. *Radicula* curvata, ad hilum versa.

Arbores. Folia *alterna, exstipulata, integra, vel rarius pinnata, integerrima, vel dentato-serrata.* Paniculæ *terminales, et versus apices ramorum axillares.* Flores *sæpius minuti, subspicati, in ramulos perbreves secus ramos horizontales dispositos.*

1. M. *pungens* (Wall.); foliis simplicibus, coriaceis, lanceolatis, basi acutis, integerrimis, utrinque glabris, nervis subtus rufo-pubescentibus; panicula rigida, dense ferrugineo-pubescenti; rachi tereti; floribus in ramulos ulti-

mos aggregatis; calyce tribracteato, sepalis subæqualibus, margine glanduloso-ciliatis; petalis tribus exterioribus rotundatis concavis, interioribus ultra medium bifidis filamenta æquantibus.—M. pungens, *Wall.! in Herb. Hook.; Wight et Arn. in Prodr. Fl. Pen. Ind. Or.* (ined.); *Wight. Cat.* No. 945. —M. congesta, *W. et Arn.* MS.

HAB. In montibus "Neelgherries" dictis.

2. M. *dilleniifolia** (Wall.); foliis simplicibus, elliptico-oblongis, basi attenuatis, subtus pubescentibus; nervis secundariis parallelis, rectiusculis, in denticulos patentes spinuliformes excurrentibus; panicula gracili, laxa, pubescenti; rachi angulato; floribus in ramulos ultimos subdiscretis; calyce ebracteato, sepalis 5 subæqualibus, margine ciliatis; petalis exterioribus rotundatis, concavis, interioribus ad basin fere bifidis filamentum perbreve æquantibus.—M. dilleniifolia, *Wall.! in Herb. Hook.*

HAB. ....

3. M. *simplicifolia* (Roxb.); foliis simplicibus, membranaceis, oblongo-lanceolatis, in petiolum longe attenuatis, integerrimis, utrinque glabris; nervis secundariis prope marginem incurvis, confluentibus; panicula gracili, laxa, pubescenti; rachi angulato; floribus in ramulos ultimos subdiscretis; calyce ebracteato, sepalis tribus majoribus margine ciliatis; petalis exterioribus rotundatis, concavis, interioribus ad basin fere bifidis filamento plus dimidio brevioribus.—M. simplicifolia, *Roxb. Fl. Ind.* 1. p. 103; *Spr. Syst.* 1. p. 36; *W. et A. Fl. Pen. Ind. Or.* (ined.); *Wight. Cat.* N. 946.—M. laxa, *W. et A.* MS.

HAB. In montosis provinciæ Maduræ.—Silhet, *Roxburgh.*

4. M. *pinnata* (Roxb.); foliis abrupte pinnatis; pinnis 6–12 jugis; foliolis elliptico-lanceolatis, utrinque glabris, denticulato-serratis, denticulis incurvis, nervis secundariis ante marginem incurvis, confluentibus; panicula laxa, puberula; rachi angulato; sepalis inæqualibus; 2 bracteiformibus; petalis exterioribus rotundatis, interioribus ad medium fere bifidis filamentum æquantibus.—M. pinnata, *Roxb. Fl. Ind.* 1. p. 104.; *Wall.! in Herb. Hook.*; *Spr. Syst.* 1. p. 36.

HAB. In Silhet; *Roxburgh.*

We have in the last species taken the part of the character referring to the number of the leaflets from Roxburgh's description, the specimen before us being imperfect in that respect.

Gen. 6. PLATYNEMA, *nob.*

Syst. Linn. DECANDRIA MONOGYNIA.

Ord. Nat. MALPIGHIACEÆ, *Juss.*

Calyx 5-partitus, basi eglandulosus. *Petala* 5, subæqualia, plana, unguiculata, margine integerrima. *Stamina* 10, alternis brevioribus; *filamenta* basi dilatata, plana, persistentia: *antheræ* lineari-oblongæ, deciduæ. *Stylus* filiformis, stamina superans: *ovarium* 3-loculare, apice 3-carinato-alatum.—Folia *opposita, stipulata, elliptica, obtusa, glabra.* Flores *terminales, racemosi.*

1. P. *laurifolium*, Nob. *in Prodr. Penins. Ind. Or.* (ined.); *Wight. Cat.* N. 947.—Gærtnera laurifolia, *Wall. List of E. I. Plants*, N. 7265.

HAB. In insula Zeylana; *Herb. mission.*

This plant is, as Dr Wallich and the missionaries point out, closely allied to *Gærtnera* of Schreber, the *Hiptage* of Gært-

* We insert this species and *M. pinnata*, although not found in the peninsula, in order to complete our account of the genus.

ner and De Candolle; but imperfect as our specimen is, we do not think that it can be actually united to that genus.

Gen. 7. SPHÆROCARYA, *Wall.*

Linn. Syst. PENTANDRIA MONOGYNIA.

Ord. Nat. SANTALACEÆ? *R. Br.*

Perianthii tubus clavatus, ovario adhærens, limbus 5-partitus. *Petala* nulla. *Glandulæ* biseriales; 5 exteriores petaloideæ, fauci calycis insertæ, staminibus alternantes: 5 interiores minutissimæ, ciliatæ, inter stamina et perianthii lacinias. *Stamina* 5; filamenta brevia, glabra, ad basin perianthii lacinias inserta, iisdemque opposita: *antheræ* biloculares. *Stylus* simplex. *Stigma* subbilobum. *Drupa* pyriformis, monosperma. *Albumen* magnum carnosum: *Embryo* brevis, in apice albuminis: *radicula* supera.—Arbores. Folia *alternantia, integra, penninervia.* Flores *racemosi:* pedicellis *brevibus, crassis, ebracteolatis.*

1. S. *edulis* (Wall.); foliis subtus ad nervos pilosis.—S. edulis, *Wall. in Roxb. et Wall. Fl. Ind.* 2. p. 371.; *Spr. Syst. Veg. Supp.* p. 101.; *G. Don, in Mill. Dict.* 2. p. 27.
Hab. In sylvis Nepalensibus, in valle æque ac in montibus; *Clariss. Wallich.*

2. S. *Wallichiana* (Nob.); foliis subtus glaberrimis.—S. Wallichiana, *Wight et Arn. in Prodr. Fl. Penins. Or.* (ined.); *Wight, Cat.* N. 948.
Hab. In dumetis montium provinciæ Maduræ.

We have not had it in our power to examine the structure of the ovarium of this genus. Dr Wallich states that "the ovulum is erect, supported by a fleshy subdiaphanous spirally twisted cord, which rises from the bottom of the ovary, and is conducted into the oblong cell by means of a proper tube or canal," which is slightly at variance with the natural order Santalaceæ.

Gen. 8. BRAGANTIA, *Lour.*

Linn. Syst. GYNANDRIA HEXANDRIA.

Ord. Nat. ARISTOLOCHIÆ, *Juss.*

Perianthium tubo globoso, limbo æqualiter 3-fido. *Filamenta* nulla. *Antheræ* 6–9, circa stylum medium, seu ejus rudimentum insertæ, extrorsum dehiscentes. *Fructus* siliquæformis, indehiscens, plurilocularis, polyspermus.—Frutices *erecti, ramosi.* Folia *lanceolata, integerrima, venosa, magna, alterna.* Flores *fusco-rubri: racemi, breves, pauciflori, axillares.*

1. B. *racemosa* (Lour.); hermaphrodita; foliis late lanceolatis; perianthii tubo 10-sulcato, limbi laciniis obtusis; antheris 6, omnibus juxtapositis; stigmatibus in discum concavum integrum coalitis.—B. racemosa, *Lour. Fl. Coch. (ed. Willd.)* 2. p. 645.; *Spr. Syst.* 3. p. 755.
Hab. In montis Cochinchinæ.

2. B. *tomentosa* (Blum.); hermaphrodita; foliis ovali-oblongis, coriaceis, supra glabris, subtus reticulatis, arachnoideo-tomentosis; racemis lateralibus, cernuis, bracteatis, tomentosis; antheris 6; stylo subquadrifido, stigmatibus

obtusiusculis.—B. tomentosa, *Blum. en. Pl. Jav.* fasc. 1. p. 82.—Ceramium tomentosum, *Blum. Bydr.* p. 1134.

HAB. In sylvas montanis humidis insularum Javæ et Nusæ Kambangæ.

3. B. *Wallichii* (R. Br.); dioica; foliis oblongo-lanceolatis, basi trinerviis; perianthii tubo lævi, limbi laciniis acutiusculis; antheris 9, triadelphis, per tria connatis; pistillo *(maris)* brevissimo; stigmatibus 9, radiantibus, ad basin unitis, tribus bifidis; fructu tereti.—B. Wallichii, *R. Brown, in Wall. List of E. I. Plants*, N. 7414.; *Wight et Arn. in Prodr. Fl. Pen. Ind. Or.* (ined.); *Wight. Cat.* N. 949.—Apama siliquosa, *Lam. Enc. Meth.* 1. p. 91.; *ill.* tab. 640.; *Rheed. Mal.* 6. tab. 28.

HAB. In dumetis montium prope Courtallum. In arenosis et apricis "in Aregatti et Mondabelle, aliisque locis" Malabariæ, copiose; *Rheede.*

(To be continued.)

Description of several New or Rare Plants which have lately flowered in the neighbourhood of Edinburgh, and chiefly in the Royal Botanic Garden. By Dr GRAHAM, Professor of Botany in the University of Edinburgh.

June 10. 1833.

Alstrœmeria aurea.

A. *aurea;* caule stricto, glabro; foliis lineare-ellipticis, sparsis, glabris, pallidis, margine scabriusculis, supra nervosis glaucis; pedunculis umbellatis, bifloris, erectis, foliis superioribus duplo brevioribus; corollæ laciniis patentibus, subæqualibus, mucronatis, exterioribus obovatis serratis concoloribus, interioribus lanceolatis integerrimis striatis.

DESCRIPTION.—*Stems* (1½ foot high, exclusive of the terminal umbel) numerous, erect, simple, glabrous. *Leaves* (4½ inches long, ¾th inch broad) very numerous, linear-elliptical, scattered, glabrous, light green, glaucous, and many-nerved on the surface, which, by the twisting of the long attenuated base, becomes the lower, slightly rough on the edges, callous at the apex, as is best seen in dry native specimens. *Peduncles* umbellate, erect, about half the length of the leaves which surround their base like an involucre, 2-flowered, the lateral flower springing from the axil of a leaf-like bractea, bearing another similar but smaller bractea on its side, and in general below its middle; and here probably in a very luxuriant state of the plant another flower would arise. *Corolla* orange-coloured, segments nearly equal in length, spreading, mucronate, the three outer segments obovate, serrated, the three inner lanceolate, the lower as well as the three outer segments of nearly uniform colour, and occasionally with one or two deep orange-coloured streaks, the two others more yellow below the apex, and having many such streaks down even to their channelled nectariferous bases. *Stamens* declined, rather longer than the lowest segment of the corolla, orange-coloured; pollen granules small, oblong, yellow. *Stigma* trifid, with short pubescence on the surface. *Style* ascending, angular, of uniform orange colour. *Germen* green, ribbed.

This species, imported by Mr Anderson, was received at the Botanic Garden from Mr Low of Clapton, under the specific name here adopted, and is now in flower in the greenhouse. I am afraid that in this, as in many other South American genera, we are unwarrantably multiplying specific names; but this is probably rightly considered distinct from any of the plants previously described. In habit it approaches nearly to *Alstrœmeria pulchella*, but probably will always be a much smaller plant.

Begonia radiata.

B. *radiata;* acaulis; foliis palmatis, utrinque, cumque petiolis et scapo elato, pilosis, lobis lanceolato-oblongis, undulatis, sinuatis; floribus dipetalis, filamentis basi solummodo cohærentibus, germine 3-alato (alis rotundatis?)

Description.—*Leaves* (7 inches across) bright green above, paler below, all radical, subpeltate, cordato-palmate, hairy above and below, with seven strong radiating nerves, very prominent below, lobes lanceolate, oblong, undulate, sinuated, dentate, unequal, the central (4 inches from the insertion of the petiol to its apex) being the longest, the others gradually smaller to the sinus; petiole rather shorter than the middle lobe, densely covered with long coarse entangled crystalline hairs, which, in fading, resemble yellow wool. *Scape* (2 feet high) tapering upwards, straight, pretty closely covered with oblong red streaks, from which spring long tortuous, acute, crystalline hairs. *Bracteæ* in opposite pairs at each division of the flower-stalk, serrated, ovate, hairy, dentato-ciliate, nerved, smaller in every succeeding pair. *Peduncles* dichotomodeliquescent, streaked like the scape, and somewhat hispid. *Flowers* rose-coloured, dipetalous, petals rotund, entire; male flowers in the cleft of the peduncles, expanding before the female. *Stamens* yellow, ascending; filaments cohering only at the base; anthers spathulate, connective extending beyond the loculaments. *Germen* 3-winged (wings rounded?)

We received this plant at the Botanic Garden, Edinburgh, from Berlin, in 1832, having the name *Begonia tanacetifolia* attached to it; but the leaves are so very peculiar, and so unlike a species of *Tanacetum*, that I cannot help suspecting our plant may have been put up by mistake, instead of another, and therefore I have ventured to apply to it another specific designation. When in a very vigorous state, it unfortunately damped off just before the flowers were fully expanded. The scape was cut and stuck into damp sand, but a few of the male flowers only expanded. The habit of the species is very singular.

Calceolaria crenatiflora.

C. *crenatiflora;* herbacea; foliis ovatis, sublobatis, dentatis, inferioribus præcipue petiolatis, utrinque caulique pubescentibus, subobliquis, floribus corymbosis, labio superiore minimo, inferiore amplo maculato crenato, laciniis calycinis late ovatis nervosis.

Calceolaria crenatiflora, *Cavanilles,* Icones Pl. 5. 28. t. 446.—*Sprengel,* Syst. Veg. 1. 44.
Calceolaria anomala, *Pers.* Synops. 1. 16.
Calceolaria pendula, *Sweet,* Brit. Fl. Garden, 155.

Description.—Herbaceous. *Stem* (1½ foot high) erect, purple towards the base, abundantly covered with soft spreading hairs, some of which are long and acute, a greater number half their length, and glandular. *Lower leaves* ovate, petioled (with the petiole 7 inches long, 3½ broad) decurrent along the petioles, slightly undulate, sublobate, dentate, suboblique, rugose, pubescent on both sides, dark green above, much paler below, and there purple towards the tip. *Stem-leaves* ovate, subacute, on much shorter petioles, smaller and more sessile upwards. *Flowers* corymbose, primary division in two or three branches, branches dichotomous with two flowers in the cleft. *Peduncles* (1½ inch long) as well as the branches having the same pubescence as on the stem. *Calyx segments* broadly ovate, subacute, spreading, densely covered with both kinds of pubescence on the outside, with the glandular only on the inner, entire nerved, nerves generally 5. *Corolla* with short glandular pubescence over the whole of the outer surface, most conspicuous on the upper lip, glabrous within, except at the insertion of the stamens, where there are a few hairs, yellow, sprinkled with orange-brown spots on the upper part of the lower lip, and on its inner side near the throat, the spots being there larger and round, in the former situation smaller and oblong, while in that part of the lower lip which is inflected in the throat they become streaks. *Upper lip* small semilunar, compressed upon the calyx, cucullate in the centre; *lower lip* very large, inflated, about a third of its lower surface parallel to the calyx, the remainder at right angles to this, and the upper surface forming an inclined plane from the throat, crenate at its lower part, the number of crenatures varying from three to five, and each frequently emarginate, inflected portion of the lower lip flat at right angles to its upper surface. *Stamens* erect, subexserted, filaments conical, slightly curved downwards, somewhat compressed, and having upon their surface a few erect, short, glandular hairs; anthers large, pale yellow, lobes divaricated, equal, deeply furrowed on their outsides; pollen cream-coloured. *Pistil* longer than the stamens; stigma small, glandular, capitate; style glabrous, slightly curved downwards; germen glanduloso-pubescent, shape and structure as in the genus, placenta large, ovules very numerous.

There is no species of this beautiful genus which forms so striking an object in the green-house as this. How far it will bear cultivation in the open air, we have yet to ascertain. I can see no reason whatever for the specific distinction between *Calceolaria crenatiflora* and *C. pendula* attempted to be drawn in the British Flower Garden. The chief distinction stated is the difference of the number of the crenatures in the lower lip, and the flowers being pendulous or suberect. The former character I find to vary continually in the flowers even on the same corymb; and the latter seems to me to depend solely on the degree of unnatural luxuriance produced by cultivation. I have both plants from Mr Low, who first raised them from seeds gathered in Chiloe by Mr Anderson, and who furnished the plant figured as *Calceolaria pendula* in the British Flower Garden, and I cannot see a shade of difference between them. The impropriety of unnecessarily changing names is absolutely caricatured by Persoon, who, knowing the plant only through the bad figure of Cavanilles, imagined the lower lip to be flat, not inflated, as in the genus, and therefore rejecting the name of Cavanilles, descriptive of a form found in, though not peculiar to the species, he gave a name applicable only to the figure.

Epacris nivalis.

E. *nivalis;* foliis ovato-lanceolatis, patentissimis, nudiusculis, infra nervosis, apice attenuatis, mucronatis, marginibus scabris; floribus axillaribus, solitariis, secundis, in pseudo-spicis longis aggregatis, corollæ tubo campanulato, calycibus acutis ciliatis multo longiore.

Description.—*Shrub* evergreen, with many long, slender, tomentous branches. *Leaves* scattered, spreading, ovato-lanceolate, attenuated at the apex, and mucronate, dark green above, slightly paler and 3-nerved below, nearly glabrous, edges slightly scabrous. *Flowers* solitary, axillary, peduncled, secund, cernuous, collected into long pseudo-spikes on the upper part of the branches, *peduncles* shorter than the leaves, tomentous, scaly. *Calyx* coloured, segments very acute, ciliated. *Corolla* white, glabrous; tube campanulate, 5-sided, pitted on the outside towards its base, so as to close it over the germen, about thrice as long as the calyx; limb of 5 reflected, cordato-ovate segments. *Stamens* alternate with the segments of the limb; filaments adhering to the tube; anthers nearly sessile in the throat, red, linear, incumbent. *Stigma* of five lobes, yellow. *Style* glabrous, white, attenuated towards its apex. *Germen* globular, green. *Hypogynous scales* semicircular, closely applied to the lower half of the germen.

This exceedingly beautiful species was introduced into the garden of Messrs Loddiges, by H. M. Dyer, Esq. in 1829. The specimens now described form pretty large bushes, and most attractive ornaments to the greenhouse in the extensive collection of Mr Cunningham at Comely Bank Nursery, near Edinburgh, where they were profusely covered with blossoms in April. It is extremely difficult to get written characters to distinguish *E. ceræflora*, *E. nivalis*, and *E. impressa*, though obviously very different species. The difficulties are increased by each seeming to vary considerably, and that in parts of structure which were considered diagnostic of the species. In the reformed characters which I have attempted here, I am forced, in distinguishing these three from each other, to rely chiefly on the tube of the corolla.

There is a variety of *E. nivalis* cultivated by Mr Cunningham, and obtained from Mr Low under the name of *E. variabilis*, in which the buds are suberect, the peduncle as long as the calyx, the tube of the corolla three times longer than this, twice as long as the leaves, and the sides grooved nearly along their whole length, the throat being slightly contracted; in all of which there is a departure from what has been considered the type of *E. nivalis*, and the flowers are larger than in this, the plant is more robust, slightly different in habit, and is rather less easily propagated by cuttings.

Epacris ceræflora is a much smaller plant than either of the others, the wood is much more slender, the leaves more crowded, and the flowers little more than half the size of theirs.

Epacris impressa,—Foliis lanceolatis, patentissimis, nudiusculis, infra nervosis, apice attenuatis, mucronatis, marginibus scabris, petiolis brevissimis; floribus pendulis, axillaribus, solitariis, in pseudo-spicis congestis, corollæ tubis prismaticis, calyce acuto ciliato multo longioribus.

Epacris ceræflora,—Foliis lanceolatis, patentissimis, nudiusculis, subaveniis, apice attenuato-mucronatis, marginibus scabris; floribus patulis, axillaribus, solitariis, secundis; corollæ tubo ovato, calycem acutum ciliatum bis superanti.

Eucalyptus amygdalina.

E. *amygdalina;* operculo hemisphærico, submutico, cupula breviore; pedunculis axillaribus et lateralibus, teretiusculis, petioli longitudine; umbellis 6–8-floris, subcapitatis; foliis lineari-lanceolatis, basi attenuatis, apice acuminato-mucronatis.—*Decand.*

Eucalyptus amygdalina, *Labill.* Nov. Holl. 2. 14. t. 154.—*Spreng.* Syst. Veget. 2. 501.—*Decand.* Prodr. 3. 219.

Metrosideros salicifolia, *Gærtner*, Fruct. et Sem. 1. 171. *a*, t. 34. fig. 3. ?

Description.—With us a rather slender-wooded *shrub*. *Branches* pendulous. *Leaves* (3–4 inches long) petiolate, linear-lanceolate, acuminato-mucronate, sometimes falcate or subsessile, ovato-elliptical and mucronate; glaucous, especially when young; distantly sprinkled with minute transparent dots; middle rib strong, veins and marginal callosity scarcely visible till dry. *Flowers* in axillary 5–8 (or more) flowered corymbs; *peduncles* scarcely longer than the petiole, stouter than it, nearly round, or obscurely furrowed; pedicels resembling the peduncle, and not much more slender. *Calyx*, including the cohering segments of its limb (operculum) scarcely so long as the pedicel; operculum hemispherical, minutely pointed, shorter than the tube (cupula). *Stamens* numerous, white, longer than the cupula. *Style* longer than the cupula, but shorter than the stamens.

This species, native of Van Diemen's Land, flowered at the Botanic Garden in the beginning of this month, when trained against the wall. We have not yet ascertained whether, like the *Eucalyptus pulverulenta*, it will thrive without this protection.

The descriptions of Fritillaria minor, Leontice Altaica, Libertia crassa and formosa, the new species Syringa Jacquinii, Oxylobium ellipticum, and Primula amœna, from want of room are delayed until our next publication.

Celestial Phenomena from July 1. *to October* 1. 1833, *calculated for the Meridian of Edinburgh, Mean Time.* By Mr Geo. Innes, Astronomical Calculator, 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*.

JULY.

D.	H.	′	″		D.	H.	′	″	
1.	7	5	15	☌ ☽ 1 μ ♐	13.	22	32	16	☽ very near ♀
2.	0	24	54	○ Full Moon.	14.	22	18	44	☌ ☽ σ ♉
2.	1	4	51	☌ ☽ 1 ν ♐	15.	2	20	1	☌ ☽ ζ ♉
2.	1	30	0	☌ ☽ 2 ν ♐	17.	7	3	36	● New Moon.
2.	5	50	8	☌ ☽ ο ♑	19.	1	59	48	Im. I. sat. ♃
4.	13	24	31	☌ ☽ η ♑	19.	3	56	38	☌ ☽ ☿
5.	2	26	1	Em. III. sat. ♃	19.	15	35	17	☌ ☽ ♂
5.	6	56	13	☌ ☽ γ ♑	21.	1	3	45	Em. II. sat. ♃
5.	10	14	13	☌ ☽ δ ♑	21.	3	24	14	☌ ☽ ν ♍
5.	10	32	8	☌ ☽ ♅	21.	5	9	43	☌ ☽ ♄
6.	14	34	–	☍ ☉ ♅	23.	3	47	29	☉ enters ♌
7.	9	32	37	☌ ☽ 2 ψ ♒	23.	21	27	48	☽ First Quarter.
7.	10	6	5	☌ ☽ 3 ψ ♒	24.	6	27	–	☌ ☿ α ♌
8.	9	13	37	☌ ☽ r ♓	24.	19	13	48	☌ ☽ 2 ξ ♎
8.	11	3	29	☌ ☽ s ♓	25.	13	14	16	☌ ☽ γ ♎
9.	12	47	25	☌ ☽ m Ceti.	25.	17	11	31	☌ ☽ η ♎
10.	4	0	30	☾ Last Quarter.	25.	21	40	0	☌ ☽ ϑ ♎ [elong.
10.	14	26	16	☌ ☽ ν ♓	26.	0	29	–	☿ greatest E.
11.	5	56	43	☌ ☽ ♃	26.	22	54	–	♀ greatest W.
11.	6	39	25	☌ ☽ 1 ξ Ceti.	27.	13	21	43	☌ ☽ ρ Oph. [elong.
11.	14	17	42	☌ ☽ 2 ξ Ceti.	27.	23	29	52	☌ ☽ D Oph.
11.	18	44	–	☌ ♀ 1 δ ♉	28.	1	14	23	Im. II. sat. ♃
11.	22	32	46	☌ ☽ μ Ceti.	28.	13	10	46	☌ ☽ 1 μ ♐
13.	11	12	–	☌ ♀ ε ♉	29.	7	21	13	☌ ☽ 1 ν ♐
13.	19	31	22	☌ ☽ 1 δ ♉	29.	7	46	38	☌ ☽ 2 ν ♐
13.	20	1	40	☌ ☽ 2 δ ♉	29.	12	9	7	☌ ☽ ο ♐
13.	20	36	54	☌ ☽ 3 δ ♉	31.	14	56	24	○ Full Moon.
13.	21	55	23	☌ ☽ ε ♉	31.	20	2	27	☌ ☽ η ♑

AUGUST.

D.	H.	′	″		D.	H.	′	″	
1.	13	35	53	☌ ☽ γ ♑	5.	19	44	15	☌ ☽ m Ceti.
1.	15	37	2	☌ ☽ ♅	6.	21	42	58	☌ ☽ ν ♓
1.	17	4	4	☌ ☽ δ ♑	7.	14	13	37	☌ ☽ 1 ξ Ceti.
3.	16	13	41	☌ ☽ 2 ψ ♒	7.	18	51	8	☌ ☽ ♃
3.	16	47	11	☌ ☽ 3 ψ ♒	7.	22	11	17	☌ ☽ 2 ξ Ceti.
4.	0	15	40	Im. I. sat. ♃	8.	6	27	22	☌ ☽ μ Ceti.
4.	15	58	39	☌ ☽ r ♓	8.	17	50	12	☾ Last Quarter.
4.	17	48	58	☌ ☽ s ♓	10.	4	35	27	☌ ☽ 1 δ ♉

AUGUST—*continued.*

D.	H.	′	″	
10.	5	7	6	☌ ☽ 2 δ ♉
10.	5	42	52	☌ ☽ 3 δ ♉
10.	7	3	26	☌ ☽ ε ♉
11.	2	9	22	Im. I. sat. ♃
11.	8	4	2	☌ ☽ ο ♉
12.	0	11	1	☌ ☽ ζ ♉
12.	3	1	59	☌ ☽ η ♊
12.	6	11	41	☌ ☽ μ ♊
12.	8	38	12	☌ ☽ ♀
13.	4	12	5	☌ ☽ δ ♊
13.	15	4	–	☍ ☉ ♅
14.	13	38	–	☌ ♂ σ ♌
14.	22	13	53	Em. II. sat. ♃
15.	14	27	12	● New Moon.
16.	20	32	7	☌ ☽ ☿
17.	0	4	26	Im. III. sat. ♃
17.	2	25	45	Em. III. sat. ♃
17.	5	1	54	☌ ☽ ♂
17.	12	40	6	☌ ☽ ν ♍
17.	18	41	12	☌ ☽ ♄
19.	22	31	29	Im. I. sat. ♃
20.	0	37	44	♀ very near ζ ♊
21.	1	51	28	☌ ☽ 2 ξ ♎
21.	19	29	5	☌ ☽ γ ♎
21.	22	25	38	Im. II sat. ♃
21.	23	22	11	☌ ☽ η ♎
22.	0	50	41	Em. II. sat. ♃
22.	3	46	15	☌ ☽ ϑ ♎
22.	6	19	24	☽ First Quarter.
22.	21	39	–	Inf. ☌ ☉ ☿
23.	10	27	22	☉ enters ♍
23.	19	4	14	☌ ☽ ϱ Oph.
24.	5	10	32	☌ ☽ D Oph.
24.	18	51	0	☌ ☽ 1 μ ♐
25.	13	3	58	☌ ☽ 1 ν ♐
25.	13	29	28	☌ ☽ 2 ν ♐
25.	17	53	2	☌ ☽ ο ♐
27.	0	25	19	Im. I. sat. ♃
27.	4	18	–	☌ ♂ β ♍
28.	2	3	9	☌ ☽ η ♑
28.	19	40	30	☌ ☽ γ ♑
28.	19	57	17	☌ ☽ ♅
28.	23	9	18	☌ ☽ δ ♑
29.	1	2	56	Im. II. sat. ♃
29.	3	27	34	Em. II. sat. ♃
30.	6	43	30	○ Full Moon.
30.	22	21	13	☌ ☽ 2 ψ ♒
30.	22	54	43	☌ ☽ 3 ψ ♒
31.	22	4	45	☌ ☽ τ ♓
31.	23	55	1	☌ ☽ s ♓

SEPTEMBER.

D.	H.	′	″	
2.	3	53	15	☌ ☽ ν ♓
2.	20	4	17	☌ ♂ ♄
3.	2	18	11	Im. I. sat. ♃
3.	20	30	35	☌ ☽ 1 ξ Ceti.
4.	1	57	32	☌ ☽ ♃
4.	4	22	54	☌ ☽ 2 ξ Ceti.
4.	12	54	48	☌ ☽ μ Ceti.
5.	3	39	57	Im. II. sat. ♃
6.	11	55	46	☌ ☽ 1 δ ♉
6.	12	27	35	☌ ☽ 2 δ ♉
6.	13	4	41	☌ ☽ 3 δ ♉
6.	14	27	19	☌ ☽ ε ♉
7.	5	41	24	☾ Last Quarter.
7.	16	10	17	☌ ☽ ο ♉
7.	20	24	52	☌ ☽ ζ ♉
8.	7	4	–	☌ ☿ α ♌
8.	7	19	0	☌ ☽ H ♊
8.	11	43	52	☌ ☽ η ♊
8.	12	18	–	☿ greatest W.
8.	12	47	–	☌ ♂ η ♍ [elong.
8.	14	59	24	☌ ☽ μ ♊
9.	13	40	58	☌ ☽ δ ♊
10.	4	13	9	Im. I. sat. ♃
10.	11	13	–	☌ ♀ δ ♋
10.	23	36	14	☌ ☽ ♀
11.	22	41	41	Im. I. sat. ♃
12.	7	44	–	☌ ☿ ϱ ♌
12.	15	42	8	☌ ☽ ☿
13.	22	0	18	● New Moon.
14.	10	30	32	☌ ☽ ♄
14.	20	29	35	☌ ☽ ♂
17.	10	35	7	☌ ☽ 2 ξ ♎
18.	3	39	48	☌ ☽ γ ♎
18.	7	25	44	☌ ☽ η ♎
18.	11	41	47	☌ ☽ ϑ ♎
19.	0	35	46	Im. I. sat. ♃

SEPTEMBER—*continued.*

D.	H. ′ ″		D.	H. ′ ″	
20.	1 58 7	☌ ☽ ρ Oph.	25.	11 40 34	☌ ☽ ♅
20.	11 52 5	☌ ☽ D Oph.	26.	2 29 58	Im. I. sat. ♃
20.	18 56 42	☽ First Quarter.	27.	4 18 58	☌ ☽ 2 ψ ♒
20.	21 38 –	☌ ☿ σ ♌	27.	5 2 41	☌ ☽ 3 ψ ♒
21.	19 8 0	☌ ☽ 1 ν ♐	27.	20 58 32	Im. I. sat. ♃
21.	19 43 14	☌ ☽ 2 ν ♐	28.	4 11 3	☌ ☽ τ ♓
21.	20 9 30	Im. III. sat. ♃	28.	6 0 59	☌ ☽ ς ♓
21.	22 27 3	Em. III. sat. ♃	28.	9 17 –	☌ ♀ α ♌
22.	0 4 14	☌ ☽ ο ♐	28.	23 4 30	○ Full Moon.
22.	22 12 3	Im. II. sat. ♃	29.	0 10 34	Im. III. sat. ♃
23.	7 2 20	☉ enters ♎	29.	2 27 29	Em. III. sat. ♃
24.	8 4 31	☌ ☽ η ♑	29.	14 38 –	☌ ☿ ♄
24.	13 7 –	☌ ☉ ♄	30.	0 48 54	Im. II. sat. ♃
25.	1 43 31	☌ ☽ γ ♑	30.	9 45 6	☌ ☽ ν ♓
25.	5 13 4	☌ ☽ δ ♑			

The Moon will be Eclipsed, July 1. and 2, *Visible* to all Europe.—The following are the times for the Edinburgh Observatory:

	D.	H. ′ ″
The Eclipse begins, . . .	July 1.	22 52 17,6
Middle, ...	...... 2.	0 30 21,2
End of the Eclipse, . . .	....	2 8 24,8

Digits Eclipsed, 10$^{dig.}$ 18′ 45″,4 on the South part of the Moon's Disc.

There will be a great Eclipse of the Sun * on 17th July, *Visible* to all Europe.—The following are the times for the Observatories of Edinburgh, Greenwich, and Aberdeen:

	D.	Edinburgh. H. ′ ″	Greenwich. H. ′ ″	Aberdeen. H. ′ ″
The Eclipse begins, . .	July 17.	4 57 7,8	4 5,8	5 2 42,1
Greatest Obscuration, ...		5 49 17,9	5 55 4,2	5 55 21,5
Visible Conjunction, ...		5 51 15,1	5 58 16,6	5 57 11,0
End of the Eclipse, ...		6 44 38,9	6 49 21,9	6 51 2,2
Digits Eclipsed at Greatest Obscuration, ...		dig. 10 0 31,9	dig. 8 47 48,3	dig. 10 9 29,9
The Moon will enter the Sun's Limb at		46° 41 18	37° 12 20	48° 19 4

from his Vertex, towards the right hand, as seen with a Telescope which does not invert.

On 20th August, at 0^h 37^m 44^s, it is *probable* that the Planet Venus may come in contact with ζ ♊ ; but the Planet and Star will not be risen at the time of nearest approach.

* An account of this eclipse was formerly inserted in this Journal for October—December 1828, where the reader will also find a Projection of it for Edinburgh Observatory.

Times of the Planets passing the Meridian, and their Declinations.

JULY.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	13 10	23 4 N.	9 4	15 42 N.	14 51	16 9 N.	7 21	10 42 N.	16 58	5 1 N.	3 3	14 51 S.
5	13 25	21 26	9 0	16 15	14 45	15 20	7 8	10 54	16 43	4 56	2 46	14 53
10	13 39	18 51	8 56	17 0	14 37	14 17	6 51	11 7	16 25	4 45	2 26	14 56
15	13 46	16 15	8 53	17 47	14 30	13 12	6 33	11 19	16 6	4 35	2 6	15 0
20	13 52	13 26	8 52	18 34	14 22	12 5	6 16	11 30	15 48	4 25	1 46	15 3
25	13 52	10 43	8 51	19 16	14 13	10 54	5 58	11 40	15 30	4 14	1 19	15 7

AUGUST.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	13 44	7 26 N.	8 52	20 5 N.	14 2	9 15 N.	5 33	11 51 N.	15 5	3 57 N.	0 57	15 12 S.
5	13 33	6 1	8 53	20 27	13 56	8 16	5 18	11 56	14 52	3 47	0 41	15 15
10	13 14	5 2	8 55	20 45	13 48	7 2	5 0	12 0	14 34	3 34	0 18	15 19
15	12 48	5 13	8 58	20 52	13 39	5 45	4 42	12 3	14 15	3 20	23 56	15 22
20	12 11	6 37	9 1	20 48	13 32	4 29	4 22	12 5	13 58	3 7	23 36	15 26
25	11 39	8 59	9 5	20 30	13 24	3 11	4 3	12 5	13 41	2 54	23 15	15 30

SEPTEMBER.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	11 2	11 52 N.	9 10	19 43 N.	13 13	1 20 N.	3 34	12 2 N.	13 16	2 33 N.	22 47	15 36 S.
5	10 53	12 37	9 14	19 5	13 7	0 18 N.	3 19	11 59	13 2	2 22	22 30	15 38
10	10 53	12 15	9 19	18 5	12 59	1 3 S.	2 59	11 53	12 45	2 7	22 10	15 41
15	11 0	10 24	9 22	16 52	12 51	2 23	2 38	11 46	12 27	1 53	21 50	15 44
20	11 12	7 26	9 26	15 27	12 43	3 43	2 16	11 38	12 10	1 38	21 29	15 47
25	11 27	3 50	9 30	13 51	12 36	5 2	1 55	11 28	11 53	1 23	21 9	15 49

SCIENTIFIC INTELLIGENCE.

METEOROLOGY.

1. *Influence of the Moon on Rain.*—From the comparison of a series of observations, continued for twenty-eight years at Munich, Stuttgard, and Augsburg, by Professor Schubler, it appears that the maximum number of rainy days takes place between the first quarter and the new moon. The number of rainy days in the last of these intervals, is to that in the first as 696 to 845, or in round numbers, as 5 to 6. And this proportion is not only true of the twenty years taken together, but also of the separate groups of four years, which give analogous numbers; we therefore conclude that it rains more frequently during the increase than during the wane of the moon. The results obtained by Schubler receive support from a series of observations made by Pilgram at Vienna. On 100 repetitions of the same phase, Pilgram found the falls of rain to be as follows: New moon 26, mean of the two quarters 25, full moon 29; consequently, at Vienna, as well as at Augsburg and Stutgard, it rains more frequently on the day of the full, than on that of the new moon. Arago remarks in regard to the observations, "*confining ourselves to the principal results, it seems difficult to resist the conclusion that the moon exercises an influence on our atmosphere; that in virtue of this influence rain falls more frequently towards the second octant, than at any other epoch of the lunar month; and, lastly, that the chances of rain are fewest between the last quarter and the fourth octant.*"

2. *The supposed Influence of the Moon on Vegetation.*—It is generally believed, says Arago, especially in the neighbourhood of Paris, that the moon, in certain months, has a great influence on the phenomena of vegetation. The gardeners give the name of *red moon* (lune rousse) to the moon, which, beginning in April, becomes full either about the end of that month, or more usually in the course of May. In the months of April and May, the moon, according to them, exercises a pernicious in-

fluence on the young shoots of plants. They maintain that they have observed during the night, when the sky is clear, the leaves and buds exposed to this light, to become red, that is to say, to be frozen, although the thermometer in the free atmosphere stood several degrees above the freezing point. They also assert, that if the rays of the moon are intercepted by clouds, and thereby prevented from reaching the plants, the same effects do not take place, under circumstances perfectly similar in other respects with regard to temperature. These phenomena seem to indicate that the light of our satellite is endowed with a certain frigorific influence; yet, on directing the most powerful burning-glasses, or the largest reflectors towards the moon, and placing the most delicate thermometers in their foci, no effect has ever been observed which could justify so singular a conclusion. Hence with philosophers the effects of the April moon are now referred to the class of vulgar prejudices, while the gardeners remain convinced of the accuracy of their observations. A beautiful discovery made some years ago by Dr Wells, will enable us, I think, to reconcile two opinions in appearance so contradictory. No one had supposed, before Dr Wells, that terrestrial substances, excepting in the case of a very rapid evaporation, may acquire during the night a different temperature from that of the surrounding air. This important fact is now well ascertained. On placing little masses of cotton, down, &c. in the open air, it is frequently observed that they acquire a temperature of six, seven, or even eight centigrade degrees below that of the surrounding atmosphere. The same is the case with vegetables. We cannot therefore judge of the degree of cold with which a plant is affected during the night, by the indications of a thermometer suspended in the free atmosphere: *the plant may be strongly frozen, although the air remains constantly several degrees above the freezing point.* These differences of temperature between solid bodies and the atmosphere only rise to six, seven, or eight degrees of the centesimal thermometer, when the sky is perfectly clear. If the sky is clouded they become insensible. Is it now necessary to point out the connexion between these phenomena, and the opinions of the country people regarding the April moon? In the nights of April and May, the temperature of the atmosphere is frequently only four, five or six centigrade degrees above zero. When this happens, plants exposed to the light of the moon, that *is to say, to a clear sky*, may be frozen, notwithstanding the indications of the thermometer. If the moon, on the contrary, does not shine—in short, if the sky is cloudy, the temperature of the plants does not fall below that of the atmosphere; and they will consequently not be frozen, unless the thermometer indicates zero. It is therefore quite true, as the gardeners pretend, that under thermometrical circumstances precisely alike, a plant may be frozen or not, according as the moon may be visible or concealed behind clouds. If they are deceived, it is only in their conclusion in attributing the effect to the light of the moon. The moon's light is, in this case, only the index of a clear atmosphere; it is only in consequence of the clearness of the sky that the nocturnal congelation of plants takes place, the moon contributes to the effect in no way whatever; although she were hid under the horizon, the effect would not be different.

3. *Influence of the Moon on Diseases.*—Hippocrates, says Arago, had so lively a faith in the influence of the stars on animated beings, and on their maladies, that he very expressly recommends not to trust to physicians who are ignorant of astronomy. The moon, however, according to him, only acted a secondary part, the preponderating stars were the Pleiades, Arcturus and Procyon. Galen shewed himself, in this respect, a zealous disciple of Hippocrates; but it was the moon to which he assigned the chief influence. Thus the famous *critical days* in diseases—that is to say, the 7th, the 14th, and the 21st, were connected with the duration of the principal phases of our satellite, and the lunar influence became the principal pivot of the system of *crises.* With regard to the theory of lunar influence on disease, it still counts a goodly number of partisans. In truth, I know not if the circumstance ought to astonish us. Is it not something to have on our side the authority of the two great physicians of antiquity; and among the moderns, that of Mead, Hoffman, and Sauvage? Authorities, I admit, are of little weight in matters of science, in the face of positive facts; but it is necessary that these facts exist, that they have been subjected to severe examination, that they have been skilfully

grouped, with a view to extract from them the truths they conceal. Now, has this procedure been adopted with regard to the lunar influence? Where do we find them refuted by such arguments as science would acknowledge? He who ventures to treat *a priori* a fact as absurd, wants prudence. He has not reflected on the numerous errors he would have committed with regard to modern discoveries. I ask, for example, if there can be any thing in the world more bizarre, more incredible, more inadmissible than the discovery of Jenner? Well! the bizarre, the incredible, the inadmissible, is found to be true; and the preservative against the smallpox is, by unanimous consent, to be sought for in the little pustule that appears in the udder of the cow. I address these short reflections to those who may think that the subject of lunar influence is unworthy of any notice.

HYDROGRAPHY.

4. *Instances of Ground Ice.*—A striking example of the formation of *ground-ice* is mentioned by the Commander Steenk of Pillau. On the 9th February 1806, during a strong south-east wind, and a temperature of + 34°.2 Fahrenheit, a long iron chain, to which the buoys of the fair-way are fastened, and which had been lost sight of at Schappelts-wrack in a depth of from 15 to 18 feet, suddenly made its appearance at the surface of the water, and swam there; it was, however, completely encrusted with ice to the thickness of several feet. Stones, also, of from three to six pounds weight, rose to the surface; they were surrounded with a thick coat of ice. A cable also, 3½ inches thick, and about 30 fathoms long, which had been lost the preceding summer in a depth of 30 feet, again made its appearance and swam on the surface; but it was enveloped in ice to the thickness of 2 feet. On the same day it was necessary to *warp* the ship into harbour in face of an east wind; the anchor used for the purpose, after it had lain an hour at the bottom, became so encrusted with ice, that it required not more than half of the usual power to heave it up.

5. *Avalanches in Grusia (Grusien).*—By information lately received from Grusia, it appears that a frightful and fortunately

rare occurrence had taken place and caused considerable sensation. On the morning of the 25th August 1832, an enormous avalanche descended suddenly from the mountain of Kasbek into a valley, through which the military road from Tiflis passes, and covered it for a distance of two wersts in length. The mass of snow extended across the entire ravine, which has a breadth of forty fathoms, and its thickness amounted to about forty faden (fathoms), so that the communication was interrupted by about a million and a half cubic fathoms of snow, ice, and masses of rock rolled down by the avalanche from above. The river Terck, which flows through the ravine, had its course so completely blocked up, that it burst through its banks at the upper end of the defile, tore away several bridges, destroyed a part of the road, and flooded the lower parts of the country, before it formed a new passage for itself. The inhabitants were saved by their own sagacity and their thorough acquaintance with the mountains, for even a week before the avalanche was precipitated, they had remarked signs which indicated with certainty the approaching catastrophe, and had accordingly removed to a considerable distance with their herds and moveable property. The forerunners of a great and dangerous avalanche are more or less frequent small avalanches of snow and loose earth from the Kasbeck, a mountain which rises to the height of 2500 toises above the level of the Black Sea. When the yearly augmenting masses of snow which lie on this mountain and its declivities, are increased to such an extent as to lose the power of coherence, they slide gradually downwards, carrying along with them large masses of rock, and giving rise to a thundering noise. It is at the same time remarked, that the mountain tributary streams of the Terck become considerably swollen and bring down earth and stones. As the Kasbek is seventeen wersts distant from the place where the avalanches are precipitated into the ravine, some time must necessarily elapse before the descending snow accumulates to such an extent as to roll over all the projecting cliffs which give protection to the road, and it is easy for the mountaineers to take to flight before the danger reaches them. Only two similar avalanches are known to have taken place in Grusia since it belonged to Russia; of which one happened in the year 1808, and the other in 1817; and notwithstanding the great and incessant labour employed for the purpose of clearing away the snow, yet in one of these instances five years elapsed ere it was entirely removed.

GEOLOGY.

6. *Hoffmann's Discovery in regard to Carrara Marble.*—According to the late investigations of Hoffmann, the famed marble of Carrara belongs to the Jura limestone formation, and even corresponds to the upper part of that deposit which affords at Solenhof and Pappenheim the well known lithographic stone. The limestone is observed rising from under the quader sandstone, at first but little changed, and in this state abounding in petrifactions the same as those that occur in the Jura limestone. With increased inclination of the strata, they become more granular, and often alternate with large masses of dolomite: at length, in an immense wall, which, in a length of six German miles, scarcely sinks to a lower level than 4000 feet above the sea, the limestone becomes throughout granular, and loses every appearance of a common Jura limestone. But, in descending towards Carrara, the Jura petrifactions appear again in the deeper beds, below Miseglia, in a road which leads to the marble quarries, and thus, according to Hoffmann, shewing that the beds of granular limestone or marble have been formed out of compact limestone, through subterranean agency The marble rests on clay-slate, which reposes on a mica-slate, supported by gneiss. Hoffman endeavours to shew that the mica-slate and gneiss have been formed from the clay-slate, through the agency of subterranean heat.

7. *Fish-bones and Scales in the Coal Formation.*—Many years ago, we pointed out to our pupils the bones and scales of fishes in the shale of the coal formation, in the neighbourhood of Edinburgh. Very lately my friend Mr Trevelyan has discovered some specimens of nearly whole fossil fish, at Wardie, near to Leith.

8. *Specific Gravity of some British Rocks.*—Compact hypersthene rock, Isle of Skye, 3.051. Trap vein in red sandstone, Isle of Lamlash, Arran, 3.014. Rock of the pillars of Fingal's Cave, 2.957. Anamesite or greenstone from Tobermory, in Isle of Mull, 2.905. Summit of Arthur Seat, with traces of

olivin, 2.886. West wall of Longraw, Arthur Seat, 2.801. Trap vein in the coal formation at Caroline Park, near Newhaven, 2.764. Rock of the Calton Hill, Edinburgh, 2.754. Trap vein in clay-slate, Rothsay, Isle of Bute, 2.746.—*Von Dechen.*

9. *Chemical Composition of some Secondary Rocks.*—The following analyses by two of our young friends will afford a good general idea of the chemical nature of several rocks connected with the coal formation near to Edinburgh.

(1.) Analysis of *Slate-clay*, from Wardie, near Newhaven. by Mr Robert Walker: It does not effervesce with acids, neither does it form a jelly with them. When exposed to a red heat, it loses interstitial water, and splits into fragments. It is found alternating with sandstone and bituminous shale of the coal formation in the above mentioned neighbourhood. Its constituents are, Silica, 60.00; alumina, 17.60; oxide of iron, 15.21; lime, 2.36; loss by heat 4.41: = 99,58.

(2.) Analysis of *Compact Felspar* from the Pentlands; by Mr John Drysdale. Specific gravity 2.53. Chemical characters: Effervesces slightly, and does not gelatinize with acids. Before the blowpipe, infusible *per se.* Heated on platinum-wire, with an excess of the salt of phosphorus, it forms a transparent and colourless glass. Constituent parts: Silica, 73.5; alumina, with a trace of iron, 11.23; carbonate of lime, 2.5; potash, 3.55; soda, 3.8; water, 4.6: = 99.20.

(3.) Analysis of *Greenstone* from Wardie, near Newhaven, by Mr John Drysdale.—Effervesces, and does not gelatinize with acids. Before the blowpipe, heated *per se,* it melts into a black glass; with the salt of phosphorus it melts into a transparent glass, yellow when hot, and colourless when cold. Specific gravity 2.873. Constituent parts:—Silica, 44.00; alumina, 11.4; iron (protoxide), 22.32; lime, 8.8; magnesia, 2.5; water and carbonic acid, 10.5: = 99.52.

(4.) *Felspar Rock* of Wardie, near Newhaven, by Mr Robert Walker.—The following is the analysis of an ash-grey rock, bearing a strong resemblance to compact Labrador felspar, but differing materially in chemical composition. It is found rising up among the strata of sandstone, slate-clay, and other rocks of the coal formation, and indeed at first sight might be taken for a Neptunian rock, were it not that it is distinctly seen passing into greenstone. Its igneous origin is beautifully seen in one part, where it has torn off a part of the slate-clay (now imbedded in it), and which has evidently undergone a sort of semifusion. From the following analysis it will easily be seen that it has a very different constitution from any felspar. It effervesces violently with acids, and does not gelatinize: its constituents are, silica, 37.20; alumina, 9.75; iron, 20.00; lime, 8.57; magnesia, 3.78; carbonic acid and water; 20.80, = 100.10.

10. *Inflammable Matter in Carnelian.*—In consequence of some remarks contained in a memoir of Dufay, published in 1732, relative to the decoloration of carnelian, Gaultier de Claubry heated, in a porcelain retort, some fragments of carnelian with deutoxide of copper. There was a sensible emission of gas, which appeared to be carbonic acid, and the fragments were deprived of their colour at the surface. In another experiment with pulverized carnelian, the development of gas was much greater, viz. 29 cubic centimetres from 100 grammes of carnelian. This appears to leave no doubt of the existence of organic matter in carnelian quartz, and to the presence of which it owes its colour. At the recommendation of Thenard, the experimenter calcined alone 100 grammes of carnelian, which lost in the operation 1.169 grammes, and furnished carbonic acid and some inflammable gas, besides an acrid liquor, which strongly reddened turnsol; no ammonia was disengaged from the liquid when treated with lime; the residue was of a greyish-white. It follows, that the colour of carnelian is owing to inflammable matter. A portion of the loss may be occasioned by the escape of water contained in the stone.

11. *Fossils in Granite.*—M. de Seckendorf has found in the Hartz, in the midst of a quarry situated near the causeway which leads to Hartzberg, fragments of greywacke, containing petrifactions imbedded (empatés) in granite. M. Hartmann, author of the Mineralogical Dictionary, confirms this statement.

12. *Geological Maps.*—In the year 1826 a Geognostical Map of Germany, in forty-two sheets, was published in Berlin by Simon Schropp & Co., which has become well known to the geologists of this country and the continent. Since that time a corrected edition has appeared, and it is with much pleasure we learn that a third, and very much improved, edition is nearly

ready, and will immediately be given to the public. This map is partly compiled from various geognostical maps already existing of some of the districts of Germany, and partly founded on original information communicated by some of the most distinguished geologists of the day. The names of the contributors are not given in the title, but we understand that the materials have been chiefly furnished by Von Buch, Alex. von Humboldt, Frederick Hoffmann, Von Dechen, and Von Oeynhausen. Besides the various scattered observations on the geognosy of Germany which have been made known since the publication of the last edition, the maps communicated to the great Vienna meeting of naturalists will also be made use of, and especially those of Partch and Rosthorn. The observations of *Zobel* and *Carnall* in Silesia, of *Klipstein* in the Vogelsgebirge, of *Stift* in the Westerwald and Lahn, and of *Merian* on the Black Forest, have caused material alterations in the delineation of those districts. The progress lately made in the knowledge of the geognostical structure and relations of Germany, has simplified considerably the series of colours employed to indicate the formations; for, in some cases, by the comparisons instituted, deposits believed to be distinct have been identified and united. Thus, while the table of colours employed in the former editions amounted to forty-eight shades, forty-one have been, in the present instance, found sufficient. The publishers of the above mentioned map have also the intention to prepare, immediately, a small general geognostical map of Middle Europe, which will be about 2 feet long, by 2 feet 8 inches broad, and include England, France, Germany, Prussia, Austria, Poland, Switzerland, and Upper Italy. The same materials will be employed for this map as for the other; and for those districts to which the latter does not extend, the best sources of information will be had recourse to. This map, which is intended for general circulation, and will appear about the end of the present year, will be very moderate in price, not more than three or four dollars. The well known spirit and liberality of Messrs Schropp & Co. ensure the good execution of the interesting undertaking we have announced.

13. *Plan in Relief of Wurtemberg.*—M. Rath, conservator of the Museum of Natural History at Tübingen, has for some time been occupied with the preparation of a plan in relief of

Würtemberg, including the principalities of Heichingen, Sigmanigen, and Fürstemberg, and the neighbouring portion of the Duchy of Baden. This plan in relief is 26 Parisian inches by 20, and is formed upon the same scale as the section published by M. Alberto in 1826, in his work on the Mountains of Würtemberg. The proportion of the horizontal distances to the heights is as 1 to 18, and in this the higher portion of the Swabian Alps has, in the plan, the height of one inch and a half, and so on in proportion the other mountains. Professor Schübler of Tübingen, who has superintended and assisted in the work, will contribute a treatise on the heights and on the geognosy of Würtemberg. The colouring may, according to the wish of the purchaser, be made to express either the leading geognostical features of the country, or the natural appearances of the surface. The price of a copy of either kind is 20 florins 24 kreutzers; and of both kinds if the two are taken by the same person, 44 florins. Geognostical Maps of Würtemberg, coloured by M. Rath after the original map by Professor Schübler, are also to be had at Tübingen.

ZOOLOGY.

14. *Hermaphrodism.*—M. Isidore Geoffroy Saint-Hilaire considers the generative apparatus altogether as formed of six principal segments, which in several circumstances are independent of each other, to-wit, of the right and left side; these are, 1st and 2d, *deep-seated* organs (ovaries, or testicles and their appendage); 3d and 4th, the intermediate organs (the womb or prostate, and the vesiculæ seminales and their appendages); 5th and 6th, *external* organs (clitoris and vulva, or penis and scrotum). The facts which the author states, establish the independence of these six segments, and shew, that there is not one of them which may not present sexual characters, the reverse of those of all the rest. These six segments correspond to six orders of different vessels; the deep-seated to the spermatic arteries, the intermediate to the branches of the hypogastrius, and the deep-seated (les profonds *) to branches of the external iliacs. M. Geoffroy divides the numerous cases of her-

* Quære externes? the external.—Edit.

maphrodism into two grand classes, hermaphrodism without excess, and hermaphrodism with excess. He subdivides the first class into four groups, to-wit, 1st, *Masculine hermaphrodism*, the generative apparatus being essentially male; 2d, *Feminine hermaphrodism*, the generative apparatus essentially female; *Neuter hermaphrodism*, apparatus without determinate sex; 4th, *Mixed hermaphrodism*, apparatus presenting a real mixture of the two sexes. He admits these subdivisons in the second class; 1st, *Masculine hermaphrodism complicated;* 2d, *Feminine hermaphrodism complicated;* 3d, *Bisexual hermaphrodism.* M. Geoffroy then passes these several genera in review. From the facts and observations contained in his papers, the author draws the following conclusions. Perfect hermaphrodism in the anatomical sense of the term, has never been observed. The most complex cases are those where there exists double organs deep-seated and intermediate, the one male, and the other female; and, in fact, the penis and clitoris, by reason of their connexions with the several bones of the pelvis, could not co-exist without a serious disturbance of all the connexions. As to perfect hermaphrodism, in the physiological sense of the word, its possibility is incontestible in animals, as in fishes, which have the two halves of the sexual apparatus quite separated from each other in the normal state, and in which there is no copulation. The frequency of hermaphrodism in general, and of each kind of hermaphrodism in particular, is very different, according to the groups of animals. Thus, in man, masculine and feminine hermaphrodisms, particularly the first, are very rare. "With reference to legal medicine, it is sufficient for me to point out here," continues the author, "the insufficiency of the precepts given by authors for the determination of the sex in doubtful cases, precepts which have appeared exact only because there had been but a very few of the combinations distinguished which nature presents. This difficulty in distinguishing the sex is the consequence of this general fact, that whilst the internal organs vary almost to infinity in number, structure, and arrangement, the external ones preserve their normal number, and the modifications which they present in other respects being intermediate between the male and female sexes, are included within limits sufficiently narrow. It is then impossible that a particular arrangement of the external organs could correspond to each of the special combinations of the internal organs." Lastly, the author remarks, that legislation admitting only two grand classes of individuals on whom it imposes duties, and grants different, and almost opposite rights, according to their sex, does not truly embrace the entire of the cases; for there are subjects who have really no sex; such are neuter hermaphrodites, and hermaphrodites mixed by superposition; and on the other side, certain individuals, the bisexual hermaphrodites, who present the two sexes united in the same degree.—*Dub. Journ. of Med. and Chem. Science*, No. VIII. vol. iii. p. 277.

15. *Vomiting in Ruminant Animals.*—M. Flourens lately read to the French Academy a paper entitled, " Experiments regarding the action of Tartar Emetic on Ruminant Animals." In a preceding memoir the author established, by means of numerous experiments, that the vomiting proper to ruminant animals differs essentially from the vomiting of other animals in this, that instead of being, as the latter, a confused rejection in a mass, it constitutes, on the contrary, a rejection which is affected only in regulated and detached portions. The new paper of M. Flourens is intended to show, that these two sorts of vomiting depend on different stomachs; and thence to arrive at the explanation of this extraordinary fact, that animals which regurgitate with most facility, do not vomit unless with extreme difficulty, or even do not vomit at all. After having instanced the experiments of Daubenton, Gilbert, and Huzard, he details his own. We cannot dwell on them here. We shall confine ourselves to repeating the conclusions which he has drawn from them. From the facts and observations contained in his paper, the author concludes, 1st, That tartar emetic produces on sheep the same general effect, that is, the same excitation of all the powers which provoke or determine the vomiting which it produces in ordinary animals; 2d, That among the different stomachs of ruminating animals, it is on the rennet bag, to say on that alone, which, by its functions, as by its structure, corresponds with the simple stomach of other animals, that the emetic displays its action; 3d, That it is to the particular, and altogether opposite, disposition of

this stomach, in reference to those for regurgitation, that is to be ascribed on one hand the facility which ruminant animals have of regurgitating, that is to say, by the throwing up into the mouth the substances contained in the first two stomachs, and, on the other hand, the difficulty which they have in vomiting, *i. e.* in rejecting and bringing back into the mouth the substance contained in the fourth stomach. If it be recollected, that this fourth stomach is that where the definite conversion of the aliment into chyme takes place, that which contains the ruminated substances, the substances which consequently must no longer return to the mouth, whilst the first two stomachs, on the contrary, are those where the aliment undergoes only a certain preparation, those which contain only the substances not ruminated, the substances which consequently must return into the mouth, we shall soon see why every thing must be disposed to render easy the rejection of the two first stomachs, and that of the fourth very difficult. Without this arrangement in fact, the ruminated substances contained in the fourth stomach would be constantly mixed together, confounded and brought back into the mouth, with the substances not ruminated, a confusion which must be an obstacle to the accomplishment of the end which nature proposed to herself to attain by the act of ru mination.—*Dublin Journ. of Med. and Chem. Science*, *May* 1833.

ARTS.

16. *Clay for Sculptors.*—Sculptors who prepare their models in clay, have frequently occasion to leave their work for a long time unfinished ; and, in such cases, often experience much difficulty from the drying and shrinking of the material. It is well to know, that, by the addition of 10 to 15 per cent. of muriate of lime, well worked or kneaded into this clay, it will be preserved for almost any length of time in a moist state, and fit for a renewal of the work without any preparation.

17. *Lute for Bottling Wine, &c.*—One part resin, one-fourth part yellow-wax, one-sixteenth part tallow ; add one-half part yellow ochre, or red or black ochre, or coal. Keep these ingredients melted over a chafing-dish ; and, when the bottle is well corked, dip the neck into the melted mass.

18. *Method of cleansing Wool from its Grease, and economising the residue.*—M. Darcet, who has long been consulted by manufacturers, advised the following method, which was tried with complete success. Immerse the wool, well washed from dirt, in a vessel containing spirits of turpentine, and let it remain from thirty-six to forty-eight hours. Withdraw, and immerse a fresh quantity. By means of a press, force out all the adhering spirit, spread the wool out to dry, and, when it is to be used, wash it in warm water containing a little alkali. When the spirits of turpentine will no longer act upon or remove the grease, distil it for fresh use, and the matter remaining in the still, treated with soda, will make good soap.

19. *Stucco for Walls.*—In Italy great use is made of a stucco which gives to the walls the brilliancy, the cleanliness, and almost the hardness, of marble. It may be variously coloured, to suit the taste of the employer. This stucco is made very easily, by mixing lime and pulverized marble, in nearly equal proportions, according to the meagerness or richness of the marble. A paste or mortar is made of this mixture, and applied to the wall in the thickness of a five-franc piece, with a trowel wet with soap-suds, and in such a way, that the whole of the wall may be finished in the same day. None but mineral colours should be mixed with the stucco, as the lime would destroy those derived from the vegetable kingdom. To obtain the greatest brilliancy, the mortar should be applied with a cold trowel. Workmen, for the sake of ease and expedition, usually employ it warm. Chips and fragments of marble may be advantageously employed for this purpose. In cases where the appearance of a marbled wall would be objectionable, on account of its coldness, any portion of it may be covered with paper.

20. *Preservation of Substances by means of Alkalies.*—M. Payen has preserved, during many months, polished instruments of iron and steel, by keeping them in solutions of potash or solutions of potash or soda—saturated solutions, diluted with one, two, or three, times their weight of water. He at first thought that the preserving power depended upon the disappearance of the air and carbonic acid in the alkaline mixture, but he afterwards concluded that alkalinity acted an essential part in the phenomenon. In fact, a very small quantity of alkali is suffi-

cient: thus, $\frac{1}{2000}$ and even $\frac{1}{3000}$ of caustic potash in water, will preserve from oxidation bars of iron, &c. immersed in it. Lime-water, diluted with its own weight of water, or, of course, without dilution, answers the same purpose. Alkaline carbonates and borax have the same effect, but they must necessarily be stronger.

21. *On the Prevention of Dry-Rot.*—At a meeting of the Royal Institution, after adverting to the extensive decay of wood in ships, houses, and other structures of that material, involving a loss of such magnitude, as to have excited almost universal search after a remedy, Mr Faraday said he should pass by all propositions for its prevention, except that one absolutely introduced by Mr Kyan, and to which Mr Faraday had paid particular attention. The process is now largely in use. The wood, prior to its application, is immersed in a solution of corrosive sublimate; in the course of a week, a load of it is found to have absorbed five gallons of solution; at the end of that time it is removed, and shortly after becomes fit for building. The preservative powers of corrosive sublimate in furs, stuffed birds, anatomical specimens, &c. are well known; and those which it exerts over wood seem to be not less decisive, and far more useful. Pieces of timber thus prepared were put into a fungus-pit at Woolwich for three years, and at the end of that time taken out perfectly sound. Canvass and calico, treated in a similar manner, were also found to be preserved from mildew and decay. Mr Faraday's suspicions appear to have been excited, not so much as regarded the preservative power of the process, but the healthiness of the wood, canvas, &c. impregnated by it; and he required that such prepared materials should be thoroughly washed, and then submitted to a test for proving the power of resisting decay. He found, after calico and canvass had been washed in water until all the solution which that fluid could remove had disappeared (mercury was still present), such *prepared* materials were preserved in a damp cellar, while the *unprepared* went rapidly to decay. Having ascertained this combined state of the mercurial preparation, Mr Faraday expressed his opinion, that the organic substances could be well preserved by it without deriving any unwholesome quality to deteriorate their ordinary application.

PROCEEDINGS OF THE SOCIETY FOR THE ENCOURAGEMENT OF THE USEFUL ARTS IN SCOTLAND.

The following articles and communications were laid before the Society during the months of February and March 1833 :—

Feb. 6.—1. Model and description of the lower part of a Lime Kiln with Double Grates and Doors. By C. G. S. Menteath, Esq. of Closeburn.

2. Model of a Railroad, or Wheel Track, for all sorts of Carriages. By the same.

3. Model of a Carriage or Waggon Drag, used in France, and applied with great advantage to loaded waggons, in the south of Scotland. By the same.

4. On the advantages of a Short Arc of Vibration for Clock Pendulums. By Mr Edward Sang, teacher of Mathematics, Edinburgh.

Feb. 20.—1. Model, Drawing, and description of a Chimney Top or Can for Curing Smoke. By Mr Alexander Grant, surgeon and druggist, 11 Broughton Street, Edinburgh.

2. Donation.—Model of a Cast-iron Chimney Top, which effectually cured a smoky vent in the Castle of Edinburgh. Invented by the late Major Straton, Royal Engineers. Presented by General Sir William Maxwell, 125 George Street, Edinburgh.

3. Models and Description of improvement in the Construction of Joiners' Moulding Planes, calculated to supersede the use of so great a number of Planes as are now in use. By Mr John Smart (son of Mrs John Smart), High Street, Brechin.

4. Model, Description, and Drawings of an Improved Safety Lock for Bankers' Safes, &c. By William Crawfurd, Esq. of Cartsburn.

5. Notice of a Prize given by the Board of Trustees, "of L. 25 for the best and most useful invention of Machinery, applicable to Manufactures, to be judged of, in the first instance, by the Society of Arts, and afterwards by them submitted to the Board of Trustees for its approval or rejection."

The following Candidates were balloted for and duly admitted Ordinary Members, viz :—

Mr David Bryce, architect, Edinburgh.
Mr Wilkinson Steele, merchant, Edinburgh.
William Brown, Esq. M. D. Edinburgh.

March 6.—1. Model and Description of a Safety Lamp for Coal Mines. By Mr John Henderson, 3 Mayfield Loan, Edinburgh.

2. Model and Description of Ventilating Bellows for Churches, Coal Mines, &c. By the same.

3. Specimens of Transfer Lithography. By Mr David Allan, lithographer, 187 Trongate, Glasgow.

4. An Alphabet for the use of the Blind. By Mr James Panal Walker, mariner, Post Office, Glasgow.

5. An Alphabet and Description, with Specimens of a mode of Printing for the Blind. By Miss Margaret Bancks, Middleby Street, Newington, Edinburgh.

Montgomery Robertson, Esq. M. D. Edinburgh, was admitted an Ordinary Member.

J. C. Loudon, Esq. Bayswater, London, author of the Encyclopædia of Cottage Architecture, &c. &c. was elected an Honorary Member.

March 20.—1. Model and description of an improved Windlass for Vessels. By Mr John Henderson, 3 Mayfield Loan, Edinburgh.

2. Model and description of improved Inside Windows for Shops; to keep the goods free from dust, smoke, and gas. By Mr Thomas Johnston, 137 George Street, Glasgow.

3. Drawing and description of an Instrument for taking the dimensions of the human body with anatomical and mathematical precision, for the purpose of fitting it to absolute nicety, with clothes. By Mr James M'Donald, tailor, 46 West Register Street, Edinburgh. The instrument was exhibited.

Mr Alexander Gilkie, surveyor, Edinburgh, was admitted an Ordinary Member.

(*To be continued.*)

List of Prizes offered by the Society for the Session 1833–34.

The Society for the Encouragement of the Useful Arts in Scotland, have announced the following Prizes for the Session 1833–34:

1. For the best and most useful Invention of *Machinery applicable to Manufactures,* to be judged of, in the first instance, by the Society of Arts, and afterwards by them submitted to the Board of Trustees for its approval or rejection;—

The Board of Trustees have offered a Prize of Twenty-five Sovereigns.

2. For the best Paper on the *Construction of Public Buildings, in relation to the Theory of Sounds,* so as to ensure the voice of the speaker being distinctly heard, so great a desideratum in such buildings:—keeping in view the two cases, 1st, Where the voice proceeds from one place, as in a Church; and, 2d, Where the speakers may be situated in different parts of the hall;—*The Society's Gold Medal, value Ten Sovereigns.*

3. For the best Specimen of Lithographic Drawing and Printing, by Lithographic Artists resident in Scotland, of subjects in *Civil and Naval Architecture, Landscape, Machinery, and Maps,* from Transfer Drawings; the size of each to be not less than 2 feet, by 1 foot 6 inches. Three impressions of *each* of these subjects to be sent;—*The Society's Gold Medal, value Twelve Sovereigns.*

4. For the best ditto, ditto, of subjects in *Portrait, Historical and Landscape,* from Chalk Drawings; the size to be not less than 9 inches by 6. Three impressions of *each* of these subjects to be sent: —*The Society's Silver Medal, value Eight Sovereigns.*

N. B. The two Prizes last mentioned are from a Fund furnished by the Association for the Improvement of Lithography in Scotland. *Specimens intended to compete for either of these two Prizes must be lodged on or before the* 1st *of March* 1834. The successful Candidates shall be bound to furnish, if required, 50 impressions of each subject which shall be found entitled to either of the above Prizes,—for which they shall be paid an extra sum, to cover the outlay for paper and printing. The Society of Arts retain to themselves the power of withholding the whole or any part of the above Prizes till a future time, if there be not more than *three* competitors, or if the Specimens produced do not appear to be of sufficient merit.

5. For the best Specimens of *Busts and other fine Ornamental Castings in Iron,* moulded and cast in Scotland by native Founders;—*The Society's Gold Medal, value Ten Sovereigns.*

6. For other Inventions, discoveries, or Improvements in the *Mechanical* or *Chemical* Arts; or by which the *Natural Productions of Scotland* could be made more available to the Useful Arts than at present,—the Society will be ready to expend a further sum, in Premiums and Honorary Medals, of *Fifteen Sovereigns.*

General Observations.—The attention of Candidates is particularly directed to the following subjects, as a specimen of what the Society would desire to be brought before them; but candidates are by no means limited to these subjects, viz.—Best construction of Screw-plates, Taps and Dies, &c. —Means by which the expense of Diagrams, &c. for Books of Science, &c. may be lessened.—Economizing Fuel, Gas, &c.—Observations on *correct* representations of *Natural Objects,* for the ornamenting of Ceilings and Walls of Rooms, in the printing of Cloth, Painting of China and Stone-ware, &c.—Selecting, Working and Tempering of Steel, or any Compound Metal, for Edge and other Tools, Dies, Springs, Plates for Engraving, &c.—Improve-

ments in Balance or Pendulum Timekeepers.—On the best Composition for Rollers employed in applying Ink to the Types in Letter-press Printing, especially with a view to preserving their adhesive and elastic properties in as uniform a condition as possible during damp and other variable states of the atmosphere, &c. &c.

The Society shall be at liberty to publish in their Transactions copies or abstracts of all Papers submitted to them.

In the event of any Communication not being considered of sufficient merit to entitle it to the whole Prize for which it competes, the Society reserve the power of lessening the Prize.

The Society particularly request, that all communications intended to compete for the above Prizes (except the 3d and 4th Prizes) may be forwarded to the Secretary during *November and December* 1833, and, *if possible, early in November*, in order to insure their being read and reported on during the Session.

Communications, Inventions, and Models, to be forwarded to James Tod, Esq. W. S. 21 Dublin Street, Edinburgh, Secretary to the Society; and it is requested, that, in all cases, *full descriptions* of the Inventions may be sent; and, where the nature of the communication requires it, that there be also sent relative *Drawings, Sketches* or *Models*, so as to enable the Society fully to judge of the merits of the communications.

Royal Institution, Edinburgh,
29*th May* 1833.

LIST OF PATENTS GRANTED IN SCOTLAND FROM 22D MARCH TO 31ST MAY 1833.

1833.

March 22. To John Obadias Newell Rutter of Lymington, in the county Southampton, wine merchant, for "an improved process for generating heat, applicable to the heating of boilers and retorts, and to other purposes for which heat is required."

25. To Samuel Hall of Basford, in the county of Notts, cotton manufacturer, for "an improved method of lubricating the pistons, piston-rods and valves, or cocks of steam-engines, and of condensing the steam of such engines as are worked by a vacuum produced by condensation, which method of condensation is applicable to other useful purposes."

April 2. To Thomas Moore Evans, of Birmingham, in the county of Warwick, merchant, in consequence of a communication from a certain foreigner residing abroad, for "certain improvements in machinery for preparing and dressing flax, hemp, and other fibrous materials.

24. To George Rodgers of Sheffield, in the county of York, merchant, and John Tatam of Hilton, in the county of Derby, gardener, for "an improved button."

1833.

April 24. To Claude Marie Hilaire Molinard, of Bury Street, Saint Mary Axe, in the city of London, merchant, in consequence of a communication made to him by a certain foreigner resident abroad, for "certain improvements on looms or machinery for weaving fabrics."

To James Brown, of Margaret Street, Commercial Road, in the county of Middlesex, rigger, for "certain improvements in capstans, and apparatus to be used therewith."

26. To Thomas Spinney of Cheltenham, in the county of Gloucester, gas-engineer, for "an improved earthen-ware retort for generating gas for the purpose of illumination."

May 15. To William Graham junior, of the city of Glasgow, cotton-spinner and power-loom manufacturer, in consequence of a communication made to him by a certain foreigner, for "an invention of a self-acting temple, to be used in the operations of weaving by power or hand loom.

To George Harris of East Woolwich, in the county of Surry, Esq., a captain in his Majesty's Royal Navy, for "a method for the reducing and preparing various vegetable substances (not hitherto in use for like purposes), and for the manufacturing them into articles in general use heretofore usually made from hemp and flax."

16. To Robert Stein of Edinburgh, Esq., for "an improved steam-engine on the rotatory principle."

To George Frederick Muntz of Birmingham, metal-roller, for "an improved manufacture of metal plates for sheathing the bottoms of ships or other such vessels, and also of bolts and other the like ship's fastenings."

21. To William Harrold of Birmingham, in the county of Warwick, merchant, in consequence of a communication he had from a certain foreigner residing abroad, for "an improvement or improvements in machinery for making or manufacturing paper."

To Christopher Robinson of Athlone, in the county of Roscommon, Ireland, distiller, for "certain new or improved machinery for transferring caloric from aeriform or fluid bodies to other bodies of the like description, and applicable to other useful purposes."

31. To Archibald Douglas of Manchester, in the county of Lancaster, manufacturer, for "certain improvements on power-looms and the shuttles used therein."

To Thomas Spinney of Cheltenham, in the county of Gloucester, gas-engineer, for "a new combination of materials for the manufacture of crucibles, melting-pots, and fire-bricks."

THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

HISTORICAL ELOGE OF LOUIS NICOLAS VAUQUELIN.

By Baron CUVIER *.

THE respect which the members of the Academy entertain for the memory of their illustrious associate, the late M. Vauquelin, obliges me again to bring forward his historical eloge, which formed part of our business at the public meeting of last year, and which ought to have been read, had time permitted, along with that of Sir Humphry Davy. The patience and perseverance which we had occasion to admire in the latter, and which raised him from the most unpromising station to the enjoyment of all the honours society can confer on its benefactors, were not less conspicuous in M. Vauquelin, who had still greater difficulties to overcome, as his parents were in a poorer condition, and he had fewer opportunities of instruction.

LOUIS NICOLAS VAUQUELIN was born on the 16th of May 1763, in a cottage of the village of St André d'Hebertat, a league and a half from Pont l'Evêque (Calvados); and an idea may be formed of the condition of his family, from the circum-

* This eloge of the celebrated chemist Vauquelin, not yet published, was sent in proof-sheet, through the kindness and attention of our friend Mr Pentland of Paris.—EDIT.

stance of his mother, when he was first sent to school, offering him as an inducement to diligent learning, the fine livery dresses which he had sometimes seen in a neighbouring castle. Being naturally inclined to diligence, he speedily acquired all that could be learned in a village school; and, without further preparation, at the age of thirteen or fourteen, committed himself to the world, and went to push his fortune at Rouen. An apothecary of that town, pleased with his appearance, took him into his laboratory; that is to say, he employed him in blowing his fire, and washing his retorts—a situation scarcely superior to that which had first been the object of his ambition, and in which he certainly was not so well clothed.

But this apothecary gave lessons in chemistry to some apprentices, and the young rustic, standing humbly behind the seats, listened with emotion. The operations in which he had taken such an humble part, had, from the first, attracted his attention: he was astonished to see them connected together by theory, and form a consistent whole. He proceeded to take notes, which he subsequently perused and meditated upon; experiencing even then, in his unhappy circumstances, the most certain consolation granted to man, that of study. His master one day found him thus employed, and what would have interested a generous heart, threw him into a violent passion; he snatched the paper from the poor child, tore it, and forbade him continuing such practices, under pain of dismissal. M. Vauquelin has often said that he never experienced such poignant distress; he shed bitter tears, and, unable to bear the sight of this unjust man, he went to Paris on foot, with a small bundle on his back, and six francs in his pocket, which had been given him by a charitable individual.

Two apothecaries employed him successively, but so little were they sensible of what he was capable, that when he became unwell, he had no other asylum than the Hôtel-Dieu; and when he left it, and wished to find employment, his paleness and weakness caused him to be everywhere rejected.

Destitute of all resource, and not knowing how to prolong his existence for another day, he walked along the street St Denis, weeping bitterly, and ready to give himself up to despair; but he at last made another trial, and found some compassion. An apothecary named Cheradame (for it is just to preserve the name of the individual whose humanity procured him the good fortune to preserve a Vauquelin), affected by his destitute condition, received him into his house, and treated him as a man ought to be treated. With the improvement of his circumstances, his ardour for learning returned; what he had written in the papers torn by his master at Rouen was not effaced from his memory; to that he added the phenomena which he had daily opportunities of witnessing, and even attempted to make experiments with the few materials which he occasionally found at his disposal. He was sometimes found in a kind of ecstasy at observing the precipitations which he had produced: he was already a chemist almost before he knew precisely what chemistry was. But chemistry was not his sole occupation: he felt that a knowledge of Latin was necessary to enable him to continue his studies; and to attain this more readily, he tore the leaves from an old dictionary, and always held some of them in his hand, when traversing the streets with medicines, or executing other commissions, till he had learned the words by heart. He likewise accompanied the young pupils when they went to gather herbs, and surprised them by the facility with which he retained the names and even the characters of plants.

So much application and rapid advancement in a scholar possessing so few advantages, was often a subject of conversation with M. Cheradame. He mentioned him to our late associate, the celebrated M. Fourcroy, his relation, who having likewise in his youth been oppressed with poverty, would naturally feel sympathy for a youth whose situation bore so much resemblance to his own. The modest offers which alone he was in a condition at that period to make, were joyfully accepted, and henceforth a career opened to M. Vauquelin, as brilliant as it had previously been the reverse. Become by degrees the assistant and the pupil of Fourcroy, the assiduous companion of all his labours, and his intimate friend, their names are united in so many memoirs of experiments and discoveries, that they will remain inseparable in the history of science; and what is perhaps still more remarkable, and confers equal honour on them both, is the fact, that, during upwards of twenty-five years, nothing ever cooled for a moment their mutual attachment, the effects of which were observable long after M. Fourcroy's death.

M. Fourcroy neglected nothing to complete the education of his pupil: he became his preceptor, and almost every thing had yet to be taught him. When he had made him acquainted with some good ancient and modern authors, and formed his language and style, he gradually introduced him into the world, and presented him to men occupied with science. He procured his admission into that society which undertook to reform the theory of chemistry and even of language, and used every exertion to have him appointed a member of the Academy of Sciences.

The influence which political events had conferred on M. Fourcroy was incessantly employed to ameliorate Vauquelin's circumstances. The offices of Inspector of Mines, of Professor of the School of Mines, and to the Ecole Polytechnique, and that of Essayer of gold and silver articles, were due to his intercession; and even when the reputation of his élève might have rendered his protection less necessary, he ceased not to avail himself of every opportunity of advancing his fortune. It was thus that M. Vauquelin was raised to the Chair of Chemistry in the College of France, and to a place in the Council of Arts and Commerce; that he was nominated one of the Commissioners for the law relating to Pharmacy, and one of the Examinators of the Ecole Polytechnique, and that he at last became the colleague of Fourcroy himself in the Museum of Natural History.

In these promotions, the Director of Public Instruction was no doubt seconded by the wishes of all the admirers of Vauquelin's works, who were generally attracted by the gentleness of his character; but if he had not been influenced by feelings of a personal nature, how many other uses might have been made of his power without any being able to find fault? The gratitude, too, of M. Vauquelin, was great and unreserved. Never did he decline any investigation required by Fourcroy; and no division of glory, even when the degree of labour was unequal, ever appeared to him unjust. It was not always Fourcroy who had made the experiment, but it was he who had formed the experimenter; all belonged to him, and what belonged to his benefactor was equally the property of Vauquelin. Long after the death of Fourcroy, he took charge of his sisters, who were poor, aged, and diseased, as he would have done of his own mother. For their sakes, he renounced the pleasure of having a family of his own, and they remained till their death in his house, the objects of his most tender and anxious care.

After what has been said, it will be perceived that a great part of M. Vauquelin's eloge must be that of M. Fourcroy[1]; and accordingly we have there spoken of their great experiment *Sur la Composition de l'Eau par la Combustion du Gaz Hydrogène*[2]; of their united labours *Sur l'Urée*[3]; on the *Différents Espèces de Calculs*[4]; and *Concrétions Animales et Végétales*[5]; of their *Analyse des Os*[6]; of their *Recherches sur les Combinaisons de l'Acide Sulfureux*[7]; *Sur la Strontiane*[8]; *Sur les Métaux unis au Platine*[9]; *Sur l'Arragonite*[10]; and numerous other substances belonging to the three kingdoms: and, finally, the numerous experiments by which they sought to establish the new theory of Chemistry; of all of these we have already spoken in such a manner as to preclude the necessity of reverting to them.

In these writings, upwards of sixty in number, the reader at once recognises the extended views of Fourcroy, and that desire to attempt and know every thing which formed one of the characteristics of his mind, combined with the coolness and unostentatious but always ingenious activity by which Vauquelin assisted him in attaining his object.

[1] Mém de l'Institut, vol. xi. p. 97.—Cuv. El. Hist. v. ii. p. 3.

[2] Ann. de Chimie, t. viii. p. 230, et t. ix. p. 30.

[3] Mém. de l'Institut, t. ii. p. 431; t. iv. p. 363, et 402.—Ann. de Chim. t. xxxi. p. 48, et xxxii. p. 30, et 113.—Ann. du Mus. t. ii. p. 226.

[4] Mém de l'Institut, t. iv. p. 112.—Ann. de Chim. t. xxxii. p. 213.

[5] Ann. du Mus. t. iv. p. 329.

[6] Bulletin de la Soc. Philom. 1803, p. 261.—Ann. du Mus. t. xii. p. 136, et t. xiii. p. 267.—Journ. de Phys. t. lxx. p. 135.—Ann. de Chim. t. lxxii. p. 252.

[7] Ann. de Chim. t. xxiv. p. 229.

[8] Mém. de l'Institut, t. ii. p. 57, et 183.—Annales de Chim. t. xxi. p. 276.

[9] Mém. de l'Institut, t. vi. p. 365, 588, et 593.—Ann. du Mus. t. iii. p. 149, et t. iv. p. 77, et t. vii. p. 401.—Ann. de Chim. t. xlix. p. 188 et 219, et t. l. p. 5.

[10] Ann. du Mus. t. iv. p. 405.

But even without taking into account the share which the latter had in these common labours, the rank which he occupies among chemists will not be materially changed; the works exclusively his own are amply sufficient to place him on an equality with the most distinguished. The amount of these works is rather surprising. We are assured that there exist more than 80, some of them on pure chemistry, and others on such branches of natural science as chemistry is fitted to illustrate.

In the year 1791 some of them appeared in the *Annales de Chimie*, and from that period every scientific periodical published in Paris contained several; affording a striking instance of what an individual can do for science, when he devotes to it all his time and faculties.

So entirely was M. Vauquelin engrossed with chemistry, that it may be said to have formed the business of every day of his life, and of every hour of the day; no labour or inquiry was ever considered an inconvenience, provided it related to chemistry; and no greater pleasure could be conferred on him than to ask him to engage in some new investigation. He seldom voluntarily proposed to himself problems which affected the great doctrines of science: it was in some measure for the sake of analysis that he analysed;—salts, stones, minerals, the produce of plants and animals,—whatever afforded scope for analysis was his peculiar province. The results, whatever they happened to be, were usually submitted to the public, without much solicitude about the consequences; but as every thing is consistent in Nature, there was scarcely one of them, however insulated it might at first appear, which did not conduce to the improvement of some process in art, to complete some theory, to rectify some received opinions, or even to evolve some general truth. It was thus that he threw a great and unexpected light on mineralogy, animal and vegetable physiology, and on subjects connected with medicine and pharmacy.

In animal chemistry, for example, the experiments which he laid before the Academy in 1791, proved that the respiration of insects, and other white-blooded animals, is of the same nature, and produces the same effects on atmospheric air, as that of the higher animals[1].

[1] Ann. de Chim. t. xii. p. 273.—Bulletin de la Soc. Philom. 1792, p. 23.

More recently, the comparative examination which he undertook, *De la Coquille de l'Œuf*[1] *des Excrémens de la Poule et de la substance dont elle se nourrit*[2], went to overthrow the hypotheses which assumed that the production of the calcareous shell was owing to the vital power of animals. Mr Brande had proved that the blood does not acquire its colour from any combination of iron, but from a peculiar animal principle[3]; and M. Vauquelin pointed out the most direct method of obtaining this principle in a separate state[4].

Physiology is indebted to him for an analysis of hair, and the very complicated principles which enter into its composition, and occasion its different colours[5]; and likewise for an analysis of chyle, in which he detected a part of the principle to the support of which this liquid is subservient in the animal economy[6].

The singular relations which he discovered along with Fourcroy between the composition of the sperm of animals and the fecundating pollen of plants, gave rise to considerations not destitute of interest; and the same may be said of his researches *Sur le Mucus Animal*[7].

During his extensive researches on *Urine* and *Calculi*, of which we have already spoken in the eloge of Fourcroy, M. Vauquelin discovered the remarkable fact, that the acid of benzoin, the produce of a foreign tree, exists perfectly formed in the urine of the herbivorous quadrupeds of our own country. Thus the intestines, and a circulation through the kidneys, are employed in an animal to combine the gaseous elements, in the same order, and in the same proportion, as the roots, the trunk, and the fruit of a tree.

At the time of his admission into the medical faculty as doctor of medicine, he selected as the subject of his thesis an ana-

[1] Ann. du Mus. t. xviii. p. 164.—Ann. de Chim. t. lxxxi. p. 304.

[2] Ann. de Chim. t. xxix. p. 3.—Bulletin de la Soc. Philom. 1798, p. 164.

[3] Chemical Researches on the Blood, and some other Animal Fluids, Philos. Trans. of Lond. v. cii. p. 90.

[4] Ann. de Chim. et de Physique, t. i. p. 9.

[5] Mém. de l'Institut, t. viii. p. 214.—Ann. de Chim. t. lviii. p. 41.

[6] Ann. du Mus. t. xviii. p. 240.—Ann. de Chim. t. lxxxi. p. 113.

[7] Journal de Phys. t. xxxix. p. 38.—Ann. de Chim. t. ix. p. 64, et t. lxiv. p. 5.—Ann. du Mus. t. v. p. 417, et t. x. p. 169.—Mém. de l'Institut, t. viii. p. 42.

lysis of the substance which is subservient to the most mysterious functions of the animal economy, that, namely, which composes the brain, the marrow of the spine, and the nerves[1]. He doubtless did not expect to discover how these functions operate, for neither chemistry nor anatomy will ever teach us this; but it was not without advantage to inquire what this substance possessed that was peculiar to itself, to determine its differences in different parts of the system, and the resemblances which it presented in different kinds of animals. All these particulars were successfully ascertained by M. Vauquelin.

Vegetable chemistry is still more indebted to him[2];—the sap peculiar to some trees[3]; the medicines most in use obtained from the vegetable kingdom[4]; the different farinaceous[5] and other alimentary substances procured from the same kingdom, and others employed in the arts, were submitted to his analysis[6]. His chemical examinations of Cassia[7], the Tamarind[8], of Hellebore[9], of Belladonna[10], of Quinquina[11], the different Kalis[12], Daphnes[13], Solanums[14], and Ipecacuanha[15], are models of pa-

[1] Mém. de l'Institut, t. ix. p. 236.—Ann. du Mus. t. xii. p. 61.—Ann. de Chim. t. lxvii. p. 26.

[2] Journal de la Soc. des Pharm. 1797, p. 46, et 1799, p. 338.—Ann. de Chim. t. xxxi. p. 20.—Journ. de Phys. xlix. p. 38.

[3] Mém. de l'Institut, t. vii. p. 50; t. viii. p. 154.—Ann. de Chim. t. xliii. p. 267.; t. xlix. p. 295.; t. liv. p. 312.; et t. lvii. p. 88.—Ann. du Mus. t. ix. p. 301.

[4] Bulletin de la Soc. Philom. 793, p. 44.—Ann. de Chim. t. lxxii. p. 191; t. lxxx. p. 314, et 318.—Ann. de Chim. et de Phys. t. iii. p. 337.—Mém. du Mus. t. iii. p. 198.—Journ. de Pharm. t. i. p. 481.; t. iii. p. 164.; t. iv. p. 93.

[5] Journal de Pharmacie, t. iii. p. 315, et 481; t. viii. p. 353.—Mém. du Mus. t. iii. p. 229, et 241.—Journ. de Phys. t. lxxxv. p. 113, et 124.—Ann. de Chim. t. lxxxv. p. 5.

[6] Ann. du Mus. t. xiv. p. 21.—Mém. du Mus. t. ii. p. 432; t. vi. p. 145.

[7] Ann. de Chim. t. vi. p. 275.

[8] Ibid. t. v. p. 92.

[9] Ann. du Mus. t. viii. p. 80.

[10] Ann. de Chim. t. lxxii. p. 53.

[11] Ibid. t. lix. p. 113.

[12] Ann. de Chim. t. xviii. p. 65.—Ann. du. Mus. t. viii. p. 7.

[13] Ann. du Mus. t. xix. p. 177.—Ann. de Chim. t. lxxxiv. p. 172.—Journal de Pharm. t. x. p. 419.

[14] Mém. du Mus. t. xii. p. 198.

[15] Ann. de Chim. et de Phys. t. xxxviii. p. 155.—Journ. de Pharm. t. xiv. p. 304.

tience and sagacity; and yet the peculiar alkalies which form the active principle in a great number of these medicinal substances—Morphine, discovered by M. Sertüner—Quinine, more important still, first observed by MM. Pelletier and Caventou, and others besides, were not the fruits of his laborious investigations; so true is it that the most unremitting assiduity, and greatest discrimination, are not always sufficient to attain to the truth, if not seconded by chance.

But it is in the mineral kingdom, above all others, that the labours of M. Vauquelin have led to results most important to science. At the request of the Council for Mines, and aided by the skilful assistants attached to that branch of the administration, he undertook a chemical analysis of minerals, at the same time that M. Haüy was occupied with the examination of their crystalline structure, and other physical properties, for his great work on mineralogy, which this same Council had asked him to undertake. On this occasion, M. Vauquelin co-operated with M. Haüy as he had previously done with M. Fourcroy, and his name appears as often on the pages of that immortal work as those of Klaproth, Bergmann, and other analysts of highest name.

It was by his labours that the agreement between the crystallization of minerals and their composition was most satisfactorily exhibited. The similarity in composition which he often observed between bodies of apparently different form, led Haüy to examine them anew, and to detect analogies of structure which had escaped his notice; and more frequently still, a resemblance or difference in structure, was confirmed by the appearances presented by analysis. This was well exemplified by the discovery of the earth named *Glaucine* by Vauquelin, who was one of the first, according to Klaproth, who have had the honour to discover new elementary substances. The name of this new earth is expressive of the saccharine taste possessed by the salts which it forms with acids. Our chemist obtained it from the beryl, or *aigue marine* [1], a kind of stone having the same crystallization as the emerald. He had not at first remarked it in the latter, owing, there can be no doubt, to the smallness of

[1] Journal des Mines, t. viii. p. 553.—Ann. de Chim. t. xxvi. p. 155, et 170.

the quantity submitted to analysis; but, at the request of Haüy, he renewed the examination, and was rewarded by the discovery of glaucine, which thus became a matter of triumph for crystallography.

A still more brilliant discovery was that of the substance called *Chrome*,—a name bestowed on it in consequence of the beautiful colours it assumes at different degrees of oxidation, and which it imparts to the minerals with which it is associated. The bright scarlet of the red lead of Siberia, the rose colour of the spinelle ruby, and the pure green of the emerald, are produced by the acid and oxide of this metal [1]. An orange-yellow is produced from it, which forms one of the clearest and most durable colours which painters can employ, and an enamel of the only pure and deep green which admits of being applied to hard porcelain. M. Laugier likewise detected this substance in stones which had fallen from the atmosphere.

The late M. Delille, to whom the singular property of this new metal was explained, inspired by phenomena of so remarkable a character, composed almost extemporaneously some beautiful verses, in which he has expressed them with much felicity:

> Peintre des minéraux, de nos plus belles fleurs,
> Il distribue entre eux les brillantes couleurs;
> L'émeraude par lui d'un beau vert se colore;
> Il transmet au rubis la pourpre de l'aurore;
> Quelquefois d'un plomb vil, fidèle associé,
> Teint d'un vif incarnat son obscur allié;
> Tantôt rival heureux des couleurs japonaises,
> Avant qu' elle ait de Sèvres enduré les fournaises,
> Il peint la porcelaine, et lui prête à nos yeux,
> Ces fonds verts et brillants qui résistent aux feux.
> Notre siècle en est fier, et, par un juste homage,
> Un jour Vauquelin y gravera l'image.
>
> *Les Trois Règnes*, Chant V.

No friend of literature will doubt, that the verses of Delille will form for our associate a more lasting monument than any images of whatever metal they may be composed. For himself, monuments interested him but little; a new fact in chemistry would have been of more importance in his eyes than the opinion of

[1] Journal de la Soc. des Pharm. 1798, p. 174.

posterity; and I am not certain that he ever read the verses I have quoted.

Nothing, indeed, could be more simple than his mode of life; no one could be more a stranger to the affairs of the world. Having been raised without effort on his part, through the influence of another, from a state bordering on indigence to a very considerable fortune, which increased the more rapidly as his personal wants were so few; elevated to the chair left vacant by the death of his patron, by the spontaneous homage of all the other candidates who unanimously gave up their claims in his favour; and honoured with all the marks of public approbation consistent with his station in society, he was never placed under the necessity of courting the notice of men in power or their subordinate agents, to promote his views. When about the age of sixty, however, an unexpected occurrence interrupted the accustomed serenity of his life. In 1824 some disturbance among the scholars led the University to adopt some measures regarding the faculty of medicine, which so slight an occasion did not seem to authorise. It was speedily settled, but the names of Vauquelin, of Jussieu, of Pinel, and of Dubois, were forgotten to be replaced on the list, a neglect the more unaccountable, as these were not only men whose high celebrity had tended to increase that of the establishment, but whose mode of life was most widely removed from every thing that could bear the least resemblance to turbulence.

It is thus that the most virtuous men too often act contrary to their own intentions, by allowing the management of affairs to fall into the hands of those whose interests are at variance with theirs. The little importance of this loss with regard to fortune, and the names of those with whom it was shared, might have rendered M. Vauquelin indifferent to a disgrace so little merited; the public, and even the government after becoming sensible of its error, used every endeavour to make reparation. He experienced a striking proof of the estimation in which he was held by the inhabitants of his native department, by being nominated by them to the Chamber of Deputies; but nothing could console him for his expulsion from the chair which his master and friend had filled, and which he regarded as his highest honour.

From that period he laboured under depression of spirits, and was seized with other complaints which he had no longer strength to resist. His bowels at last became affected in such a manner as to leave little chance of recovery. A short visit to his native country in 1829, seemed to restore some degree of strength, but exposure to severe weather during a ride of too long continuance, and some neglect of proper regimen, produced an aggravation of his disease, which the anxious care of his friends, who assembled round him from Caen and Paris, could not in the least alleviate. He died in the night of the 14th or 15th of October 1829, at the Château d'Hébertat, the proprietor of which, M. Duhamel, lavished upon him all the attention which the warmest regard and most delicate generosity could dictate.

These were the sentiments which it was impossible not to feel for that union of science and modesty which characterized M. Vauquelin. Although rich, surrounded with pupils who were devoted to him, and celebrated in every country where science is cultivated, he had made no change in the habits of his youth. Every year he returned to his village, where, however, he possessed considerable property.

He there renewed his acquaintance with the peasants who had been his associates at play or at work; there also he found his aged mother, spinning as when she had no other possession but her poor cottage; he walked with her into the country, took her along with him in his visits, and accepted of no invitation unless she was included, whatever was the rank or opulence of those who invited him.

At Paris, his life was scarcely less simple; it was passed in his laboratory or among a few friends, who, for the most part, were the companions of his scientific labours; his gentleness and fine ideas, sometimes of a humorous kind, and always expressed without reserve, gave to his conversation a peculiar character. His language was the same in this circle as in the society of the most distinguished persons, and he used no more ceremony with the Sovereign of Europe, who sometimes visited him, than he did with the humblest apothecary who attended his lectures.

The first Consul had one day received a letter, which seemed to be nothing but a blank sheet, and his attendants being alarmed, some supposing that it contained writing in sympathetic ink, and others imagining it to be a criminal attempt, M. Vauquelin was called, and after examining the paper, and suddenly recollecting the date of the day on which it was received, exclaimed "My God, it is merely an April fool." Few but himself could have taken liberty thus to sport with a power, which even at its commencement seemed to be omnipotent.

If we compare him with the extraordinary genius whose life I have related at the commencement of this sitting, it cannot be said that M. Vauquelin, notwithstanding his innumerable researches, and the interesting and singular discoveries with which he has enriched science, is to be considered equal to Sir H. Davy. At the same time science owes him scarcely a less enduring gratitude. The former has soared like an eagle over the vast extent of physics and chemistry, and on each he has thrown from on high a dazzling light, shewing to view their doctrines disposed in an order altogether new. Vauquelin, more modest, has illustrated their most secret details, and penetrated into their more obscure recesses. If the name of the one is written at the head of every chapter, that of the other will be repeated in every paragraph. The genius of the first has created brilliant theories, the sagacity of the second has established a multitude of particular facts; but it is known that the microscope is not less fruitful in wonders than the telescope; and the history of science, especially as exhibited in Sir Humphry Davy, will teach us that theories pass rapidly away, but that facts are eternal.

THE NUMERICAL RELATIONS OF ANIMALS.

1. MAMMALIA.

	Year.	No. of Species.
Linnæus enumerates *, ...	1767	221
Humboldt †, ...	....	500
Desmarest ‡, ...	1822	850
Temminck ||, ...	1827	860

* Systema Naturæ, edit. 12. Holmiæ, 1767;—the last edition superintended by Linnæus.

† Ann. de Chim. et de Phys. xvi.

‡ Mammalogie; Paris, 1820 et 1822. 4to.

|| Monographies de Mammalogie, vol. ii.; Paris, 1827.

	Year.	No. of Species.
Lesson *,	1827	1124
Minding †,	1829	1230
Fischer ‡,	1830	1126
Bonaparte ‖,	1831	1138

If we take into account the discoveries of these few last years, we may reckon in round numbers the living species at 1100. Lesson enumerates many species which are doubtful; and Temminck mentions those only which have been well determined.

2. BIRDS.

	Year.	No. of Species.
Linnæus,	1767	904
Buffon,	.....	1700
Lesson,	1830	6500
Bonaparte,	1831	4099

3. AMPHIBIA.

Linnæus,	1767	204
Lacepede,	1802	500
Merrem §,	1820	579
Humboldt,	......	700
Bonaparte,	1831	1500

4. FISHES.

Linnæus,	1767	376
Bonaterre ¶,	1788	746
Lacepede,	1802	1300
Cuvier **,	1827	5000
Bonaparte,	1831	7000

5. MOLLUSCA (INCLUDING THE CEPHALOPODA).

Linnæus,	1767	832
Lamarck ††,	1822	3028
Schmidt ‡‡,	1830	4548

* Manuel de Mammalogie; Paris, 1827.

† Ueber die Geographische Verbreitung der Saugethiere; Berlin, 1820.

‡ Synopsis Mammalium; Stuttgardt, 1830.

‖ Isis, 1832, Heft 3. Linnæus, Humboldt, Temminck, and Minding, enumerate only the living Mammalia, the others also the fossil, of which we know 120 species. Fischer enumerates, besides the 1126 well determined species, also 200 dubious.

§ Systema Amphibiorum.

¶ Encyclopedie, 4to.

** Histoire Naturelle des Poissons.

†† Animaux sans Vertebres.

‡‡ The number in Schmidt's collection at Gotha.

6. ANNELIDES.

	Year.	No. of Species.
Linnæus,	1767	50
Blainville *,	1827	315

7. CRUSTACEÆ.

Linnæus,	1767	111
Fabricius †,	1793	259

8. ARACHNIDA.

Linnæus,	1767	97
Fabricius,	1793	138

9. INSECTS.

Linnæus,	1767	2616
Fabricius,	1800 to 1805	12,513

According to the different Orders, the numbers are as follows:

	Fabricius.	Linnæus.
Coleoptera,	4330	903
Diptera,	1224	262
Hymenoptera,	2101	314
Neuroptera,	170	83
Aptera,	123	62
Orthoptera,	235	...
Lepidoptera,	2919	780
Hemiptera,	1384	253
Myriopoda,	27	19

It may not be uninteresting, as regards insects, to compare the progress of the classes and species with the number of genera, between Linnæus in 1767, Fabricius from 1794 to 1805, and Latreille, in the 2d edition of Cuvier's Regne Animal, in 1829:

Number of Genera.	Latreille.	Fabricius.	Linnæus.
Crustacea,	209	12	3
Arachnida,	66	11	4
Insecta,	1423	431	...
Coleoptera,	700	181	30
Orthoptera,	36	8 }	12
Hemiptera,	84	46 }	

* Dictionnaire des Sciences Naturelles, tom. xlvii. vers.: the Leech, which he separates, and of which he enumerates 39 species, is here included.

† The number of Crustacea, Arachnida, and Lepidoptera, are from Fabricius, Entomologia Systematica, 1793 and 1794; the other orders of Insects are according to his Systema Antliatorum, Rhyngotorum, &c. Humboldt enumerates 44,000 species of Insects; Sachs in the Berlin *Zeitung* 50,000 Insects, 26,000 Arachnida? 1500 Crustacea.

Number of Genera.	Latreille.	Fabricius.	Linnæus
Neuroptera,	27	12	7
Hymenoptera,	207	83	10
Lepidoptera,	87	15	3
Diptera,	258	81	10
Myriopoda,	8	2	2
Thysanura,	4 }		
Parasita,	9 }	5	5
Suctoria,	1 }		
Rhipiptera,	2	...	...

10. ENTHELMINTHA.

	Year.	No. of Species.
Linnæus,	1767	15
Zeder,	1803	390
Rudolphi *,	1819	1100

11. RADIARIA OR ECHINODERMATA.

	Year.	No. of Species.
Linnæus,	1769	46
Blainville †,	1830	280

12. MEDUSA.

	Year.	No. of Species.
Linnæus,	1767	11
Eschscholtz ‡,	1829	208

13. ZOOPHYTA OR POLYPI ||.

	Year.	No. of Species.
Linnæus,	1767	134
Blainville,	1830	536

14. ROTATORIA.

	Year.	No. of Species.
Linnæus,	1767	8
Ehrenberg §,	1832	291

15. INFUSORIA.—POLYGASTRICA.

	Year.	No. of Species.
Linnæus,	1767	8
Ehrenberg,	1832	291

The total number of known living species of animals thus appears to be:

* Synopsis Entozoorum; Berolini, 1819. 8vo. At present, probably the number of known species of Vermes may amount to 1500.

† Dict. des Sciences Naturelles, tom. lx.

‡ Sytem der Acalephen. Berlin.

|| The Actiniæ and Spongiæ are included under this head.

§ Zur Erkentniss der Organisation im kleinsten raum. Berlin.

Mammalia,	1,100
Birds,	6,500
Amphibia,	1,500
Fishes,	7,000
Mollusca,	5,000 ?
Annelides,	315 ?
Crustacea,	1,500
Arachnida,	3,000 ?
Insecta,	50,000
Enthelmintha,	1,500
Radiaria,	280
Medusaria,	208
Polypi or Zoophyta,	536
Rotatoria,	119
Infusoria,	291
Total Number,	78,849

The number of Fossil animals may be stated as under:

Mammalia,	120
Birds,	25
Amphibia,	50
Fishes,	250
Mollusca,	3,100
Crustacea,	100
Insecta,	150
Radiaria, } Annelides, }	350
Zoöphyta,	500
Total,	4,645

In order to compare the numerical relations of the animals of single lands, we shall place together the Fauna of Greenland, that of Wurtemberg, and that of the vicinity of Nice, or of the Maritime Alps. The animals of the Fauna of Greenland are according to Fabricius's *Fauna Grönlandica*, Hafniæ, 1780; the Wurtemberg animals are from a small work entitled, "*Uber Wurtemburgs Fauna*," Stuttgard, 1830; the animals of the Nice district are from Risso's *Histoire Naturelle des principales Productions du Midi de l'Europe*, Paris, 1827. These three may be considered as the representatives of the middle and southern parts of Europe; and although Greenland does not belong to Europe, it may be considered as a general representative of the polar Fauna:

	Greenland, Lat. 60°—70° N.	Wurtemberg, Lat. 47° 30′—49° 30′ N	Nice, Lat. 43° N.
Mammalia,	31	41	59
Birds,	54	213	306
Amphibia,	1	18	40
Fishes,	44	47	400
Crustacea,	38	(with Lernæa), 4000	200
Arachnida,	15		100
Insecta,	64		1600
Mollusca,	61	100	1085
Annelides,	62	13	82
Enthelmintha,	25	48	70
Radiaria,	14	...	100
Zoophyta,	58	11	200
Infusoria,	...	12	...
	467	4503	4242

It may here be observed, that the Infusoria and Enthelmintha are but slightly noticed: there may be in Wurtemberg 300 or upwards of Infusoria, and even more of Enthelmintha; the marine and other Infusoria of Greenland and Nice are not mentioned; and it is evident that the number of insects is too small for the maritime Alps.

Even more interesting than the numerical relations are those connected with colour, which, however, can only be studied with effect in great collections, and with the assistance of good coloured drawings and engravings. On this subject, we have the following, among other questions, to answer. How are the colours related in the animal kingdom in general, and also in the separate classes, orders, and genera? Do we find particular colours predominating in certain genera, orders, &c. or are they peculiar to them? What are the relations of the dorsal and abdominal colours, and latero-dorsal and latero-abdominal colours? What influence has light? How are the colours related in warm and cold countries? How are the colours in the animal kingdom disposed, according to latitude and longitude, and height above the level of the sea? Has the sea, and fresh-water lakes, &c. determinate influences on differences of colour? Investigations of this kind belong to general natural history, and the characteristic of the animal kingdom. Unfortunately, these general physiognomical relations in zoology have hitherto been much neglected. Botanists are further advanced in their representations in the delineation of the physiognomy of plants. It is exceedingly to be regretted, that, with the exception of some partly antiquated, partly unsatisfactory, or, when good, illustrative only of particular classes, treatises on the geographical distribution of animals, such as those of Zimmerman, Latreille, Prichard, Ferusac, Minding, we have no general classical work on this beautiful branch of zoology.—*Professor Rudolph Wagner, Erlangen.*

THE ROCK OF GIBRALTAR. *By Professor* HAUSMANN.*

THE Rock of Gibraltar undoubtedly claims a distinguished rank among the most remarkable appearances which the south of Europe offers for our consideration. Powerful changes on the earth's surface have probably separated it from the rest of Spain. And the boldness of man has, in another sense, followed the example of physical forces, by founding and rendering impregnable the above situation upon a foreign soil; and thus insuring the continuance of the intercourse of the most powerful insular empire in the world with the coasts of the Mediterranean.

This wonderful rock rises with singular steepness from amidst the waves which break against it; and only a narrow neck of land, consisting of sand, forms the loose band by which it is connected with the continent †. Is the present the original one, or was the now completely isolated rocky colossus once united with the much smaller height of San-Roque? Was the separation between the two effected by the rush of water, occasioned by the higher level of the sea, in earlier times, threatening destruction to the whole of the southern promontory of Spain, or was the rocky wall elevated suddenly out of the sea, through some hidden force, or from a partial sinking down of the

* Translated by George F. Hay, Esq.

† Such is the apparent connection; but it has been well ascertained that the sand is only a superficial covering of the rocky masses, which, deeper down, form a firmer union.

strata, by which they were changed from a horizontal into the perpendicular situation?

Many may imagine that an answer is easily to be found to these questions. But I would rather at once confess, that this problem appears to me to belong to the innumerable geological mysteries, the proper time for the explanation of which has not yet arrived. Supposing that it be undetermined in what way the rock of Gibraltar obtained its present remarkable shape, still we cannot be mistaken in saying, that the mass of the rock acted as a powerful obstacle during the resistance which the southern promontory of Spain made to the waters which attempted to rush across or through it. The almost perpendicular strata of flinty slate of the basis, and of the compact limestone of the principal mass, would form with their whole surface a barrier at right angles to the rush of water, and thus a stronger barrier would be formed than by the soft sandstone strata of the neighbouring districts. We have existing proofs upon the faces of the rock, which cannot be mistaken, of the powerful workings of the sea, and the influence which it has had in shaping the rock all around. And we can see that the heaving up of the strata, or their overthrow, in no way belonged to the period of the convulsions by which the union of the Atlantic and Mediterranean seas was effected. And in unison with the above facts, there are deposits at the southern promontory, which shew the various heights of the tides at periods before the bursting through of the waters. The celebrated breccia containing bones, (knochenbrekcie *) which fills up the crevices of the rock, and which first drew the attention of naturalists to the rock of Gibraltar, occurs likewise in many other parts of the Mediterranean. And this circumstance is a proof that the Rock of Gibraltar was particularly affected by the same revolutions which occasioned a re-formation of the coasts of the Mediterranean Sea.

The different sides of the narrow rock vary in form. On the north and east side, the rock is in general so precipitous as to be almost perpendicular; while at particular places there are formidable overhanging masses. Upon the west side, on the con-

* Vid. J. Frid. Blumenbachii Specimen Archæologiæ Telluris. 1803, § 4. p. 9.

trary, it is upon the whole more continuously flattened, while there are likewise here isolated perpendicular cliffs entering into the formation of the rock. The far projecting foot of the rock towards the south, consists of two interrupted divisions, having cliffs which are partly perpendicular. The under part, which is called Europa Point, is about 105 English feet above the sea; the second, Windmill Hill, is about 330 feet above the sea. From here the rock rises steep to its highest southern point, which is named St George's tower, to which a narrow steep pathway conducts, called Mediterranean Stairs. The above, like the northern pinnacle, possesses a height of about 1400 feet *. The crest of rock which unites the two, and which is in some places extremely narrow, is upon the whole somewhat lower in height upon the western declivity. Not very far from the Signal house, which is placed upon the highest point of the rocky crest, at an elevation of 1276 feet, there is the opening of a spacious cave, which is covered with long calcareous stalactites. Around the western, northern, and eastern borders of the rock, there is a continued flat land, which, towards the north, runs into the small neck of land that unites Gibraltar with the neighbouring country. The town is situated on the west side of the rock, upon the above flat, and the higher part of the town has the declivity of the rock as a shelter. The flat space of the eastern border is very narrow. Few houses are situated on this part, and these are more threatened than protected by the overhanging cliffs. This shore runs southward towards a steep inclined plane, consisting of sand, and against which the waves dash to a considerable height. This part is entirely cut off by a perpendicular rocky wall projecting into the sea, and is thus separated from the border of the under southern division of the rock.

On the east side of the rock, nature has rendered fortification unnecessary, but the other sides are protected by art. The works of the fortress not only surround the entire border of the rock, but they extend in the most varied lines to the highest pinnacle of the same. And they cover not only the surface of

* The highest pinnacle, called the Sugar Loaf, has a height of 1439 English feet above the sea.

the rock, but are carried into its interior by blasting the rocky mass.

The organised nature which clothes the rock, is no less unusual than its mineral formation. The vegetation is a rare mixture of productions originally European, as well as African and American. And thus there is, in its way, as animated a picture of the intimate union which the isolated rock forms between distant lands, as is afforded to us by the narrow flat space at the foot of the rock; where we see men stirring about in the most lively intercourse, whose various constumes and languages enable us to distinguish the different nations to which they belong.

The plants growing wild on the rock, are in general the same as those which clothe the flat hills on the coast between Malaga and Gibraltar.* The *dwarf palm*, which is predominant, mounts up as high as the crest of the rock, taking root in the clefts of the limestone; and, upon the western declivity, the situation is so favourable, that it is found with stems of from four to six feet high. Between these palm bushes, and in the wide crevices of the rocks; a species of *ape* (Simia Inuus, Lin.) takes up its abode. Gibraltar possesses these animals as well as many amphibia and insects, in common with the opposite coast of Africa. Succulent plants, as the *agave* or *aloe*, and various species of *cactus*, bound the under margin of the above wild vegetation. In the neighbourhood of the gardens, the succulent plants, intermingled with the various plants in cultivation, form a very variegated scene. The effect is greatly heightened by a pleasure plantation † which has been formed of late years upon what was formerly a wild part of the western flat land, near the Alameda, which is shaded with trees. This spot is adorned by red-flowering luxuriant *Pelargonia*, and roses; and jessamine and orange blossom likewise exhale the most delightful fragrance.

The rock, which thus in a small space unites the most re-

* These are enumerated in Professor Hausmann's View of Spain, in a previous volume of this Journal.—Edit.

† Gibraltar owes to its present worthy and meritorious Governor, Sir George Don, the above delightful spot, as well as many other ornamental improvements.

markable mixture of the productions of different countries and parts of the earth, likewise exhibits the most striking changes of meteorological phenomena. Now we observe its summit clear, in an instant afterwards it is enveloped in mist and clouds. These may hang upon the cliffs for a whole day, while perhaps the foot of the rock and the sea are enlightened by clear sunshine; while a sudden change of the wind suffices to separate or elevate the covering of clouds. It also sometimes happens that the opposite sides of the rocky wall have quite different kinds of weather. A thick wet fog may settle on the east side, while the west side enjoys and reflects back the most agreeable sunshine. There may be a storm on the eastern declivity of the rock, while it is calm on the west side. Thus, therefore, it is not only the waves which are broken against the rock of Gibraltar; but the weather likewise is interrupted by its vast mass of wall; it is, in a peculiar sense, a screen both of the wind and of the weather.

The variety of remarkable objects, and the changes in the appearances of the neighbourhood, are not the only circumstances by which the eye is intensely fixed upon Gibraltar. The views, likewise, which are afforded there in the distance, are of the most extraordinary nature which any headland can afford; and every side of the rock, in this respect, imparts particular delight. The narrow ridge of the summit, at the border of the perpendicular precipice, towards the east, unfolds to view the unmeasurable expanse of the sea, which is bounded only by the Spanish coast upon the west. The unassisted eye traces this line of coast as far as beyond Marbella; and along the green encompassing border of the higher range of mountains, insulated bright white villages are discovered, and which may easily be distinguished from the comparatively dull looking watch-towers. Towards the west, we behold the broad bay, and the beautifully formed mountain range, which rises behind Algesiras, and declines towards the hill of San Roque. That town, with its long aqueduct, constructed by the Moors, appears no less clearly marked than this elevated fortification. The bay is animated with the masts of vessels; and every change of the wind occasions a variety in this lively picture, from the departure and arrival of ships. Although these objects are so attractive and amusing, they are still far surpassed by the views commanded by the station on the southern terrace. We behold the coast of Africa extended before us, from Tangier as far as beyond Ceuta. The great transparency of the atmosphere makes the distant objects appear so near to the spectator, that he sees not only the outline and indentures of the mountain range with the greatest exactness, but can even distinguish a part of Ceuta. The observer learns to decide accurately, that the mountains at the eastern extremity of the wide inlet behind the projection of the coast upon which Ceuta is situated, are only apparently continuous with the mountain range which rises behind them ; and is led, from the form of these, to conjecture, that, according to their constitution, they agree with the transition-slate formation which constitutes the fundamental strata of the rock of Gibraltar ; and that they are not composed of the limestone which forms the principal mass of the latter rock.

The observer, musing on the surrounding phenomena, inquires, What power was it which broke through the mighty opposing rock ? In what period of the primitive world did the astounding catastrophe take place, which has paved the way for the liveliest intercourse among late generations ? The answer to this and many other questions remains engraven in hieroglyphics upon the pillars of Hercules; and the most ingenious combination of these symbols will permit only a few interpretations to be derived from them with certainty. But the rock, which withstands the shock of the elements, declares, in writing which has no ambiguous meaning, that, with its existence, there are connected a series of the most remarkable events which have taken place at the most different periods,—from the voyages of the Phœnicians, until the contest against the floating batteries. Thus an exact knowledge of the formation of the southern promontory of Europe would be highly interesting ; and the fact, that there is a firm and intimate union between the nature of a country and the history of its inhabitants, would give additional countenance to the inquiry.

BIOGRAPHICAL SKETCH OF ANTHONY SCARPA.

Scarpa, in modern times, is in all probability the man who, as a physiologist and surgeon, has acquired the greatest and most extensive reputation. His name was not merely European; it was spread over the world: his discoveries in anatomy and surgery have been every where viewed with admiration; they have been every where useful. His works have been translated into, and commented upon, in every language. He has left the most profound sentiments of love and veneration in the hearts of his numerous disciples, and, at the same time, seeds which have every where produced good fruit. There is hardly a society, literary or scientific, who have not regarded it as an honour to be connected with him, and on the death of Sir Humphry Davy, he was named one of the eight learned foreign associates of the French Institute. Honours, titles, and rewards of crowned heads, were transmitted to him in his retreat. The necessity of repose, the diminution of his physical powers, especially of sight, induced him to renounce practice, and retire to his magnificent country-house, where, surrounded by one of the finest collections of pictures, objects of art, and antiquities, he portioned out his time among the muses, fine arts, agriculture, anatomy, and surgery, which he never ceased, even at his great age, to enrich with some original idea or some new discovery.

Till the last moment of his life, he retained a perfect serenity, and that astonishing intellectual vigour which had been so advantageous to him during his life; he died at the age of 85, in the arms of his pupils,—of the illustrious professors whom his scientific knowledge had connected with the University of Pavia. The heirs of his talents never quitted him for an instant during the malady which carried him off; they paid their master, friend, and adopted father, the most assiduous and affectionate attention; by their anxiety and gratitude they adorned the latter moments of the man to whom they were indebted for their acquirements, and the honourable situations they occupy in the Ticinian

School. Happy are they who have run a long career so useful to humanity,—who die full of days,—whose death is bewailed, and who are surrounded with friends who close their eyes!

Scarpa was born at the commencement of the year 1748, at La Motta, a little village of Friouli, of worthy but poor and obscure parents. An uncle, rector of the village, who doubtless had a presentiment of the reputation of his illustrious nephew, sent him to Padua, where he defrayed the expenses of his education. It was not long before he had reason to congratulate himself on his foresight. Young Scarpa soon shewed what he would become one day, by the immense and rapid progress which he made in his studies. A great man could not find himself incessantly opposite another distinguished individual without saying tō himself, " *ed io anche, io son pittore.*" Scarpa at first had Morgagni as a master, who was not tardy in discovering in his pupil, all the genius of his future eminence; he soon made him his friend and fellow-labourer. At this age, Scarpa refreshed himself from his labours by devoting himself to literature; during the long soirées of the carnival, which he spent in the society of Morgagni, they enlivened their scientific conversations by reading the comedies of Plautus in a loud voice.

The Duke of Modena having occasion for an anatomical dissector for his University, applied to Morgagni to fill up this chair. The latter having solely in view the advancement of science, and forgetting his interest and his affection, proposed his favourite pupil, who was gratefully received. Scarpa quitted Padua for Modena, when he was twenty-two or twenty-three years old, and gave his first lessons in anatomy in 1772. It was there that he composed and dedicated his first work on anatomy, to Francis III., his Mæcenas, under the title of *De structurâ fenestræ auris et de tympano secundario, anatomicæ observationes;* Mutinæ 1772, in 8vo.

During the same season, the Grand Duke conferred on him the situation of chief surgeon to the hospital of Modena. The more his occupations multiplied, the more time he found to do them all. Notwithstanding his anatomical lessons, the increase of his medical practice, the daily attention which the hospital required, he found time for anatomical researches, for preserving these by means of the very beautiful designs which he made, and of writing his observations in the purest and most elegant Latin. His second work, which appeared soon after the first, was entitled, *Anatomicarum annotationum liber primus, de gangliis et plexibus nervorum*; Mutinæ 1779, in 4to.

After Scarpa had been established nine years at Modena, the Duke, for reasons which are unknown, thought proper to diminish the salaries of the whole of the professors; Scarpa then requested permission to travel to Paris and London, which it was impossible to refuse.

It was in this excursion that he became acquainted at Paris, London, and in Holland, with the most distinguished physicians and surgeons, such as Vicq d'Azyr, Pott, John Hunter, &c.

At Paris he shewed Vicq d'Azyr his beautiful drawing of the olfactory nerve, who wrote these words on its margin, "I have, for the first time, seen the ramifications of the olfactory nerve."

John Hunter said in his memoir on this nerve, that the ramifications in the engraving of Scarpa were too small; and the professors of Pavia, who are in possession of this monument of the early labours of their master, admit that the criticism of the illustrious English surgeon is well-founded.

Scarpa was at Paris at the same time with the philosophical Joseph the Second, who was then traversing Europe incog. The celebrated Brambilla, physician to the emperor, was astonished at seeing Scarpa there; he expressed his surprise, and said that he did not think that he could have quitted Modena; Scarpa replied, "You are aware that when a distinguished nobleman is in disgrace at court, he is invited to travel for his health: this at present has befallen me." Brambilla felt directly, that he ought to take advantage of this unique opportunity, to try and attach to the University of Pavia, a professor who he foresaw would confer on it the greatest eclat; he mentioned it to the Emperor, who was extremely anxious to adopt the happy idea of Brambilla, and made the most honourable proposals to the pupil of Morgagni; but the latter, more affected by the feelings of gratitude which he thought were due to the Duke of Modena than his interest and his convenience, did not accept the chair in Pavia in the year 1783, till he had been invited by the Duke himself, in the most formal manner.

The accession of Scarpa to the chair at Pavia, was certainly of immense benefit to this University, and there is no doubt it was owing to the fortunate suggestion of Brambilla. As a benefactor rarely forgets the objects of his kindness, Brambilla from that moment eagerly embraced every favourable opportunity of augmenting the lustre of the University of Pavia. It is necessary to state that he was born there. But how often are many people living at a court surrounded with every kind of distinction and honour, seen forgetting their country ! This was not the case with Brambilla ; he always shewed himself an excellent citizen, and he has left an honourable monument in his native city.

Scarpa, during the same year, made the inauguration of his entry into the University, in a Latin discourse, of which the title was, *De promovendis anatomicarum administrationum rationibus, oratio ad tirones.* Ticini, 1783, in 4to.

In 1785, at the opening of the new anatomical theatre, he pronounced an eloquent discourse, under the title, *Theatri anatomici Ticinensis dedicatione, oratio habita pridie calend. Novembris, ann.* 1785.

It was then that he yielded to his favourite passion with incredible ardour, viz. to anatomical researches and studies, for which, it must be agreed, he had a wonderful disposition. He was endowed with a patience which the longest and most laborious toil could not fatigue ; he had an eagle-eye, which enabled him to detect the most minute object ; he possessed a manual dexterity which rendered the most delicate and difficult dissection easy ; in fine, he was endowed with an admirable spirit for observation and induction, which conferred an inestimable value on the discoveries which he made with the scalpel.

One of the first works which he printed at Pavia, was a continuation of that which he had already published at Modena, *Anatomicarum annotationum liber secundus, de organo olfactûs præcipuo, deque nervis nasalibus e pari quinto nervorum cerebri.* Ticini, ann. 1785, in 4to.

He soon after presented a memoir in the first volume of the Public Disputations of the Medico-Chirurgical Academy of Vienna, *De nervo spinali ad octavum cerebri accessorio commentarius. Vindobonæ*, ann. 1788.

Two years afterwards, the following memoir appeared, *Anatomicae disquisitiones de auditu et olfactu.* Ticini, 1790, in fol. max.

An English anatomist having stated in the Royal Society of London, that the heart had no nerves, *cor nervis carere*, Scarpa accepted the challenge, and some months had hardly elapsed, when he threw himself into the arena with this motto, *Regiæ Societati Londinensi sacrum*, the famous work in folio, entitled *Tabulæ neurologicæ ad illustrandam historiam cardiacorum nervorum, noni nervorum cerebri, glosso-pharyngei et pharyngei ex octavo cerebri.* Ticini, 1794.

In glancing at this work, which cost him so many nights of toil, and which was composed during short intervals, which he did not steal, however, from his duties in teaching anatomy and chemistry, we may easily conceive the enthusiasm with which it was received by the learned in every country; from this time Scarpa led the van in his science, and, more happy than many others, he never descended from this eminent situation, to which he was raised with such rapidity.

In 1799, he presented the learned with a valuable work, a true model for analytical observation, on the formation and internal structure of bones, with the title *De penitiori ossium structura commentarius.* Lipsiae, ann. 1799, in 4to.

An accidental circumstance favoured this work, and perhaps inspired him with the idea; it was the discovery of an antique cemetry, in the ruins of which he found bones which seemed to have been prepared for displaying their organisation. Long afterwards, new experiments, and some valuable observations on the pathology of the bones, induced Scarpa to publish a second edition, enriched with six tables from the admirable pencil of Anderloni, by the title *De anatomiâ et pathologia ossium commentarii.* Ticini, 1827.

He published soon after, in the Memoirs of the Italian Society, which was then sitting at Verona, his researches on a monstrosity, which he named a *tauro-vacca,* called *Free martin* in England. At this period Scarpa renounced his anatomical labours, to devote himself entirely to the practice of surgery. The works which he had published had already acquired for him, not only in Italy, but throughout Europe, a renown well worthy of envy, and which has never been surpassed. As great an anatomist as physiologist, it was during the eighteenth century that he encircled his forehead with a glorious crown, and the present age had hardly commenced, when he had reaped a glorious immortality in the plains of surgery. Scarpa could not have made a more prudent division at the epoch of his labours. When in his panegyric on Carcano Leone, he said, "The history of surgery gives us one useful hint, viz. that the most clever and celebrated surgeons have always commenced their career by studying anatomy deeply;" does he not seem to speak of himself, and partially to refer to the history of his life? It is certain, that during early life, when the feelings are most vigorous, when the body has the greatest power to undergo great fatigue, and withstand the deleterious influence of the emanations from subjects, it is the moment which is favourable to the consecration of the day, and often the night, to delicate dissections, to examinations which always call forth new researches; it is thus that the eye and the hand become qualified for the practice of the healing art, it is thus that, rich in consequence of his observations and his experience, the anatomist of Pavia soon acquired the reputation of the most adroit and skilful surgeon.

He began his new career in 1801, by publishing his work on the Diseases of the Eye. * This remarkable work, which immediately had an immense success, which passed through five editions in Italy, and was repeatedly translated into the French, English, and German languages, was the harbinger of all that could be expected from a scholar, who was at this time considered as the first surgeon in Italy, and probably in Europe. He did not disappoint the world: in 1803 he presented the schools of surgery with a smaller work, but of great importance,

* *Saggio di osservazioni e di esperienze sulle principali malattie degli occhi.* Pavia, 1801. 4to.

on the congenital disease called the *Club-foot**. Before the works of the Professor of Pavia on this disease, its treatment was empirical; now that we know the causes of it, and the numerous dissections that Scarpa has made of club-feet, have explained the true nature of the disease, its treatment has assumed a more rational, sure, and methodical character. The very ingenious apparatus which Scarpa contrived to remedy this disease, generally cures it in the space of two or three months. Since that time, it has been simplified and rendered more perfect, but the improvements are principally the result of his labours.

When the French invaded Italy in 1796, the Cisalpine republican government bound all its employés by an oath of a formula perfectly new, which contained an expression of hatred to kings. Scarpa refused to take it, and declared he would rather give up his chair: the government had the good sense to keep him in his situation, and allow him to act according to his own feelings. About the year 1804, Scarpa obtained leave to retire; but, in the ensuing year, Napoleon having arrived at Milan for the purpose of being crowned, said to Scarpa, in the presence of the whole of the Professors, "You have quitted your chair—you should resume it: so valiant a soldier should die on the field of battle." At this invitation Scarpa returned, and again took the chair of Clinical Surgery. It was at this time that Napoleon assigned him a pension of 5000 francs, out of the bishoprick of Ferrara.

One of the strongest claims to the gratitude of his contemporaries and posterity, was his great work on Aneurism, which was published in 1804. The subject was suggested by the question which the Society of Medicine in Paris proposed in 1798, to throw light on the controversy as to the different modes of operating in this disease of the arteries. It was not a mere theory—the result of meditations in the silence of the study—but the consequence of numerous and varied experiments made

* *Sui piedi torti congeniti esalea maniera di corregere questa deformita.* It is with pleasure that I notice here the orthopaidean establishment of Orbe, in which Mr Martin, successor of Venets and Jaquards, has obtained the greatest success in the treatment of the congenital deformities.

on all kinds of animals, in which he was enabled to compare the reciprocal value of the different modes of tying the arteries. It cannot be too frequently noticed, that the name of Anderloni is intimately connected with that of Scarpa. The engravings which enrich the treatise on Aneurism will never be surpassed in beauty or perfection, and will with difficulty be equalled. These engravings, like those of all the other works of Scarpa, are always faithfully copied after the designs of their great master. *

A new subject of meditation soon prepared him for a new work. A disease of too common occurrence, the protruding of a portion of the intestines from its natural position, and which is known by the generic term *Hernia,* seemed to him worthy of attention. The work which he shortly afterwards published on this important subject procured the eulogiums and the gratitude of all the academies and every great master of the art. This eminently classical work soon appeared in every European language. † Every page exhibits the profound anatomist and the able surgeon: not only has he thrown a light on the mechanism hitherto unknown or unexplained, by means of which every hernia is produced, but he has also fully explained, in every kind of descent, the dispositions of the ring of the *funiculus spermaticus*, the epigastric, crural and obturatrix arteries. He has given excellent rules on the cutting of the ring, and has wisely based his preference for the multiple cutting on grounds which have been confirmed by experience. His modern works on the cicatrisation and obliteration of the preternatural anus, consecutive on gangrenous hernia, are the fruits and the complete result of his researches on the funnel-shaped contraction of the peritoneal sac, and the changes suffered by the intestine inclosed in it. This work, which was

* *Sull' aneurisma, riflessioni ed osservazioni anatomico-chirurgiche.* Pavia, 1804.

† *Sulle Ernie, memorie anatomico-chirurgiche. Due edizioni, la prima alla stamperia reale a Milano, nel* 1809 *; e la seconda in Pavia,* 1819. *In fol. max.* Shall I be forgiven for stating here, that Scarpa in his work mentions me honourably, by making, in a few lines, an extract from a memoir which I have published on the fatty *Herniae* of the *linea alba.*

translated into the French language by Mr Cayol in 1812, has been considerably augmented in a new Italian edition, in which the various memoirs published separately have been re-written. He published a supplement to his *Treatise on Hernia* two or three years afterwards, to which he added his researches on that of the *perineum*. These works, which were translated into the French language by Mr Olivier, form the completion of the translation by Mr Cayol.*

From that time his reputation became so great that he was afterwards regarded as the oracle of surgery.

Napoleon, as king of Italy, named him successively, Chevalier of the Iron Crown, and Member of the Legion of Honour. The Emperor Francis I., who succeeded Napoleon in these States, decorated him with that of the Cross. Thus did every sovereign and every government express the regard and esteem which they had for this great man.

In concurrence with the desire of Joseph II., and by way of showing his gratitude to his Mæcenas, he, with his friend and colleague Volta, undertook a journey to Vienna. This prince received Scarpa and his illustrious companion with that courtesy and affability which are the peculiar characteristics of the present family;—to aid science, he induced these learned men to extend their journey through the whole of northern Germany, and besides furnished them munificently with all the pecuniary assistance which could favour such a project.

In 1820 he undertook a journey through southern Italy, but merely with the intention of travelling as an amateur of science and the fine arts, as an admirer of the beauties of nature, which were about to develope themselves before his eyes; and it must be admitted, that he required the strongest discretion to escape the continual solicitations of those who wished to consult him. In this manner he traversed Tuscany, the Papal States, and the kingdom of Naples; it was in this classic land that he appeased, as it were, the inextinguishable thirst which he had for acquiring additional knowledge, and perfected the admirable

* I cannot avoid noticing here, that Dr Wishart of Edinburgh is the faithful and elegant translator into the English language of Scarpa's works, and that he was also his friend.

tact with which he was endowed for criticising the *chefs d'œuvres* of the fine arts.

Scarpa withdrew entirely from instruction in the year 1812; he was at that time appointed Professor *emeritus* of Anatomy, Clinical and Operative Surgery. Soon afterwards he was proclaimed Director of Medical Studies, a duty very honourable in itself, which he raised to a higher degree of splendour by the eclat of his name, as well as by the numerous services which he rendered to the Faculty of Medicine. It was a delightful sight to see the three Faculties, of which the University of Pavia is composed, directed at the same time by as many men, equally distinguished in their respective sciences,—Tamburini, Scarpa, and Volta. Of these three great men it may be said that they died on duty, still in the exercise of their function as directors of learned institutions. Scarpa survived his illustrious colleagues many years: this third torch, on being extinguished, left the University of Pavia covered with funebral crape,—with him disappeared the last trace of the illustrious triumvirate.

In 1814 Scarpa was appointed Director of the Medical Faculty. The principal duties were carefully to observe that the studies were regular and complete, to preside at conferring degrees; in short, to carry into effect the course of medical studies which had been recently sent from Vienna. Scarpa, however, soon perceived that it was not in keeping with the existing state of knowledge; that it was defective in many respects, especially in what regarded the study of surgery. He wrote frequently on the subject to the Government: he transmitted many observations to them pregnant with wisdom and energy, that a revision of the plan might be attained, but it was to no purpose. He pleaded the cause of comparative anatomy which the Government had proscribed; he proposed the disjunction of zoology from mineralogy, by showing that it was impossible for one professor to give a complete and perfect course of both sciences in the same year:—his remonstrances and his writings were not approved of. Tired of preaching in the desert, he renounced his situation of Director. The Government of Milan, who saw this determination of Scarpa with deep displeasure, nevertheless accepted his resignation, but never contemplated the appointment of a successor.

Though he had withdrawn from the practice of surgery, he still continued to promote its advancement. In operating for the stone he preferred the lateral operation with the gorget of Hawkins, on which he made an improvement, which rendered the incision of the prostate parallel with that of the teguments: he energetically and successfully opposed the recto-vesical operation. He always applied the ligature according to the plan of Anel, that had been neglected, but which was revived and perfected by Hunter, which consisted in leaving the aneurismatic bag untouched, and obliterating the artery in the place where it is healthy, and at a point between this bag and the heart, leaving the employment of replacing the principal arterial trunk, and supporting the life of the organ below, to the collateral vessels. He explained a new kind of aneurism, to which he gave the appellation of aneurism by anastomosis of the bone, which consists in the anomalous dilatation of the many small arterial vessels in these hard parts, and which never occurs without the total disappearance of all the hard part of the bone. Scirrhus and cancer, neuralgy, perinaeal hernia, the artificial pupil, the sanguineous varicose tumours, complicated ascites, dropsy of the spermatic cord, the functions of the nerves, which proceed from the brain and spinal marrow, of which some are destined for the organs of sense, and the others for those of motion, and many other matters in medicine and physiology, received from him a new light, and are collected in three thick volumes *.

We have already seen Scarpa undertake his journey to Southern Italy in 1820, loaded with years. His love for the fine arts, especially painting, was the principal motive for this excursion. It was whilst surveying the rich rooms of Tableaux in Florence, that he made a magnificent collection of original pictures of all the Italian Schools, at a great expense. In this department of the fine arts he acquired so elegant a taste, and so perfect a judgment, that his opinion was often requested regarding pictures whose origin was dubious: every one knows the judgment which he passed on a magnificent picture, the

* *Opuscoli de Chirurgia di Antonio Scarpa*, 3. vols. Pavia 1825 and 1832.

property of Count Suardi of Bergamo, and which he declared was the portrait of Guido Baldo, Duke of Urbani, the work of the divine Raphael; his decision may be seen in a letter which Scarpa published in the *Bibliotheque Italienne.*

In this journey he discovered a casque of antique iron, admirably sculptured, which he made known by publishing an account of it, enriched with superb engravings *.

It was in this manner that, surrounded with the various objects of his affections, he spent days worthy of emulation in his beautiful mansion on the banks of the Po; he was very fond of agriculture, and though he did not publish any thing on this subject, he invented and practised new methods of cultivation which have been frequently mentioned in different works, and adopted with success by a great many farmers. It is difficult to find any branch of the great tree of science which was not a source of enjoyment to him, and which he did not cultivate with success.

The Anatomical Museum of Pavia, begun by Rezia, received an augmentation from Scarpa, particularly of his own preparations †. Proceeding in his footsteps, Jacopi ‡, Fattori, and latterly the celebrated Panizza, at present Professor of Anatomy, have successfully enriched it, so that at present it may be fearlessly designated as one of the most beautiful and useful anatomical museums in Europe.

The dignified and gentlemanly manner with which he filled the chair of Professor, captivated the respect and the attention of his audience. He may, perhaps, some day be equalled,—he will never be surpassed. He had an admirable arrangement and method: his discourse was as charming as it was perspicuous; his voice was sonorous and animated, and his eloquence commanded the most profound silence among his audience: his behaviour had a certain austerity, tempered by an amiability

* *Sopra un elmo di ferro squisitamente lavorate a cesello, lettera del Prof. Antonio Scarpa all Cav. Bossi. Pavia;* tipografia Bizzoni in giau. fogl. Vélin di pag xxii. con tavol incis' in rame.

† *Index Rerum Anatomicarum Musæi Ticinensis.* Ticini, 1804.

‡ *Tu Marcellus eris.*—The premature death of this young professor who gave promise of all the genius of his master, was the source of the most acute grief which Scarpa ever experienced.

and sweetness full of attraction. These rare qualities easily secured him every heart, and surrounded him with veneration.

His anatomy was not restricted to a simple and uninteresting description of the organs; he knew how to embellish it with physiological and surgical reflections of the greatest interest. Thus, not only were his lectures resorted to by a crowd of young people who studied the medical sciences, but he also enumerated among his auditors, physicians and distinguished surgeons, as well as learned men quite unconnected with the healing art.

Scarpa was tall, well made, and might have been considered handsome. His manner was full of grace: in society he was extremely agreeable when he chose; but when he was not called upon to do the honours of his house, and found himself in a company which was indifferent to him, then absorbed in his thoughts, sitting apart, his chin resting on the head of his cane, his legs across, silent, and immoveable, he might have been taken for a statue.

He was ardently attached to the pleasures of the chase, in which he acquired unusual address. In all probability it was to this exercise that he was indebted for part of his strength, and of that suppleness, of that activity in his limbs, which he retained even to the most advanced age. His place of retirement and living in the country, were his great passion: he was in the habit of spending his autumnal vacations in his charming mansion of Bonasco, situated on a delightful hill on the other side of the Po; there he appropriated his mornings to the composition of his chirurgical works, the rest of the day he devoted to his friends, the chase, and rural matters; the evenings were passed in reading and literary conversations.

He died after suffering for many years from an affection of the bladder, accompanied with violent spasms, and a disposition to spitting blood, which degenerated into an incurable ulcer. He was attended in his sufferings with a tenderness and perseverance altogether filial by some pupils and intimate friends, at the head of whom we ought to enumerate Professors Panizza, Cadroli, and Rusconi.

Let us be satisfied with having rendered this feeble mark of respect to the memory of the venerable Nestor of modern surgery, to this benefactor of humanity, whose name is spoken of with regret by all his fellow-citizens, and will be proudly repeated by posterity. Let us hope that within a short time, friendship and gratitude will furnish us with the memoirs of this illustrious man, of which he himself has left the principal materials in his papers. J. P. M.

P. S. It is right to render to Cæsar what belongs to Cæsar. I think it is my duty to say that this biographical notice is principally extracted from one which has just been published by Mr Chiappa, and that of Mr Carron de Villards. I owe much also to a letter from my friend Professor Rusconi.

Bibliotheque Universelle, 1832.

REPORT OF A LECTURE ON THE CHEMISTRY OF GEOLOGY DELIVERED AT ONE OF THE EVENING MEETINGS AT THE UNIVERSITY OF LONDON, *by* EDWARD TURNER, *M. D. F. R. S. L. E., Sec. G. S.*

THE lecturer began by explaining, that, under the title "Chemistry of Geology," he included all those geological phenomena to the elucidation of which chemical principles were applicable. The subject, he said, was one of great extent. He might proceed to consider the affinities which operated in forming the crystalline rocks of the non-fossiliferous series,—to develope the several theories by which it is attempted to account for volcanic action,—to show by what means the soft materials of aqueous deposits were converted into solid rocks,—to trace the effects of heat in modifying the appearance and nature of previously consolidated masses,—to endeavour to explain the origin of mineral waters,—and speculate on the obscure subject of the formation of veins. But he would not then venture to discuss any of those topics, the rather as some of them were then under investigation. He meant to confine his remarks to two parts of the subject: First, to the causes which give rise to the disintegration of rocks, thereby providing the materials for new, by the destruction of pre-existing geological formations; and, secondly, to the production, by means of aqueous solution, of siliceous and other deposites, which were commonly regarded as insoluble. He would touch cursorily on the former, chiefly with a view to facilitate the comprehension of the latter.

I. *Disintegration of Rocks.*—The principal agents concerned in the disintegration of rocks, might, it was said, be conveniently arranged, under three heads :—

1. Mechanical agents; such as rain, rivers, and torrents, or, generally, water in motion. This subject, the lecturer said, did not require comment on that occasion, as it was not only familiar to the geologists, but foreign to the plan of his lecture.

2. The alternate congelation and liquefaction of water. In all situations liable to alternate frost and thaw, this was a most fertile source of destruction to rocks.

Water, insinuating itself into fissures, or between the strata of rocks, and congealing there, tore asunder the firmest masses by the immensely expansive force which water exerts in freezing, kept together the disjointed parts as by cement while it remained solid, and, on thawing, left them to fall asunder by the mere force of gravity. This was perhaps the most influential cause of the vast ruin daily witnessed in the valleys of Switzerland, and in all countries where high mountain-chains are intersected by deep narrow gorges, bounded by bare precipitous and irregularly-fissured escarpments. By the operation of the same cause, buildings were defaced and destroyed. When water froze within the cavities of porous stones, the particles were frequently more or less disunited from each other, and crumbled into dust at the first thaw. Building materials differed in their destructibility by frost. The compact tenacious sandstone of Edinburgh suffered little, while some of the handsome Colleges of Oxford gave melancholy proof of the injury which it might occasion in the more porous and less tenacious oolite of that country. The lecturer observed, that a scientific knowledge of the cause of such decay had led to the suggestion of a ready mode of estimating the durability, as far as frost was concerned, of different building materials. The freezing of water was a process of crystallization attended, as in most other cases, with forcible increase of volume. The crystallization of salts was a similar phenomenon, and gave rise to a similar effect. When a stone was dipped into a saline solution, and then suspended in the air to dry, the crystallization of the salt produced a certain amount of injury; and the effect due to one operation might be multiplied to any extent by the repetition of the same process. The experiment of a few days might thus be made to imitate the effect of numerous winters, and the relative durability of different materials be ascertained prior to their selection for building. The salt most applicable to such substances was found to be the sulphate of soda*.

3. Chemical Action.—The affinities which principally contribute to affect the integrity of rocks, were stated to be those of water and carbonic acid for potash and soda, and that of oxygen for iron. The changes referred to were frequent in felspathic rocks, and were exemplified in a very striking manner in the formation of porcelain clay from granite and other allied rocks rich in felspar. All granitic regions presented examples of this nature, and in none were they more remarkable than in Cornwall and Auvergne. It was probable that the long-continued action of pure water might produce decomposition; but the effect of its affinity for the alkalies of the rock was materially aided by that of carbonic acid for the same bases. This was shown by the increased decomposing power of water when charged with carbonic acid, and by the action of moist carbonic acid gas on granite, as exemplified in the volcanic districts of Auvergne. Basaltic rocks were likewise prone to decomposition, partly in consequence of containing felspar, and partly from the protoxide of iron of the augite or hornblende which enters into their composition. The passage of the iron into a higher degree of oxidation was due to atmospheric oxygen applied in a liquid state to the rock through the medium of water. It was probable that carbonic acid likewise co-operated;—that, as in the rusting of iron, a carbonate of the protoxide was first generated, which subsequently passed into the hydrated peroxide of iron.

The rocks in which these changes occurred, underwent a total

* M. Brard in Ann. de Chim. de Phys. vol. xxxviii. p. 160.

alteration both in their mechanical state and chemical constitution. Their tenacity was so entirely destroyed, that the slightest force, a shower, or the breeze, sufficed to overcome the cohesion of their particles. The alkali of the felspar was entirely washed away, and an earthy mixture combined with water remained. The ochreous tint of decomposed basalt and greenstone, sufficiently indicated that their iron had passed into a higher state of oxidation; but felspar often left a perfectly white earth, the small portions of iron and manganese contained in the original rock having been removed, probably in the state of carbonate, during the progress of disintegration. These changes constituted one of the great sources of the alkalies present in springs and in the soil; and the alkaline matter of the nitrates of potash and soda, generated so abundantly in parts of India and America, had probably the same origin. They likewise accounted for the connexion observed between the agricultural character of the soil of certain districts, and the rocks from which it was derived. The decomposition of granitic rocks led to deposites of clay and sand, which were too entirely free from each other, and from lime, to be suitable for the growth of plants; while the earth derived from most basaltic rocks was an intimate mixture of argillaceous, siliceous, and calcareous matter, in proportions peculiarly favourable to vegetation.

II. *Deposites from Aqueous Solution of Substances commonly considered insoluble.*—The lecturer next discussed the second branch of this subject, referring more especially to siliceous depositions, such as flint, calcedony, and rock-crystal. Many circumstances, he remarked, proved the fact that silica very frequently existed in solution. Mineral waters, he said, commonly contained silica. Chemists, indeed, frequently overlooked it in their analyses; but when carefully sought for, it might in most instances be detected. It was constantly contained in the sap of certain plants, if not in all. For it was shown by the late Sir Humphry Davy, that silex is contained in grass, and in the epidermis of reeds, corn, canes, and of hollow plants in general. The existence of silex in the sap of the bamboo, was not only attested by its flinty epidermis, but by the siliceous concretions called *tabasheer*. Similar evidence was afforded by some fossils, which contained silex in such a form as to indicate that it was deposited from a solution. In proof of his position, the lecturer exhibited samples of shells having their form preserved in silex, some beautiful specimens of silicified coral, and a suite of chalk flints which displayed the structure of sponges and other zoophytes. For the opportunity of exhibiting such specimens, he was indebted to the indulgence of the President and Council of the Geological Society. Traces of organization might, by careful examination, be so frequently detected in chalk flints, that he was disposed to the opinion of those geologists who considered flints in general as zoophytes fossilized by silica. The lecturer next adverted to the formation of calcedony, and shewed specimens which, though found in igneous rocks, had their aqueous origin clearly established by the stalactitic form which they possessed. Similar masses of calcedony existed in some flints, and passed into the substance of flint by insensible gradations. The hollow balls of crystals called geodes, afforded similar testimony, by presenting both calcedony and rock-crystal, under circumstances indicative of pre-existing solution.

The fact being established,—that siliceous minerals are frequently formed from aqueous solution, the lecturer went on to state the principles by which he thought the solution of siliceous matter, and its subsequent deposition, might be explained. The first observation he would make related to the meaning of the term insoluble. Chemists, he said, apply it to substances which are not found to lose any appreciable weight when subjected to the action of water. It was not affirmed that absolutely nothing was dissolved in such cases, but that the quantities were too small to be appreciated. This was true even of the most insoluble substance known to chemists; namely sulphate of baryta. But though the weight of such bodies was not perceptibly diminished by trials conducted in the laboratory during a short interval of time, and with small quantities of water, the effect of the same operation, as performed on a great scale in the mineral kingdom, during hundreds and thousands of years, and with unlimited quantities of the menstruum, might be, and doubtless was, very different. It was not necessary, however, to have recourse to this mode of reasoning. Substances, he said, which are inappreciably soluble in one state, may be freely dissolved in another. Silex in the finest powder may be boiled in water without perceptible solution; but if presented to that solvent while in the nascent state, it was freely dissolved. Substances in the act of being formed from their elements, or of separating from previously existing combinations, do not possess that force of aggregation which properly belongs to them, and in such states of transition they have a peculiar aptitude to combine with other bodies. This property is observed more or less in all bodies, but silica offers one of the most striking illustrations of it. Siliceous earth, in its nascent state, is freely soluble in water, and in various acid and saline solutions, which do not perceptibly dissolve ordinary flint, however finely it may be pulverized; and the alkalies and alkaline carbonates, which dissolve silex even in its solid condition, take it up while nascent in far greater quantity. Now, in the decomposition of felspathic rocks, which had been referred to in the first part of the lecture expressly with a view to that subject, the silex was exposed to the united action of water and alkali at the moment of passing from the state of combination which constitutes felspar, and would be expected to be freely dissolved. That it was so, might be proved by a comparative view of the constitution of porcelain clay and felspar. He would represent their composition, he said, by a formula expressive of the number of equivalents of each element; though, in doing so, he did not mean to assert that porcelain clay was strictly an atomic compound. Thus:

Felspar. **Porcelain Clay.**

$$(\dot{P}o + 3\,\dot{S}i) + (\underline{\overset{\dots}{A}l} + 9\,\dot{S}i);\ (\underline{\overset{\dots}{A}l} + 3\tfrac{1}{2}\,\dot{S}i).$$

The lecturer stated, that the porcelain clay referred to was a sample from Villarica, which he had analyzed during the course of the winter. Besides aluminous and siliceous earth, it contained 21.3 per cent. of water. Mr Rogers of Philadelphia had obligingly analyzed for him some porcelain clay from the vicinity of Mont Dor in Auvergne, which had a similar constitution. Berthier and Rose had likewise analyzed porcelain clay from other localities, and each found the ratio of the two earths to be nearly two equivalents of alumina to three of silica. Its constitution, accordingly, appeared subject to very slight variation. The formulæ shewed that every two equivalents of alumina, present in porcelain clay along with three and a half of silica, corresponded in the original felspar, from which it was derived, to twelve equivalents of silica and one of potash. Hence the quantity of silica carried off in solution was enormous.

The lecturer then went on to explain how it happened that silica, existing in solution, was deposited so as to constitute minerals. One obvious principle, he stated, was the molecular attraction which exists between similar particles of matter, as was proved by facts without number. Its existence was attested by the globular form assumed by water, oil, mercury, and other liquids; by the separation from one another of salts in crystallizing out of mixed solutions; by the formation of crystals during the slow deposition of vapour, as when camphor was subliming slowly in a glass bottle, the particles attaching themselves to one another, rather than spreading uniformly over the surface on which they collect; and by the tendency of like molecules to get together and cohere while intermixed with a mass of dissimilar matter, rendered liquid by heat, as when particles of titanium diffused in a furnace, through a mass of iron, seek out each other and form regular crystals, or when minerals crystallize out of melted lava or basalt: so from solutions of silex, whether strong or dilute, the particles are disposed to adhere together whenever they cease to remain in solution.

Another principle applicable to this question, was the following: Whenever substances, insoluble in their ordinary state, were dissolved by the force of favourable circumstances, such solutions were very prone to decomposition. They formed instances of peculiarly unstable equilibrium. The slightest disturbing causes, as agitation, change of temperature, or the affinity, though slight, of some other body for the solvent,—would in such cases put an end to the solution. Illustrative examples of this principle were afforded by solutions of tin, titanium, and peroxide of iron, in a neutral state. He might probably quote albuminous solutions as an instance from the animal kingdom. Water cooled carefully below its usual point of congelation, and saturated solutions of Glauber's salts, were liquids in which a similar instability of equilibrium was conspicuous. The lecturer, in illustration, here showed two solutions of Glauber's salt, —he explained that the mere pressure of the atmosphere, on removing the cork, or the slightest agitation, often caused such solutions to become solid; and that when these failed, the introduction of a solid body, especially a crystal of Glauber's salt, or of any substance having even a feeble affinity for the salt or its solvent, such as a globule of air or carbonic acid gas, generally determined immediate crystallization. The solutions on the lecture table, retained their form after removal of the cork, and after gentle agitation: one of them instantly became solid on the introduction of a glass tube; and the other bore the introduction of the tube, but crystallised instantly when a globule of air from the lungs was blown through the tube. The principle elucidated by these facts was, he said, directly applicable to his argument. A solution of silica oozing slowly into the cavities of a porous or cellular rock might yield a deposite as a consequence of evaporation, of a slight affinity between the silica and some substance with which it accidentally came into contact, or of the solvent power of an alkali which had contributed to its solution being lessened by passing from the state of a simple carbonate to that of a bicarbonate, or by entering into some other mode of combination. The siliceous matter, being once solid, would most probably be insoluble in the menstruum by which it had been originally dissolved, and in that state would promote the increase of the deposit by its molecular attraction for the silex still remaining in solution. In this manner, might cavities of considerable size be gradually filled up with calcedony, flint, or rock-crystal. It was difficult, he said, to indicate the precise circumstances which determined the form assumed by the silex; but it was probable, agreeably to the laws of crystallization, that the development of regular crystals was owing to the extremely slow progress of the same process, which, when less slow, might cause the deposit to be amorphous. In the formation of calcedony and flint, it was most likely, as Brongniart supposed, that the silica, as in operations in the laboratory, was deposited in a gelatinous form, hardening gradually by evaporation, and the cohesive attraction of its particles. The regularly disposed lines which were so beautifully displayed in some varieties of calcedony, seemed owing to successive deposition; one layer succeeding another, each assuming the form and irregularities of the preceding, and differing in tint, according to the absence or presence of small varying quantities of foreign matter, such as iron and manganese. In the case of flint, it was necessary, he said, to account for that remarkable tendency which silica possessed, to occupy the place of organic matter, as exemplified by the specimens of flint, silicified wood and coral, on the lecture-table. This phenomenon, the lecturer thought, might be explained on the principles which had been developed that evening.

Siliceous solutions, infiltrating through organic masses in progress of decay, might readily be decomposed by the affinity of gases, or other compounds, generated during slow putrefaction, either for the silica itself, or for its solvent. In either case a deposit of silex would result. Consistently with this view, it was well known that flints contained traces of bitumen, or some similar substance of organic origin. To it the dark colour of flints was owing, and to its destruction the whiteness of roasted and bleached flints was attributable.

The lecturer, in conclusion, briefly referred to the formation of some other minerals. He explained that the production of crystals of selenite, celestine, and heavy spar, obviously resulted, in many cases, from the sulphuric acid arising one while from burned sulphur in volcanic districts, and at another from oxidizing pyrites, acting upon contiguous masses containing lime, strontian, and baryta. He showed a specimen of red oxide of iron, possessed of a stalactitic form, decisive of aqueous origin; and oxide of manganese, he said, sometimes occurred in a similar state. He considered such specimens to have been originally deposited in the state of carbonates, out of solutions of carbonic acid, and to have been subsequently still farther oxidized—a change which he illustrated by a specimen of carbonate of manganese, kindly given to him by Mr Philips, in which the progress of conversion was distinctly exhibited. He also suggested a possible explanation of the origin of the pyrites so often found in fossil shells, imbedded in clay, which abounds in nodular pyrites. It had been observed that sulphates undergo gradual decomposition by the action of organic matter; and he thought it, therefore, far from improbable that sulphate of iron, generated from oxidized pyrites, might, by the deoxidizing agency of animal remains, be reconverted into sulphuret. —*Annals of Philosophy, July* 1833.

DR OPPENHEIM ON THE STATE OF MEDICINE IN EUROPEAN AND ASIATIC TURKEY.

The father of medicine in Turkey was an Arabian, named Lochmann, appointed in the seventeenth century by Mahommed, to discharge the sacred functions of physician. The miracles performed by Lochmann were numerous, and tradition has recorded them in glowing colours: he was a wandering dervise, and taught his art to the brethren of his order, who, retaining to this day the precious secrets he revealed, continue by birth-right the practitioners of Turkey *. As might be expected, this religious order of physicians are greater proficients in superstition than in practical medicine, and except being acquainted with the virtues of a few plants, they absolutely know nothing. It is true, indeed, that they attempt to acquire confidence by appealing to supernatural agency, divination, astrology, talismans, and cabalistic figures.

Sometimes they attribute the origin of disease to the special wrath of God, in others to the interference of devils, but never perform the ceremony of deprecation or exorcism, without a multiplicity of rites and sufficient pay. Where money is given in the expected quantity, their prayers are endless, their beads are told *ad infinitum*, picked sentences of the Koran are sewn together, and given to the patient to swallow; or, when a fluid

* The Turks, with a happy knack of distorting Frankish names, have confounded Hoffman with Lochmann. Thus Hoffman's liquor they call Lochmann-Rouch.

menstruum is preferred, the holy words are written with chalk upon a piece of board, this is washed, and the water with which the ablution is performed, forms a draught potent in proportion to its impurity. Amulets, however, form the favourite charm of the Turks; and, over the whole of the east, Mahammedans*, Jews, and Christians, appeal to their protection, when threatened or overtaken by misfortune. Hence, few die without wearing two or three amulets, to whose safe guardianship they had intrusted their lives. They generally consist of a scrap of paper, containing a sentence from the Koran or Bible, embellished with cabalistic figures, and folded in a triangular shape, enclosed carefully in a little bag, and worn next the skin, either by means of a string hanging from the neck, or by being stitched inside the turban. Some amulets, supposed to possess a spell capable of protecting from ball and dagger, are sold at an enormous price. Thus, says Dr Oppenheim:—

"After the defeat and death of Wihli-Beg in Monastir, an amulet (Nusko) was found on his body, which he had purchased for sixty thousand piastres. The Selictar (sword-bearer) of the grand Vizier, had its virtues renewed by a dervise, and then wore it himself. I asked him how it happened that the fate of its late possessor had not rendered him sceptical concerning its protective powers. He answered that nought, save the holy will of the Sultan, exceeded this Nusko in power, and that so long as he who wears it refrains from provoking the displeasure of his sovereign, he is secure against the hottest fire of the enemy or the poniard of the assassin."

The unsuccessful Turkish suitor invokes his amulet to soften the obdurate heart of his mistress, and those who are afflicted with ophthalmia, ague, and various other diseases, often place their whole reliance upon the virtues of a scrap of consecrated paper. As the dervises who practise the healing art, can alone infuse power into these amulets, they foster the public credulity, and by selling them at an enormous price, contrive to lose nothing by the confidence of their patients being transferred from themselves to the amulets they manufacture. This is silly and melancholy enough; but after all, while the newspapers of Great

* The name of the prophet is pronounced *Mahammed.*

Britain advertise every day hundreds of specifics; while there are purchasers in abundance for quack medicines, such as Morrison's pills, which heal every disease; while the aristocracy of the country besiege the door of St John Long; when a nobleman and a member of parliament, still considered sane by his constituents, has sworn in a court of justice, that St John Long's frictions caused globules of quicksilver to exude from his skull; when a barrister of reputation in Dublin believes and asserts that the same liniment drew a pint of water from his own brain; when half the community of Dublin believed the miracles of Hohenlohe; when a commission, appointed by a grave and learned society of physicians in Paris, has reported favourably of the miraculous effects of animal magnetism; when we recollect all this, I say, ought we to indulge too freely in ridiculing the Mahammedans for their trust in amulets, or the Turkish matrons for their dread of the evil eye of the stranger, and their belief that all the maladies of their offspring spring from its blasting influence? Another superstition of the Turks is, an observance of lucky and unlucky days for prescribing or taking medicine, and it is singular enough, that they consider Friday, the most unlucky day of the week with ignorant Christians, as the most propitious, while Tuesday is regarded as peculiarly unlucky, and no one thinks either of the exhibition of drugs or the performance of operations, even in the most urgent cases, upon a Tuesday. It was on a Friday that the memorable flight of Mahammed took place, by which his life was saved. Every one in society who can afford to pay for such useful information, takes care to purchase from the astrologers an interpretation of his destinies, as fixed by the stars that presided over his nativity, and each person has his own lucky and unlucky day of the week. It is well known, that even the mighty genius of Napoleon was enslaved by somewhat a similar superstition. The total ignorance and incompetence of the native practitioners have not altogether escaped the observation of their countrymen, for it has been long ago remarked, that a foreign physician, particularly if a Frank, is supposed by the Turks in general, to be possessed of far superior knowledge, and accordingly they are followed with avidity. Whoever appears in any part of Turkey dressed like a Frenchman, an Englishman, or a German, in fact, whoever wears a hat and not a turban, is immediately looked on as the possessor of medical knowledge, and is at once called "Hekim Baschi," and must, *nolens volens*, immediately enter upon practice, for the Turks crowd round him, and hold out their hands that he may feel their pulse, which, in their opinion, is all that is necessary to enable the physician to form a correct diagnosis, and they believe, therefore, that when the pulse has been felt, nothing more is required to give an insight into the nature of their disease, and the proper method of treatment. Others of the crowd, thinking themselves sufficiently acquainted with the nature of their own maladies, seek in the physician only a person to supply them with the remedies they themselves indicate, and accordingly, one applies to him for a vomit, another for a purgative, a third for a medicine to produce wind, another for one to expel it; for the ancient pathology, that diseases are caused by an excess or deficiency of wind in the various organs and cavities of the body, is still common; thus, a headach is caused by wind in the head, dyspnœa by wind in the chest. The physiology of respiration is thus rendered very simple, and the trachea becomes the air pipe not merely of the lungs, but of the whole body.

The encouragement thus given to foreign practitioners, has generated the greatest abuses, for as there are no means of ascertaining the acquirements of strangers, many, induced by sordid views, embark on a system of barefaced quackery, and thus persons who have followed other employments at home, are suddenly physicians in Turkey. Dr Oppenheim was invited to attend a consultation with an eminent French physician at Smyrna, who candidly told him, that the only preparation he had for the profession was, service in the army as drum-major! Among the staff-surgeons of the Turkish army, was a Maltese, who had been a letter-carrier at Corfu, and an Italian captain of a merchant vessel, who had been shipwrecked on the coast of Asia Minor. A Genoese gentleman, implicated in the late revolutionary attempts in Piedmont, and who had long served in the army, applied to Dr Oppenheim, who gave him sixteen recipes, by means of which he was set up in the world, being soon afterwards appointed physician to the governor of Jambul! Nothing can exceed the heterogeneous materials of which the mass of practitioners is composed; foreigners from all countries, and of all trades, but chiefly Greeks, Jews, and Armenians, the religious orders of all the different forms of worship that are professed in Turkey, besides gypsies, barbers, and old women. Of the foreigners some are well educated, and a few, whose names Dr O. mentions, are excellent surgeons and experienced physicians, but such are "few and far between." It is a pity that the state of medicine is so low in a country, where the inhabitants esteem so highly the medical art, and where all are inclined to respect physicians; by the Turks, a skilful physician is almost ranked as a saint, and the appellation "Hekim," is the surest protection against either religious or political persecution. In the last campaign against the Russians, often, says Dr O., was the uplifted sword of the half barbarous Turk arrested on the cry of "Hekim" being uttered by his vanquished foe. The modern Greeks give the title of Excellency to the physician, and old Homer estimated the value of a good surgeon and physician very precisely, in saying that he was worth half-a-dozen colonels *! It may be here mentioned as a curious fact, that the formation of the immense empire of Great Britain in the East Indies, was, in its infancy, greatly aided by the respect entertained for the acquirements of an English physician named Boughton, the successful exertion of whose medical skill enabled him to obtain from the native princes, what the East India Company had for forty years in vain struggled to possess, the liberty to make a permanent settlement and build a factory. There is a particular district of Greece called Sagor, in the Paschalick of Janina, where the profession of medicine is, as it were, the national characteristic and the chief occupation of the inhabitants, whose right to practise is hereditary, and whose knowledge consists in recipes and rules of treatment, handed down from generation to generation. Three or four villages in this district are complete medical hives, sending forth their annual swarms of physicians, who spread themselves over the whole of Macedonia, Albania, and Rumelia, and, in short, over the whole Turkish empire. They follow the good old Greek fa-

* It is difficult to assign their proper rank to many of the chiefs and minor heroes of the Iliad. In calling them colonels, I mean no offence to the dead.

shion, which sanctioned this lazy sort of hereditary diploma, and looked on the descendants of Esculapius as accomplished physicians from their very birth. In other states, it is not rare to find a predilection for certain trades and manual occupations, which are cultivated almost exclusively by the inhabitants of certain districts, who migrate in multitudes over the whole of Europe in search of employment. Thus, Bavaria supplies broom girls, Savoy organ-players and bear-dancers, Lombardy her workers in plaster of Paris and makers of images, to all neighbouring and even many distant countries; while in France, every shoe-black is a native of Auvergne, every gate-porter is from Switzerland; and in Spain, every water-carrier comes from Gallicia; formerly Ireland supplied London with sedan chairmen, and now with coal-heavers *. It was reserved, however, for *Sagor* to stand forth as the productive mother of doctors, an offspring scarcely less dangerous than that which the soil of Bœotia yielded, when the crop of armed men sprung up before the astonished eyes of Cadmus.

Jewish physicians abound in Turkey, and are not a whit better informed than the Albanians. They wander about the country, with their apothecary's shop upon their back, and are, in fact, perfect medical pedlars. Their traffic is not confined to the sale of medicines alone, for they vend cosmetics of all sorts, soaps, oil of roses, charms, and colours. The poorest of this class carry wallets, and walk the streets and bazaars, at every pace uttering the shrill cry "ei Hekim!" "ei Hekim!" *(a physician, a physician.)* Now and then you may see them stopped in the street by some unhealthy looking Turk, whose pulse they feel, and instantly roar out, "bilirim senin hastalik," (I know thy disease,) and without asking the patient a single question, they open their wallets, give him a pill or a powder, which he swallows on the spot, after bestowing on the physician two or three half farthings (paras) for his advice and medicine! Knowledge came from the East; it has travelled slowly to be sure, but here it has arrived at last, and lo, our fees, formerly paid in gold, are *changed* into silver, and undergoing

* In the reign of Charles the Second of England, the number of Scotchmen who carried on the trade of *pedlars* in Poland, amounted to 25,000!—Vide article Pedlar, *Encyclopædia Britannica.*

the rapid process of depreciation, the distant tinkling of brass may be heard even now by the ear, practised in the sounds of coming events! * As long as the fates permit, let the profession struggle against the adoption of this oriental custom, let it in this instance prefer the usages of the West to the wisdom of the East, let it not be said of us, that we are "avari, ambitiosi, quos oriens non occidens satiaverit." † Strange as it may appear, the Turkish physicians are almost exceeded in singularity by their patients, who require the most extraordinary qualifications on the part of their medical attendants. Thus, nothing so enhances in their eyes the value of a physician, as his being able to tell every thing after feeling the pulse. By the pulse alone, he must know not merely the nature of the disease, but must be able to say whether the patient slept well the night before, what he ate during the day, whether the bowels are open, &c. &c. After having once felt the pulse, the physician must put no question to his patient, for it is considered as a sign of ignorance; at his very first visit, he must declare, from the pulse, at what precise time the patient will die or recover. The governor of Adrianople, Halish Pacha, once visited the tent of the Russian general, Paulin, where Dr Oppenheim and two other physicians were attending at levee. Each of the three successively was presented to the Pascha, who made them feel his pulse; and when the ceremony was over, he immediately declared, that one of them was incomparably a better physician than the others, for said this wise Pascha, he felt my pulse much better!

"Often," says Dr Oppenheim, "on presenting my passport to a Turkish officer, the moment he read the words '*Hekim Baschi*,' has he turned out the guard and drawn them up, in order that I might feel the pulse of each. This, of course, I used to do with vast gravity and apparent attention, and the men were quite pleased upon being informed that they were in excellent health!"

Many of the knavish Greek physicians pay the domestics to give them private intelligence, concerning the diet, evacuations, &c. of their patients, whom they afterwards impose

* Coming events have shadows, why not sounds?

† Tacitus—*Agricolæ vita.*

on, by making them believe that their sole source of information was the state of the pulse. When the physician, by means of the pulse, has declared the precise nature of the disease, and the exact moment of its termination, the Mussulman requires him to give a certain medicine, to have some particular effect in determining some evacuation, which is to prove critical. No medicine gets the least credit, or in their eyes can be the least effectual, unless it produce sweat, urine, or purging. The Turk is fond of large doses, too, in order to produce a more decided crisis, and he always prefers medicine in the shape of a draught, or rather drink, (sherbet.) He dislikes emetics, and nothing will induce him to allow the exhibition of an enema. It is quite vain to endeavour to make him alter his diet; of this he cannot conceive the use. In the month of May, it is not unusual for them to submit to what is termed the spring cure. An active purgative is first taken, and afterwards the expressed juice of various plants, such as Taraxacum, various grasses, &c. are taken daily, along with a drink of whey. The most favourite purifier of the blood, however, is *viper broth.* The most esteemed vipers are caught in the neighbourbood of Adrianople, and are sent thence in great numbers to Constantinople, and other parts of the empire. They are kept in wooden vessels, and when wanted for use they are drawn out through the bung-hole. It is needless to remark, that this operation requires much caution and skill, in spite of which, as happened in an instance which Dr O. himself witnessed, the poor apothecary is sometimes bitten. The bite often, but not always, proves troublesome, or even fatal. When this dangerous article of the materia medica has been safely extracted from the vessel, his head and skin are instantly taken off, and the animal is cut into thin slices, which are boiled with water to make broth. The most effectual of the means employed either for the prevention or cure of diseases by the Orientals, is the bath *(Hamam.)* The long continued frictions employed, the stretching, drawing, kneading of the limbs and flesh; the pulling and working of the joints, &c., all tend to exercise a healthful influence; it is astonishing, what a command over the joints an experienced attendant at the baths possesses. He twists them in every direction, and you almost feel, as if he had performed on you a number of successive dislocations and reductions, following each other with surprising rapidity. In chronic diseases of the skin, gout and rheumatism, these baths are invaluable.

The public baths are very handsome, capacious buildings, of which there are several in each town. The bather undresses in a large and spacious hall, provided with benches, and having a fountain playing in the centre. He ties a silken girdle round his loins, and puts on a pair of wooden sandals, and is then introduced into the first chamber; which like the rest is lighted from above, and is flagged with marble. Its heat is moderate, and is intended to prepare the bather for the higher temperature (99°½) of the second chamber, which is arched, and has the flags all heated from below. In the centre of the second chamber, is an extensive platform of marble, elevated about a foot above the floor, on which you stretch yourself at full length, while the attendant goes through the various manipulations on your body already spoken of. This finished, you proceed to one of the numerous alcoves or recesses with which this chamber is provided, and here the process of bathing, properly so called, begins; warm water flows from a pipe into a marble basin, the bather sits down naked on the warm floor, and his attendant, with a piece of cloth made of camel's or horse's hair, which he dips frequently into the water, forms a lather of a sweet-scented soap, and with this rubs every part of the body, and finally, pouring warm water over the bather, completes his purification. He is then covered with warm cotton cloths, and conducted into the outer hall, when he lies down for half an hour on a bench, takes a cup of coffee or a glass of sherbet, and then dresses himself.

The expense of such a bath is so trifling, that it is in the power of even the poorest Turks to make use of them. Every where the baths for the different sexes are in different parts of the town. To the women they afford not merely the luxury of bathing, but the opportunity of meeting their friends and acquaintances. They have been described by Lady Wortley Montague, in colours more glowing than might appear seemly in the pages of a scientific Journal, and, therefore, it may be prudent to omit the subject altogether, merely observing, that, as is natural, they are the chief strongholds of gossip and scandal, and afford the anxious mothers ample opportunities not merely of shewing their daughters to other matrons, but of seeking wives for their sons. In Turkey, the practice of letting blood in spring, formerly common in Great Britain, is still prevalent.

With regard to the manner in which the more respectable part of the medical profession is paid, it evidently evinces a great want of confidence, or rather extreme distrust. In England, it is commonly believed, that the word of a Turkish gentleman or nobleman, once given, may be implicitly relied on; but it is too clear, from the narrative of Dr Oppenheim, that a most lamentable want of principle prevails even amongst the upper ranks. Wo to such a nation, for mutual distrust among individuals prevents all unity and energy of action on the part of the rulers; private corruption inevitably portends the public downfall.

"There is," as Burke beautifully remarks, "a confidence necessary to human intercourse, and without which men are often more injured by their own suspicions, than they could be by the perfidy of others."

The sick Turk, says Dr Oppenheim, makes promises, the convalescent Turk breaks them. In consequence of this disposition, the physician is often obliged to draw up a specific contract in writing, and according to a legal form, before he undertakes the treatment of a case or the performance of an operation. The contract is deposited in the hands of a magistrate, who can enforce payment, and whose zeal in the discharge of this duty is quickened by the legal fee of ten per cent., to be deducted from the stipulated sum. It is not very rare, however, for the patient to evade the ends of justice, by paying the magistrate twenty per cent.; when this is done, the physician's contract too often turns out to be waste paper. These contracts, however, in general afford the physician tolerable security, and are especially necessary when capital operations are performed, as without them he may lose not merely his fee, but his life, in case his patient dies, for the Turk considers the knife of the surgeon in the light of a weapon wielded by an enemy, and thinks himself called on to avenge the death of a relative after an operation. This is hard enough upon the poor surgeon, who, to avoid more fatal consequences, is often obliged to pay blood-money to appease the death of relatives. To avoid these consequences, the surgeon and one of the nearest relatives of the patient repair together to the *cadi*, if it be a small, or to the *mufti* if a large town, and obtain from him a *protection* (fetwa), by which the surgeon is secured against all prosecution if the patient dies. Dr Oppenheim, himself, felt the force of this Turkish antipathy to the performers of unsuccessful operations. After the battle of Monastir, on the 24th August 1830, he amputated the leg of a wounded Deli*: the Deli died. In a few months, Dr Oppenheim was sent by the Grand Vizier to inspect recruits at Pristina, and was invited to the house of the *Cadi*.

"After the customary compliments, he asked me, 'Are you physician to the Grand Vizier? Did you operate on the Deli, Soliman-Aga?' I answered in the affirmative. 'Then,' said the Cadi, 'you behold here the father of Soliman-Aga, who claims blood-money from you, which money it is most just you should pay him.'"

Dr Oppenheim being sufficiently acquainted with the usages and manners of the Turks, and depending upon the protection of the Vizier, was no way intimidated, and soon brought both the Cadi and Aga's father to reason, by means of a few wholesome threats.

When a physician has treated a patient who dies of internal disease, he incurs no risk, unless the deceased held some important and lucrative government post; in such cases, the relatives and dependants of the deceased, being deprived by his death of their station and emoluments, are apt to wreak their vengeance on the physician, who, however, generally takes care to be out of the way on such occasions. At other times, medical men are employed to give opinions, concerning not the living but the dead! This may appear strange, but it is the fact, and it is for such opinions that they are sure to be best paid, for they have it in their power to make what conditions they please with their employers. In Turkey, whenever a governor of a pro-

* The Delis form the flower of the Turkish cavalry, and their name means *madman*. They are so called from their frantic impetuosity in battle.

vince, or mufti, or any other *employé* of the government dies, the whole of the treasure in his possession immediately finds its way into the coffers of the state; therefore, it becomes an object of paramount importance for the family, to conceal, if possible, the death of their relative, until they have either made off with his money, or what is a safer method of proceeding, until they have used one portion of it to bribe the members of the divan into conniving at their keeping the remainder. The father of the present Pascha of Uskup, it is now ascertained, was buried four years before his death was announced. During the interval, his son had carried on all the public business in the father's name, and the signature of the latter was affixed to all official documents. During this period, medical advice was sought for in all quarters, and eminent physicians were even brought from Constantinople. They were consulted, but for very evident reasons, were never permitted to see the patient, a matter esteemed of little consequence in Turkey, provided the state of the pulse is accurately described.

"I must confess," says Dr Oppenheim, "that being at the time but little acquainted with Turkish manners, I was any thing but pleased upon being sent for by Abduraman, the Pascha of Kalkandehl, to treat some patients in his harem. I was received by the Pascha with all those marks of distinction, which the Turk of consequence bestows on a Christian physician, when he has occasion for his services. After he had complimented to excess myself individually, and had extolled the wisdom of the Franks generally, he informed me, that his whole harem was sick, but that with my aid, he had little doubt that his three wives would be speedily cured. The first lady I visited was about twenty-four years of age, who laboured under a catarrhal fever. I promised to cure her in a few days. The second was nearly twenty years old, and of a well marked strumous diathesis. She laboured under a chronic ophthalmia and herpetic eruption. My prognosis was, in her case, more cautious, but favourable; but I specified no fixed period for her recovery. In the third apartment, lay a lady about thirty years old, who had anasarca and ascites, and was also in the last month of pregnancy; her breathing was so much affected, that I feared also the existence of hydrothorax. As I afterwards learned, three months previously she had used the strongest medicines to produce abortion, but in vain. In addition, she had, for the last year, been afflicted with a badly treated ague; these circumstances led me to suspect organic disease of some of the abdominal viscera; I say suspect, for no examination of the abdomen would be permitted. I told the Pascha, that she would be probably delivered of a still-born child, and that she would not survive its birth many days. *Bakkalom! Allah Kaerim! Insch Allah!* (we shall see; God is great—God be merciful) exclaimed he, and inexperienced as I was, I little dreamed that these were mere stereotype * expressions. The Pascha appeared to take the liveliest interest in this lady's state, and required me to feel her pulse four times a-day, and to send him, as often, a report concerning her health. Whenever I spoke to him on the subject, his uniform reply was, 'Give her, I beg you, the best medicines you have; right strong medicines, and she will yet recover—God is great!' The dreaded day came at last; she was delivered of a dead child, and in two hours the harem resounded with the cries of the female slaves. In the east, the females are the first to announce either joy or sorrow. If any thing happy occurs, they utter a cry of joy, modulated by a rapid and quivering motion of the tongue against the palate and teeth. When sorrow is to be expressed, the cry is longer and sharper; the shrieks of the slaves in question were decorously loud and protracted, and they rent their garments and tore their hair. I sought not to be the first bearer of the news to the Pascha, whose anger I dreaded; when I arrived at his apartment, I found that he had already learned the sad news, and I felt greatly astonished at finding the man, who had been all anxiety and alarm at my former visits, now quite composed and tranquil. When I entered, he exclaimed '*Allah Kaerim!*'"

In the course of a short time, all the courtiers and principal officers had come in successively, each, as he entered, using the same invariable phrase addressed to the Pascha, "she is dead, thou shalt live."

The mother and child were consigned to the grave before

* In the original "*diese sterotypen Aussrufungen*," stereotype exclamations —a strong and original expression of Dr Oppenheim.

evening, for in Turkey, among the great there is no lying in state, among the poor no waking. The believer in the Koran hastens to inter the body of his relative, with as little delay as possible, for every moment that the body after death remains above ground, is spent by the soul in agony. The corpse is wrapped in a cerecloth, and committed, without a coffin, to the grave. The grave is about two feet deep, and is covered over with boards, on which the earth is heaped; the head of the body is turned towards Mecca. This practice of burying so quickly, must, in many cases, occasion persons to be buried alive, for it is followed by the whole population of the country, Jews and Christians, as well as Mahammedans. The day of his chief wife's death was marked by no unusual occurrence in the house of the Pascha. The inmates conversed, followed their occupations, and ate their meals just as if nothing happened: one alteration was indeed observable; during the lady's illness, every one had spoken of her state, and evinced the greatest sympathy for her sufferings, now, not a syllable was uttered about her. It was the same in the harem, where Dr Oppenheim, who had now learned the use of the expression, "she is dead, you shall live," found the other two wives of the Pascha very well pleased at what had happened, for they said that their departed friend, who, as the eldest, held the reins of authority in the household, had not led them a very comfortable life of it. These ladies made Dr Oppenheim a present of garments embroidered in the harem, and the Pascha, well contented with his services, sent a guard of honour to accompany him two days' journey from his residence.

Apothecaries there are none in Turkey, and no shops for the sale of medicine, except at Constantinople, and one or two other large towns. Indeed, in a country where the physician is seldom able to write, such shops would be useless. Every physician, consequently, mixes the medicine for his own patients, and is surrounded in his office by a chaotic confusion of gallipots, pill-boxes, drugs, &c. The labels are most curious, and present a truly polyglot assortment of Greek, Latin, Hebrew, Italian, &c. The correctness of the orthography and grammar of these labels, may be judged of by one specimen, "*unguenti diversi*," which adorned a box in one of the best shops in Adrianople. Good medicines are to be had at Smyrna, Salonica, and Constantinople, to which places they are imported from Marseilles, Trieste, and Venice; as they find their way into the interior, they are more liable to be adulterated. Where there exists nothing like a medical police, no check upon such mal-practices, it may be readily conceived that no restraints are placed on the sale of poisons, and, consequently, poisoning by design and poisoning by accident are very frequent. Indeed, it occasionally happens, that a patient coming to a doctor, gets medicine weighed in a scale still soiled with corrosive sublimate or arsenic, and in quite sufficient quantity to despatch the unfortunate sufferer. Often, too, it happens, that inexperienced beginners and ignorant pretenders, give powerful medicines in poisonous doses, in which case the writhings of the patients are interpreted as symptoms of their being possessed, and forthwith the Turkish dervise and the Christian priest are in requisition, and proceed simultaneously with their different forms of exorcism. The precaution of having recourse to the rites of two different religions, is taken to avoid the possibility of mistake or failure, for, say they, we cannot *a priori* tell whether our friend is possessed by a Mahommedan or by a Christian devil.

Poisoning by design is still more frequent than poisoning by accident, and our good honest Irish practitioner, who regards the oath of Hippocrates to be quite as unnecessary as the oath he is obliged to take against the Pretender, will understand better the necessity of many of the clauses ascribed to the father of physic, when he is told, that, in the east, the physician is too frequently, to this day, the venal instrument of such heinous mal-practices. Indeed, according to the religious views of many Turks, it is no sin to poison an enemy, for the attempt to do so will assuredly fail, if he is not fated so to perish! Besides, it is merely a measure of self-defence, for if you do not anticipate your enemy, he is sure to poison you.

"Melancholy, as it is," says Dr Oppenheim, "to witness such mischievous misinterpretation of a Mohammedan dogma, it is still more melancholy to see persons who profess Christianity engaged in the same guilty course, for it cannot be denied that too many of the native Christians of the Greek Church are willing agents upon such occasions. In truth, no honest person ought to engage himself as domestic physician to any great man in Turkey, for if he be called on to poison, and refuses, it may cost him his life. Of this I myself had a convincing proof. The late campaign of the Turks against the Albanians was brought to a successful conclusion, not by superior courage, numbers, or discipline, but by craft and treachery. Two of the most powerful foes of the Sultan, Whely-bey and Asslan-bey, surnamed the Lion Chief, were invited, during a truce, to witness a review of the Turkish regular troops, which to them was a matter of great interest and novelty. The Vizier had it so arranged that they were both shot dead as they were passing in front of one of the battalions. The Vizier's son, Emin, Pascha of Janina, ensnared and despatched some of his most formidable opponents in a nearly similar manner at Janina. One evening at levee, the Grand Vizier made a sign for me to remain, and when all the courtiers had left the room, he ordered in coffee, pipes, and a chess-board, and I then found myself alone in company with a man who expected and received unconditional obedience from every one of his attendants, and at whose nod more than one hundred thousand heads had fallen. Having signified that I should be seated on the divan, he smoked, but according to etiquette, I left my pipe untouched; and when we had made a few moves at chess, he raised his head, looked fixedly into my eyes, and said, 'Hekim-Baschi, I have enemies, you can and will assist me!' He then made the sign for me to retire, which, of course, precluded the possibility of my replying. I made my obeisance, and rode home greatly agitated and alarmed, for the meaning of the Vizier's words was but too intelligible. At that time I was attending two Albanian chiefs of note, who were afraid to trust themselves to the care of the Vizier's physician, and who had applied to me as an officer of the staff for advice. The Vizier was aware of this, and wished me to despatch my two patients. I revolved in my mind the difficulties of my situation, and saw no other method of escaping than by making large pecuniary sacrifices, in the way of bribe, to the Vizier's avaricious *Seraff*, (Paymaster), and his *Grammatiko*, (Secretary). In the mean time I feigned sickness, and remained at home. Twelve days had elapsed since my interview with the Vizier, and nothing remarkable had occurred. On the morning of the thirteenth day, my servant brought in my pipe and coffee as usual; I had nearly finished the cup, when I perceived an unpleasant taste, which excited my suspicion; I immediately took an emetic, and hurrying to the apothecary of the forces, he immediately recognised in the cup nearly two drachms of corrosive sublimate, upon which I swallowed the whites of several eggs, and experienced no further bad effects. Though the favour I enjoyed at court, and the prominent station to which I had been advanced in the medical department of the army, had made me an object of envy to many, each of whom might wish to see me removed, yet it was but too evident, that the blow aimed at my life had descended from a high quarter, and, accordingly, I used every exertion to obtain a passport (*buerouldi*), and, at last succeeding, hastily quitted Turkey."

Such attempts as that made on the life of Dr Oppenheim are very frequent in Turkey, and are too often successful. Hence, it is usual, when speaking of any one who has become remarkable for power, influence, or wealth, to observe, "*He will probably soon die of poison!*" Hence, also, the avidity with which the rich cultivate the friendship of every newly arrived physician, particularly of a Frank. They are anxious to purchase his services, in order that he may not be employed by others to poison them. Of course, where poisoning is so frequent an occurrence, the feelings of a Turk of rank are by no means enviable, particularly when he is sick. It is then that he suffers mortal fear of being poisoned, and to prevent such a disaster, he always takes the precaution of making either the physician or a slave take part of the medicine by way of trial. The illness of the master thus sometimes undermines the constitution of the slave, who is found in this extraordinary service to undergo a long-continued series of vomitings and purgations. Of course, they at least must offer up sincere prayers for his recovery. When a bottle of physic is opened, and the dose measured out, it is again immediately sealed up with the master's private seal, to prevent the introduction of any poison. It is for this reason also, that the Turks are so fond of getting medicine from the hand of the physician who has made it up, for they thus render him responsible for its effects. In this country, such a precaution would perhaps only render a patient more liable to be poisoned. Our author next gives us the particulars of a visit to another harem, which are so characteristic of Turkish manners, that I cannot refrain from giving the details in the Doctor's own words:—

"Like every body else, I felt a strong curiosity to get a peep at the beautiful females annually imported in such numbers from Georgia and Circassia to Constantinople, where they are brought at a very early age to be sold and distributed all over the empire, to serve their masters as servants or as mistresses. I was also extremely anxious to witness the domestic arrangements of these little female colonies: fortune was propitious, and soon afforded me the desired opportunity. The favourite wife of Kiaja Bey, an officer high in the confidence of the governor of Adrianople, fell sick. The Pascha, who had great confidence in me, recommended my services, which were accepted, and a black eunuch was sent to my quarters to accompany me to the harem. It lay about an English mile from the residence of Kiaja Bey; we first knocked at a small wicket, which was opened, and on entering, we found ourselves in a garden, tastefully ornamented, and containing a light and airy summer-house, near which the cooling waters of a fountain played into a beautiful basin of white marble. I was directed to seat myself near the fountain, and was immediately served with a pipe and coffee, while preparations were made in the harem for my reception. In a quarter of an hour, I was conducted through the garden to another door, which was opened by a female covered with a veil, who, it seems, was the guardian and turnkey * of the harem. I was now led through another garden to the building of the women, which was evidently very populous, and I could distinguish the curious faces of children and slaves, white and black, peeping at me in every direction. At last the door of the sick lady's room was opened, and I entered into a very handsome but small apartment, with closed blinds and hung in red. The patient lay on pillows, placed on the carpet near the divan, and was so entirely covered from head to toe with

* This is not exactly the word used by Dr Oppenheim—it seems, however, appropriate.

white cloth, that I could only guess that she was present. I seated myself on the divan, close to her head, and now all unnecessary attendants were ordered to withdraw, so that I was left in company with my patient and interpreter *, the matron already spoken of, and two little children of the sick lady. All the questions I asked were answered from under the cloth, with simplicity and clearness, and many of them, which, in some of our young ladies, might have excited *mauvaise honte*, were replied to in the most natural and easy manner. On my desiring to feel her pulse, one small white hand and then another made its appearance from under the cloth, and when I asked to see her tongue, she raised the cloth, so as to disclose the face of a beautiful brunette, about twenty years of age. This last act, apparently, was an effort which shocked the prejudices of my fair patient, for immediately, like a snail that suddenly withdraws itself into its shell, she shrunk back under the cloth, and I then quitted the apartment, and having put some necessary questions to the matron, I was brought into the *selamlick* or the *boudoir* of the master of the house, where I was again regaled with a pipe and coffee.

"Quite pleased with this visit, I was brought into the presence of *Kiaja Bey*, who, on being informed that, if my patient followed the prescribed directions, she would be well in a few days, ordered me to be honoured with a pipe and coffee, and a purse of five hundred piastres. My prognosis was confirmed, and the recovery of the lady contributed greatly to raise me in the estimation of the Pascha †."

(To be continued.)

OBSERVATIONS ON THE HYGROMETER. *Communicated by the Author.*

The data necessary for determining the quantity of moisture contained in a given volume of air, are, its density, temperature, and the temperature at which dew is deposited.

The density and temperature of the air are, of course, most

* Probably the black eunuch.

† The above interesting view of Dr Oppenheim's work on the State of Medicine in Turkey, is taken from that excellent periodical the "Dublin Journal of Medical and Chemical Science." July 1833.

readily measured by means of the barometer and thermometer; but with respect to the instrument best adapted for finding the dew-point, and to which the term Hygrometer has been generally confined, meteorologists are by no means so well agreed.

Various inventions have been proposed for this purpose, such as those of Leslie, Daniell, Saussure, De Luc, and many others; but it is intended to confine the observations in this paper to two of these, the hygrometers of Professor Leslie and Mr Daniell, and more particularly to the theory of the former instrument.

Professor Leslie's hygrometer indicates simply the degree of cold produced by the evaporation of water, and from this datum, in connexion with those of the density and temperature, both the absolute and relative dampness of the air are most ingeniously deduced. Mr Daniell's hygrometer, on the other hand, enables us to find the dew-point directly by experiment. It is assumed, indeed, in using this instrument, that the air would be saturated with moisture, if reduced to the temperature at which a cold surface becomes covered with dew; but the truth of this supposition is so nearly certain, that the dew-point may still be said to be experimentally determined.

Much difference of opinion exists respecting these hygrometers. As far as regards the ease and accuracy with which observations may be made, that of Professor Leslie is certainly better adapted to general use. But, as has been stated, Mr Daniell's hygrometer possesses one, and perhaps only one, decided advantage, in that it indicates the dew-point without the intervention of theory.

Among the objections which are urged against the latter instrument, none seems more important than the frequent want of coincidence between the real dew-point and the temperature indicated, at the corresponding instant, by the interior thermometer. The result of the observation is often rendered doubtful from this cause, even when the æther has been applied with the utmost caution. The explanation of the want of coincidence alluded to, evidently is, that the thermometer is entirely a relative measure, as well with respect to the *time* in which any change of temperature takes place, as to the *degree* of the change; and although the rate at which the temperature varies may be so adjusted as to coincide very nearly with that of the expansion or contraction of the thermometric fluid, thus rendering the latter an absolute measure of the former, still it only becomes so accidentally.

With respect to Professor Leslie's hygrometer, it must be confessed, that there seems still to remain a degree of uncertainty about its theory; indeed nothing but the belief that some such defect existed, could have prevented the universal adoption of this the most easily constructed, and most convenient, of all hygrometers. The remaining observations will consist of a brief review of the theories of this instrument which have been proposed, and of the formulas for calculating the dew-point derived from these, so far as they are known to the writer.

Theory of Professor Leslie's Hygrometer.

Professor Leslie's own theory is*, that the degree of cold produced by evaporation, is proportional, under the same pressure, to the dryness of the air when its temperature is reduced to that of the evaporating surface. This, according to Mr H. Meikle, is also Mr Ivory's view of the subject.

The only other theory with which the writer is acquainted, is that proposed by Dr Anderson †, namely, that the degree of cold is *nearly* proportional to the rate of evaporation under the same circumstances. Or, in other words, that the degree of cold is nearly proportional to the dryness of the air at its unreduced temperature.

But our ideas respecting these theories, and the formulas deduced from them, will be rendered more precise by employing the following symbols.

t = The temperature of the air, (in degrees of Fahrenheit).

t' = The temperature of the evaporating surface.

t'' = The temperature of the dew-point.

$L = \frac{50}{9} \times (t - t')$ = The indication of Leslie's Hygrometer.

$D = t - t'$.

$\left.\begin{matrix} f_t \\ f_{t'} \\ f_{t''} \end{matrix}\right\} =$ The force of vapour, as measured by a column of mercury, at the temperatures t, t' and t'' respectively.

* See Article Meteorology in the Supplement to the Encyclopædia Britannica.

† See Article Hygrometry in the Edinburgh Encyclopædia. The original idea of this, however, is due to Dr James Hutton, the geologist. See Daniell's Essays, page 199.

$\left.\begin{matrix} g_t \\ g_{t'} \\ g_{t''} \end{matrix}\right\} = \left\{ \begin{matrix} \text{The weight of moisture sufficient to saturate a given} \\ \text{volume of air at the temperatures } t, t' \text{ and } t''. \end{matrix} \right.$

B = The height of the barometer in inches.

It has been stated, that, according to Professor Leslie, L is proportional, under the same pressure, to the dryness of the air at the temperature t'; that is, when B is constant, L is proportional to $g_{t'} - g_{t''}$. From this theory Professor Leslie deduces the following formula for calculating the weight of moisture which a given volume of air contains;

$$g_{t'} - \frac{L}{a} = g_{t''}$$

the value of a being constant for the same pressure. In order, however, to simplify this formula, the volume of air which $g_{t'}$ is sufficient to saturate is so chosen as to render $a = 1$, under the presure of 30 inches, and

$$g_{t'} - L = g_{t''} \qquad (1.)$$

But the dryness of the air, when the temperature is reduced to t', being also proportional to $f_t' - f_t''$, the elastic force of vapour at the dew-point, may, in like manner, be found by means of the formula

$$f_{t'} - \frac{D}{6} = f_{t''} \qquad (2)$$

Mr H. Meikle * has deduced from the same theory the following approximate formula for finding the value of t'':

$$t - \frac{D\,(D + 99)}{t'} = t'' \qquad (3)$$

which is remarkable both for its convenience in calculation, and the ease with which it may be remembered.

These formulas agree well, in general, with observation when t does not differ much from the value it had in the experiment by means of which the coefficient a or b was determined. For example, if the value of b in eq. (2), have been ascertained when $t = 67.2$, the formula will give the dew-point with considerable correctness when the temperature of the air is neither much above nor below 67.2; but when it greatly exceeds or falls short of that temperature, the theoretical dew-point will, in the former case, be too low, and in the latter too high. This obser-

* Edinburgh Phil. Journal.

vation has suggested a modification of Professor Leslie's theory, which will afterwards be proposed.

Dr Anderson, taking a different view of the subject from Professor Leslie, considers D as nearly proportional to the quantity of water evaporated under the same circumstances, which quantity varies as $f_t - f'$, where $f' = \frac{447.4 + t}{447.4 + t''} \times f_{t''}$ = the actually existing force of vapour. Dr Anderson's formula deduced from his theory is

$$f_t - \frac{D}{36 - \frac{1}{10} D} = f' \qquad (4)$$

This equation, like those derived from Professor Leslie's theory, seems to deviate most from experiment at high temperatures; but the error is of an opposite kind, the calculated being often much above the observed dew-point. Indeed, when t is large, it will be found, upon calculation, that Dr Anderson's equation frequently gives $t - t'' \angle t - t'$, which is impossible. There are also one or two points in Dr Anderson's reasoning respecting this formula, on which the writer would venture, with deference, to make a few observations.

Having stated that the equation $D = m(f_t - f')$ requires a correction depending upon D, Dr Anderson * introduces the consideration of it with the following remarks: "It must be evident, however, from the view we have taken of the cooling process, that a thermometer with a moistened bulb ought to be reduced through the same number of degrees in equal times, and thus reach the maximum in a sudden and abrupt manner, —a supposition which is neither consistent with the law of continuity nor conformable to observation; for, although the diminution of temperature is, at first, nearly uniform, the effect gradually diminishes as the process advances, and the differences becoming every instant smaller and smaller, are at last altogether evanescent. The cause of this deviation from the state of things we at first supposed, is to be ascribed to the diminished evaporation arising from the cooling of the moistened surface." Now, although the evaporation is doubtless diminished from the cause which Dr Anderson assigns, yet the continual retardation of the cooling process seems to arise in but a slight degree from this source; for, suppose d = the small portion of heat which

* Art. Hygrometry, para. 56.

the vapour rising from the wet surface carried off in equal successive instants of time, and that in each of the same times, the surrounding bodies restored to the evaporating surface a portion of heat $= \frac{1}{9}(t - t')$ where t' is variable, then it follows that, during the 1st, 2d, 3d, ... nth instants of time, the actual decrements of temperature would be $(1 - \frac{1}{9})\,d$, $(1 - \frac{1}{9})^2\,d$, $(1 - \frac{1}{9})^3\,d$, ... $(1 - \frac{1}{9})^n\,d$; and that the temperature of the evaporating surface would constantly approach, while it never attained, the limit $t - (9 - 1)\,d$. It therefore appears, even on the supposition that d suffered no diminution, that $t - t'$ would not reach its maximum suddenly.

Immediately after the passage to which the above remarks refer, Dr Anderson proceeds to apply the proposed correction to the equation $D = m\,(f_t - f')$ by substituting $\left(P - \frac{D}{r}\right)$ for m, P and r being constant quantities to be determined by experiment. Then, from two experiments, conducted apparently with admirable care and ingenuity, he deduces the following equations:

$$P = 34.66 + \frac{15.2}{r}$$

$$P = 35.34 + \frac{6.9}{r}$$

Now Dr Anderson's theory evidently requires, that the value of r, deduced from experiment, should be positive; but had it not been for one oversight in calculating the first of the above values of P, it would have appeared that r was negative, and therefore that the theory of his correction was, in some way, defective. Upon repeating the calculation, it will be found, that, in the first equation, the quantity $.22723 = f_{t''}$ had inadvertently been used for $.24223 = f'$, and that by correcting this, the equations became

$$P = 35.89 + \frac{15.2}{r}$$

$$P = 35.34 + \frac{6.9}{r},$$

where r is evidently negative.

It was before remarked, that the relation between the calculated and observed values of $f_{t''}$, suggested a modification of Professor Leslie's theory. This consists simply in adding one limitation to his former enunciation of that theory, and may be thus expressed. The degree of cold is proportional to the dryness of the air at the temperature of the evaporating surface, B (and t) being constant. This limitation respecting the temperature of the air, which is marked above, by being enclosed within brackets, is the only modification proposed. The necessity for its introduction is grounded upon the observation, that the ratio of D to $f_{t'} - f_{t''}$, seemed evidently, though slowly, to increase with t or f_t.

Having been unable theoretically to determine the law according to which the ratio of D to $f_{t'} - f_{t''}$, increased with the temperature of the air, it was assumed that

$$D = C f_t \, (f_{t'} - f_{t''}),$$

$$\text{or } f_{t'} - \frac{D}{C f_t} = f_{t''}. \qquad (5)$$

and the constant quantity C was found by means of the first of Dr Anderson's experiments.

Although this formula did not correspond in a satisfactory manner with experiment, yet the relation which was accidentally observed to subsist between its results and those of equation (2), suggested what appears to be either accurately, or very nearly, the law according to which the ratio of D to $f_{t'} - f_{t''}$ varies.

Having found the values of b and c, in formulas (2) and (5), by means of Dr Anderson's experiment, it was remarked that both equations erred when t was either much greater or less than 67.2, and, what was of most importance, that the errors, which then were nearly equal, were always of opposite kinds. The evident inference was, that the arithmetical mean between the corresponding sides of the two equations, that is, the formula

$$f_{t'} - \frac{(c f_t + b) \times D}{2 \, b \, c f_t} = f_{t''} \qquad (6)$$

would represent very nearly the manner in which the ratio of D to $f_{t'} - f_{t''}$ varies with the temperature of the air. The writer has accordingly found that, under a considerable range in the values of t and D, the differences between the results of this equation and experiment, are not greater than may be ascribed to errors of observation.

The values of b and c will afterwards be introduced into the above formula, along with the correction for pressure; and, in the first of the accompanying tables, the results of equations (1), (3), (4), and (6), will be found compared with observation in fifteen instances. It may be remarked, that, in all the calculations, the elasticity of vapour was ascertained by means of Dr Anderson's table, except in temperatures below zero, or greater than 100°, when the elasticity was calculated, like the table, by means of Biot's formula. Professor Leslie's formula was calculated according to the directions, and with the assistance of the tables, contained in the article Meteorology, in the Supplement to the Encyclopædia Britannica.

Correction for Pressure.

In the preceding observations, B has been supposed = 30 inches. When the pressure exceeds or falls short of this, the co-efficients of L and D require a correction. Regarding the theory of this correction, however, and the exact amount of it, there seems to be some difference of opinion.

According to Professor Leslie, when the place of observation is above the level of the sea, it must be increased by a quantity proportioned to the altitude; that is, proportional to log. $\frac{30}{B}$ nearly. So that, on this theory, the same value of L indicates, under a less pressure, a *less* degree of dryness.

Dr Anderson being of opinion that D is proportional to the quantity of water evaporated, that is, generally, to $\frac{30}{B}(f_t - f')$, proposes, as the correction for pressure, to multiply D by $\frac{B}{30}$; and consequently he conceives the same value of D to indicate, under a less pressure, a *greater* degree of dryness. Dr Anderson's formula, corrected for pressure, is

$$f_{t'} - \frac{\frac{1}{6}BD}{180 - \frac{1}{2}D} = f' \qquad (4)'$$

Mr Meikle appears to agree with Dr Anderson as to the nature, though not as to the amount, of the correction. Mr Meikle's experiments seemed to shew that D is nearly proportional to $\frac{57}{B+27}$. It does not appear, however, whether Mr Meikle considers $t' = t - D$, or $t' = t - \frac{B+27}{57}D$; that is, whether the value of D only is to be corrected, or whether both D and f_t are to be corrected for pressure.

It will be observed that it is the object, both of Dr Anderson's and Mr Meikle's experiments, to ascertain how D varies with B; t and t'' being supposed constant: but if, as Mr Meikle allows,

$$f_{t'} - \frac{D}{x} = f_{t''} \qquad \text{or } x = \frac{D}{f_{t'} - f_{t''}}$$

when x varies only with B, then surely the true object of enquiry is not how D, but how $\frac{D}{f_{t'} - f_{t''}}$, varies with B; and the correction for pressure ought not to affect the value of t', but only of $(t - t')$.

The practical determination of the correction for pressure, must be attended with considerable difficulty, whether the experiments be conducted in the open air at different altitudes, or, like those of Dr Anderson and Mr Meikle, in the receiver of an air-pump. In the latter case the air is exposed to the action of sulphuric acid, and $f_{t''}$ reckoned $= o$, or, at least, it is supposed to be constant; but this supposition cannot be verified beyond a certain temperature, even by means of Mr Daniell's hygrometer. When the former method of ascertaining the influence of pressure is adopted, it is necessary to *assume* that the formula for finding the dew-point is correct under a pressure of 30 inches. On this principle, the writer compared, in a variety of instances, the indications of Leslie's and Daniell's hygrometers at different altitudes, and found that when D was multiplied by $\frac{B + 27}{57}$, as suggested by Mr Meikle, the calculated agreed better with the observed dew-point than any other hypothesis. He therefore proposes to adopt this as the correction for pressure in equation (6), which, accordingly, after the substitution of 87.719 for b, and 132.17 for c, becomes

$$f_{t'} - \frac{(f_t + .66372)(B + 27)D}{10000 f_t} = f_{t''} \qquad (6)'$$

But, as before stated, there is a diversity of opinion respecting the *cause* as well as the *degree* of the variation of D with the pressure. It has occurred to the writer that some light may be thrown upon this subject, by considering whence the heat is derived which is dissipated during evaporation.

Professor Leslie regards the heat in question as contributed entirely by the portion of air which dissolves and carries off the moisture; while Dr Anderson thinks it is exclusively derived from the moist bulb.

That neither of these opinions singly is correct, seems apparent from the following considerations:—If, as Professor Leslie supposes, the heat is derived entirely from the air, what reason can be assigned for the temperature of the evaporating surface continuing steadily so much below that of the surrounding medium, from which it must necessarily be constantly receiving heat? surely this can only be caused by its imparting to the dissolved moisture as much heat as it receives. Again, if the moist surface supplied the whole heat which becomes latent in the vapour, as maintained by Dr Anderson, then, when the evaporation is greatly increased by a current of air, the degree of cold should be proportionally increased, which is contrary to observation and experiment. Hence it seems necessarily to follow, that the heat employed in converting the water into vapour is derived both from the air and from the moist surface of the hygrometer.

Further, when the pressure is diminished, the capacity of the vapour for heat is augmented, and the increased quantity of caloric required for its formation must be derived from the same sources as before, namely, the moist bulb and the contiguous air, and probably in the same relative proportions. But the capacity of the *air* being also augmented, it evolves, when its temperature is reduced by contact with the wet surface, a quantity of heat corresponding to the increased absorbing power of the vapour, or at least to that part which is exerted on itself; so that, had the vapour been supplied with all its heat by the air, it is possible that the cold might not have varied with the pressure. As has been shown, however, a portion of the heat which becomes latent in the vapour is derived from the wet bulb of the hygrometer; and since, unlike the air and vapour, this unelastic body has not its capacity augmented by the diminution of pressure, the whole additional efflux of heat from it must be sensible, and be indicated by the descent of the liquid in the stem. Such, perhaps, may be the cause of the variation of D with the pressure.

According to this theory, when t and t'' are constant, $\frac{D}{f' - ft''}$ ought to be proportional to $\frac{(1-n)\,B + n\,30}{B}$ or to $\frac{.6\,B + 12}{B}$, since n appears to be nearly $= .4$.

TABLE containing Fifteen Comparisons of the Calculated with the Observed Dew-points.

Barometer.	Temperature of the Air.	Temperature of the evaporating surface.	Difference of Temperature.	Observed Dew-point.	Calculated Dew-points. According to Professor Leslie's formula.	Calculated Dew-points. According to Dr Anderson's.	Calculated Dew-points. According to Mr H. Meikle's.	Calculated Dew-points. According to the proposed formula.	Difference between the Calculated and Observed Dew-points. Professor Leslie's formula.	Difference. Dr Anderson's.	Difference. Mr Meikle's.	Difference. The proposed formula.	Remarks.
29.750	67.2	52.0	15.2	35.7	21.7	33.6	33.4	35.7	— 14.	— 2.1	— 2.3	0.	This and the two following experiments are taken from the Art. Hygrometry in the Edinburgh Encyclopædia.
30.025	56.4	49.5	6.9	39.5	38.5	39.5	41.7	40.7	— 1.	0.	+ 2.2	+ 1.2	
29.350	65.0	51.5	13.5	35.45	25.4	35.1	35.5	36.6	— 10.	— 0.35	+ 0.05	+ 1.1	
29.787	82.0	76.8	5.2	74.0	72.8	76.8	75.0	75.0	— 1.2	+ 2.8	+ 1.0	+ 1.0	Observations made in India at the level of the sea.
29.830	81.0	72.1	8.9	68.0	64.4	71.4	67.75	68.6	— 3.6	+ 3.4	— 0.25	+ 0.6	Do. do.
29.780	81.5	70.9	10.6	66.5	61.6	70.0	65.2	66.5	— 4.9	+ 3.5	— 1.3	0.	Do. do.
29.800	74.75	67.3	7.45	63.0	60.1	65.2	63.0	63.6	— 2.9	+ 2.2	0.	+ 0.6	Do. do.
28.739	91.5	69.2	22.3	60.5	43.34	71.7	53.7	60.1	— 17.16	+ 10.6	— 6.8	— 0.4	The remaining observations were made on some hills in the south of India.
28.739	91.5	70.7	20.8	62.5	48.8	72.9	57.4	62.7	— 13.7	+ 10.4	— 5.1	+ 0.2	
28.807	87.5	71.48	16.02	64.0	54.5	72.0	62.5	65.4	— 9.5	+ 8.0	— 1.5	+ 1.4	
24.342	70.25	60.0	10.25	54.0	44.9	57.3	53.88	53.6	— 9.1	+ 3.3	— 0.12	— 0.4	
22.945	61.75	54.37	7.38	48.0	41.0	50.8	49.4	47.98	— 7.0	+ 2.8	+ 1.4	— 0.02	
22.921	63.0	53.46	9.54	46.0	35.5	49.0	46.46	45.3	— 10.5	+ 3.0	+ 0.46	— 0.7	
22.917	61.75	46.09	15.66	26.5	—1.1	31.0	29.58	25.0	— 27.6	+ 4.5	+ 3.08	— 1.5	
22.909	57.75	47.75	10.0	36.0	22.7	39.0	38.49	35.7	— 13.3	+ 3.0	+ 2.49	— 0.3	
									+ 0. — 27.6	+ 10.6 — 2.1	+ 3.08 — 6.8	+ 1.4 — 1.5	Maximum error in excess and defect.

Observations on the above Table.—In the 4th of these experiments, it will be remarked that the dew-point, calculated according to Dr Anderson's formula, coincides with the temperature of the evaporating surface; and, in the 8th, 9th, and 10th cases, that it exceeds that temperature. In the 4th and succeeding observations, the quantities in the column marked difference of temperature, were ascertained by means of Leslie's hygrometer, and then reduced to degrees of Fahrenheit. The observed dew-points were obtained by means of Daniel's hygrometer. The cases selected for comparison were those in which it was recorded that the dew-point had been well ascertained. Leslie's hygrometer, and the thermometers attached to Daniel's, were verified and corrected by means of other instruments.

TABLE, by means of which the Dew-point may be found when the Temperature of the Air is between 40° and 110°, and the Barometer at 30 inches.

Difference between the Dry and Moistened Thermometers.

t	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
40°	36.7	33.0	28.8	24.0	18.1	11.4	2.2	-11.5																										
41	37.8	34.3	30.3	25.8	20.6	14.3	6.2	-5.0																										
42	38.9	35.6	31.8	27.6	22.7	16.9	9.7	0.2																										
43	40.1	36.8	33.2	29.3	24.7	19.4	12.9	4.6	-7.0																									
44	41.1	38.1	34.7	30.9	26.2	21.7	15.8	8.5	-1.2																									
45	42.2	39.3	36.1	32.5	28.4	23.9	18.5	12.0	3.6																									
46	43.4	40.5	37.4	34.0	30.1	25.7	20.8	14.8	7.4	-2.6																								
47	44.4	41.7	38.7	35.5	31.9	27.9	23.3	17.9	11.4	3.1																								
48	45.5	42.9	40.0	37.0	33.5	29.7	25.5	20.6	14.7	7.3	-2.4																							
49	46.6	44.1	41.3	38.4	35.1	31.6	27.5	23.0	17.7	11.2	2.9																							
50	47.7	45.2	42.6	39.7	36.6	33.3	29.5	25.3	20.4	14.7	7.4	-2.0																						
51	48.8	46.4	43.8	41.1	38.2	35.0	31.4	27.4	22.9	17.7	11.3	3.3																						
52	49.8	47.5	45.1	42.4	39.6	36.6	33.2	29.7	25.3	20.5	14.8	7.8	-1.4																					
53	50.9	48.6	46.2	43.8	41.1	38.1	34.8	31.3	27.4	23.0	17.8	11.5	3.7																					
54	51.9	49.7	47.5	45.0	42.4	39.6	36.6	33.3	29.7	25.6	20.8	15.3	8.5	-0.2																				
55	53.0	50.8	48.6	46.3	43.8	41.1	38.2	35.1	31.8	27.8	23.4	18.4	12.4	4.9																				
56	54.0	52.0	49.8	47.6	45.2	42.6	39.8	36.8	33.6	30.0	26.0	21.4	16.1	9.5																				
57	55.1	53.1	51.0	48.8	46.5	44.0	41.4	38.5	35.5	32.1	28.3	24.1	19.2	13.5	6.4																			
58	56.1	54.2	52.2	50.0	47.8	45.4	42.9	40.1	37.2	34.0	30.5	26.6	22.1	17.0	10.8																			
59	57.2	55.3	53.3	51.2	49.1	46.8	44.3	41.7	39.0	35.9	32.6	28.9	24.8	20.1	14.6	7.9																		
60	58.1	56.3	54.4	52.4	50.3	48.1	45.7	43.2	40.6	37.7	34.6	31.1	27.3	23.0	18.1	12.2																		
61	59.2	57.4	55.5	53.6	51.5	49.4	47.1	44.7	42.2	39.4	36.4	33.2	29.7	25.7	21.2	15.9	9.6																	
62	60.3	58.5	56.7	54.8	52.8	50.7	48.5	46.2	43.7	41.1	38.3	35.2	31.9	28.2	24.0	19.3	13.7																	
63	61.3	59.6	57.8	55.8	54.0	52.0	49.8	47.6	45.1	42.7	40.1	37.1	34.0	30.5	27.6	22.3	17.3	11.4																
64	62.3	60.6	58.9	57.1	55.2	53.2	51.2	49.0	46.7	44.3	41.7	39.0	36.0	32.7	29.2	25.2	20.6	15.3																
65	63.3	61.7	60.0	58.2	56.4	54.5	52.5	50.4	48.2	45.8	43.4	40.7	37.9	34.8	31.5	27.8	23.6	18.8	13.2															
66	64.4	62.7	61.1	59.3	57.5	55.7	53.7	51.7	49.6	47.3	45.0	42.4	39.7	36.8	33.7	30.2	26.4	22.1	17.0															
67	65.4	63.8	62.2	60.5	58.7	56.9	55.0	53.0	51.0	48.8	46.5	44.1	41.5	38.8	35.8	32.5	29.0	25.0	20.4	15.1														
68	66.4	64.9	63.2	61.6	59.9	58.1	56.3	54.3	52.3	50.2	48.0	45.7	43.2	40.5	37.8	34.7	31.4	27.7	23.5	18.8														
69	67.4	66.0	64.3	62.7	61.0	59.3	57.5	55.6	53.7	51.6	49.5	47.3	44.9	42.4	39.7	36.8	33.6	30.2	26.3	22.0	17.1													
70	68.5	67.0	65.4	63.8	62.2	60.5	58.7	56.9	55.0	53.0	51.0	48.8	46.5	44.1	41.5	38.7	35.8	32.5	29.0	25.0	20.5													
71	69.5	68.0	66.5	64.9	63.3	61.6	59.9	58.1	56.2	54.4	52.4	50.3	48.1	45.7	43.3	40.6	37.8	34.8	31.4	27.8	23.7													
72	70.5	69.1	67.5	66.0	64.4	62.8	61.1	59.3	57.5	55.7	53.7	51.7	49.6	47.3	45.0	42.5	39.8	36.9	33.8	30.4	26.5	22.3												
73	71.5	70.1	68.6	67.1	65.6	64.0	62.3	60.6	58.8	57.0	55.1	53.1	51.1	49.0	46.6	44.2	41.6	39.0	36.0	32.8	29.2	25.3												
74	72.6	71.1	69.7	68.2	66.6	65.1	63.4	61.8	60.1	58.3	56.4	54.5	52.5	50.4	48.2	46.0	43.5	40.8	38.1	35.0	31.7	28.1												
75	73.6	72.2	70.7	69.2	67.7	66.2	64.6	63.0	61.3	59.5	57.7	55.9	54.0	52.0	49.8	47.6	45.2	42.7	40.1	37.2	34.1	30.7	27.0											

TABLE—*continued.*

Difference between the Dry and Moistened Thermometers

t	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
75°	73.6	72.2	70.7	69.2	67.7	66.2	64.6	63.0	61.3	59.5	57.7	55.9	54.0	52.0	49.8	47.6	45.2	42.7	40.1	37.2	34.1	30.7	27.0											
76	74.6	73.2	71.8	70.3	68.9	67.3	65.8	64.2	62.5	60.8	59.1	57.2	55.3	53.4	51.3	49.2	46.9	44.5	42.0	39.2	36.3	33.1	29.7											
77	75.6	74.2	72.8	71.4	69.9	68.4	66.9	65.3	63.7	62.1	60.3	58.5	56.7	54.8	52.8	50.7	48.5	46.2	43.8	41.2	38.4	35.4	32.2											
78	76.6	75.3	73.9	72.5	71.0	69.5	68.0	66.5	65.0	63.3	61.6	59.8	58.1	56.2	54.2	52.2	50.1	48.0	45.6	43.1	40.4	37.6	34.6	31.2										
79	77.6	76.3	75.0	73.5	72.1	70.7	69.2	67.6	66.1	64.5	62.8	61.1	59.4	57.6	55.7	53.7	51.7	49.6	47.3	45.0	42.4	39.7	36.8	33.7										
80	78.6	77.3	76.0	74.6	73.2	71.7	70.3	68.8	67.2	65.7	64.1	62.4	60.7	58.9	57.1	55.2	53.2	51.1	49.0	46.7	44.3	41.7	39.0	36.0										
81	79.7	78.3	77.0	75.6	74.2	72.8	71.4	70.0	68.4	66.9	65.3	63.7	62.0	60.3	58.5	56.6	54.7	52.7	50.6	48.4	46.1	43.6	41.0	38.2	35.2									
82	80.7	79.4	78.1	76.7	75.3	73.9	72.5	71.0	69.6	68.1	66.5	64.9	63.2	61.5	59.8	58.0	56.1	54.2	52.1	50.0	47.8	45.4	43.0	40.3	37.4									
83	81.7	80.4	79.1	77.8	76.4	75.0	73.6	72.2	70.7	69.2	67.7	66.1	64.5	62.8	61.1	59.4	57.5	55.6	53.7	51.6	49.5	47.2	44.8	42.3	39.6									
84	82.7	81.4	80.1	78.8	77.5	76.1	74.7	73.3	71.8	70.4	68.9	67.3	65.7	64.1	62.4	60.7	59.0	57.1	55.2	53.2	51.1	48.9	46.6	44.2	41.6	38.9								
85	83.7	82.4	81.1	79.8	78.5	77.2	75.8	74.4	73.0	71.5	70.0	68.5	67.0	65.4	63.7	62.0	60.3	58.5	56.6	54.7	52.7	50.6	48.4	46.1	43.6	41.0								
86	84.7	83.5	82.2	80.9	79.6	78.2	76.9	75.5	74.1	72.7	71.2	69.7	68.2	66.6	65.0	63.3	61.6	59.9	58.1	56.2	54.2	52.2	50.1	47.8	45.5	43.0								
87	85.7	84.5	83.2	81.9	80.6	79.3	78.0	76.6	75.2	73.8	72.4	70.9	69.4	67.9	66.3	64.7	63.0	61.3	59.5	57.7	55.8	53.8	51.7	49.6	47.3	44.9	42.4							
88	86.7	85.5	84.3	83.0	81.7	80.4	79.1	77.7	76.3	74.9	73.5	72.1	70.6	69.1	67.5	65.9	64.3	62.6	60.9	59.1	57.2	55.3	53.3	51.2	49.0	46.7	44.3							
89	87.7	86.5	85.3	84.0	82.7	81.4	80.1	78.8	77.4	76.0	74.6	73.2	71.8	70.3	68.8	67.2	65.6	63.9	62.2	60.5	58.7	56.9	54.9	52.9	50.8	48.5	46.2							
90	88.7	87.5	86.3	85.1	83.8	82.5	81.2	79.9	78.6	77.2	75.8	74.4	73.0	71.5	70.0	68.4	66.8	65.2	63.6	61.9	60.1	58.3	56.4	54.4	52.4	50.3	48.0	45.6						
91	89.7	88.5	87.3	86.1	84.9	83.6	82.3	81.0	79.7	78.3	76.9	75.5	74.1	72.7	71.2	69.7	68.1	66.5	64.9	63.2	61.5	59.7	57.9	56.0	54.0	52.0	49.8	47.5						
92	90.8	89.6	88.4	87.2	85.9	84.6	83.3	82.0	80.7	79.4	78.0	76.6	75.2	73.8	72.4	70.9	69.4	67.8	66.2	64.6	62.9	61.2	59.4	57.5	55.6	53.6	51.5	49.3						
93	91.8	90.6	89.4	88.2	87.0	85.7	84.4	83.1	81.8	80.5	79.2	77.8	76.4	75.0	73.6	72.1	70.6	69.1	67.5	65.9	64.2	62.5	60.8	59.0	57.1	55.2	53.2	51.0	48.8					
94	92.8	91.6	90.4	89.2	88.0	86.7	85.5	84.2	82.9	81.6	80.3	78.9	77.5	76.1	74.7	73.3	71.8	70.3	68.8	67.2	65.6	63.9	62.2	60.4	58.6	56.7	54.7	52.7	50.5					
95	93.8	92.6	91.4	90.2	89.0	87.8	86.5	85.3	84.0	82.7	81.4	80.1	78.7	77.3	75.9	74.5	73.0	71.5	70.0	68.5	66.9	65.3	63.6	61.9	60.1	58.3	56.4	54.4	52.3					
96	94.8	93.6	92.4	91.2	90.0	88.8	87.6	86.3	85.1	83.8	32.5	81.2	79.8	78.4	77.1	75.7	74.3	72.8	71.3	69.8	68.2	66.6	64.9	63.2	61.5	59.7	57.8	55.9	54.0	51.9				
97	95.8	94.6	93.4	92.2	91.0	89.8	88.6	87.4	86.1	84.8	83.5	82.2	80.9	79.6	78.2	76.8	75.4	74.0	72.5	71.0	69.5	67.9	66.3	64.6	62.9	61.2	59.4	57.5	55.4	53.5				
98	96.8	95.7	94.5	93.3	92.1	90.9	89.7	88.5	87.2	85.9	84.6	83.3	82.0	80.7	79.4	78.0	96.6	75.2	73.7	72.2	70.7	69.2	67.6	66.0	64.3	62.6	60.8	59.0	57.1	55.1				
99	97.8	96.7	95.5	94.3	93.1	91.9	90.7	89.5	88.3	87.0	85.7	84.4	83.1	81.8	80.5	79.2	77.8	76.4	75.0	73.5	72.0	70.5	68.9	67.3	66.7	64.0	62.3	60.5	58.6	56.7	54.7			
100	98.8	97.7	96.6	95.4	94.2	93.0	91.8	90.6	89.4	88.1	86.8	85.5	84.2	82.9	81.6	80.3	78.9	77.5	76.1	74.7	73.2	71.7	70.2	68.6	67.0	65.4	63.7	61.9	60.1	58.3	56.4			
101	99.8	98.7	97.6	96.4	95.2	94.0	92.8	91.6	90.4	89.2	87.9	86.6	85.3	84.0	82.7	81.4	80.1	78.7	77.3	75.9	74.5	73.0	71.5	70.0	68.4	66.8	65.1	63.4	61.6	59.8	57.9			
102	100.8	99.7	98.6	97.4	96.2	95.0	93.8	92.6	91.4	90.2	89.0	87.7	86.4	85.1	83.8	82.5	81.2	79.9	78.5	77.1	75.7	74.2	72.7	71.2	69.7	68.1	66.5	64.8	63.1	61.3	59.4	57.5		
103	101.8	100.7	99.6	98.4	97.2	96.0	94.8	93.6	92.4	91.2	90.0	88.8	87.6	86.3	85.0	83.7	82.4	81.0	79.6	78.2	76.8	75.4	74.0	72.5	71.0	69.5	67.9	66.2	64.5	62.7	60.9	59.1		
104	102.8	101.7	100.5	99.4	98.2	97.1	95.9	94.7	93.5	92.3	91.1	89.9	88.6	87.3	86.1	84.8	83.5	82.2	80.8	79.4	78.0	76.6	75.2	73.7	72.2	70.7	69.1	67.5	65.9	64.2	62.4	60.6		
105	103.8	102.7	101.6	100.4	99.3	98.1	97.0	95.8	94.6	93.4	92.2	91.0	89.7	88.5	87.2	85.9	84.6	83.3	82.0	80.6	79.2	77.8	76.4	75.0	73.5	72.0	70.5	68.9	67.3	65.6	63.9	62.1	60.3	
106	104.8	103.7	102.6	101.4	100.3	99.1	98.0	96.8	95.6	94.4	93.2	92.0	90.8	89.6	88.3	87.0	85.7	84.4	83.1	81.8	80.4	79.0	77.6	76.2	74.8	73.3	71.7	70.2	68.6	67.0	65.3	63.6	61.8	
107	105.8	104.7	103.6	102.5	101.3	100.2	99.0	97.8	96.7	95.5	94.3	93.1	91.9	90.6	89.4	88.1	86.8	85.6	84.3	83.0	81.6	80.2	78.8	77.4	76.0	74.5	73.0	71.5	70.0	68.4	66.7	65.0	63.3	
108	106.8	105.7	104.6	103.5	102.3	101.2	100.0	98.9	97.7	96.5	95.3	94.1	92.9	91.7	90.5	89.2	88.0	86.7	85.4	84.1	82.7	81.4	80.0	78.6	77.2	75.8	74.3	72.8	71.3	69.7	68.1	66.4	64.7	63.0
109	107.8	106.7	105.6	104.5	103.4	102.2	101.1	99.9	98.7	97.6	96.4	95.2	94.0	92.8	91.6	90.8	89.1	87.8	86.5	85.2	83.9	82.6	81.2	79.8	78.4	77.0	75.6	74.1	72.6	71.0	69.4	67.8	66.2	64.5
110	108.8	107.7	106.6	105.5	104.4	103.2	102.1	101.0	99.8	98.6	97.4	96.3	95.1	93.9	92.6	91.4	90.2	88.9	87.6	86.3	85.0	83.7	82.4	81.0	79.6	78.2	76.8	75.3	73.8	72.4	70.8	69.2	67.5	65.9

TABLE shewing the Correction to be applied when the Barometer is either above or below 30 inches.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
30.2	29.8					.02					.05					.07					.09					.12					.14				.16
30.4	29.6					.05					.09					.14					.19					.24					.29				.32
30.6	29.4					.07					.14					.21					.29					.36					.43				.48
30.8	29.2					.09					.19					.28					.38					.47					.57				.64
31.0	29.0	.02	.05	.07	.09	.12	.14	.17	.19	.21	.24	.26	.29	.31	.33	.36	.38	.41	.43	.45	.48	.50	.53	.55	.57	.60	.62	.65	.67	.69	.72	.74	.77	.79	.82
32.0	28.0	.05	.09	.14	.19	.24	.29	.33	.38	.43	.48	.53	.57	.62	.67	.72	.77	.82	.86	.91	.96	1.01	1.05	1.10	1.15	1.20	1.25	1.30	1.34	1.39					
	27.0	.07	.14	.19	.29	.36	.43	.50	.57	.65	.72	.79	.86	.94	1.01	1.08	1.15	1.22	1.30	1.37	1.44	1.51	1.58	1.65	1.73	1.79	1.87	1.94	2.01						
	26.0	.09	.19	.29	.38	.48	.57	.67	.77	.86	.96	1.06	1.15	1.25	1.34	1.44	1.54	1.63	1.74	1.83	1.93	2.03	2.12	2.22	2.31	2.41	2.50	2.60							
	25.0	.12	.24	.36	.48	.60	.72	.84	.96	1.08	1.20	1.32	1.44	1.56	1.68	1.80	1.92	2.04	2.16	2.28	2.40	2.52	2.64	2.76	2.88	3.00	3.12								
	24.0	.14	.29	.43	.57	.72	.86	1.01	1.15	1.29	1.44	1.58	1.73	1.87	2.01	2.16	2.30	2.45	2.59	2.73	2.88	3.02	3.19	3.33	3.47	3.62									
	23.0	.17	.33	.50	.67	.84	1.01	1.18	1.34	1.51	1.68	1.85	2.02	2.18	2.35	2.52	2.69	2.85	3.02	3.19	3.36	3.53	3.70	3.86	4.03										
	22.0	.19	.38	.57	.77	.96	1.15	1.34	1.54	1.73	1.92	2.11	2.30	2.50	2.69	2.88	3.07	3.26	3.46	3.66	3.85	4.04	4.23	4.42											
	21.0	.21	.43	.65	.86	1.08	1.30	1.51	1.73	1.94	2.16	2.38	2.59	2.81	3.02	3.24	3.46	3.67	3.89	4.10	4.32	4.54	4.75												
	20.0	.24	.48	.72	.96	1.20	1.44	1.68	1.92	2.16	2.40	2.64	2.88	3.12	3.36	3.60	3.84	4.08	4.32	4.56	4.80	5.04													

Description and Use of the two preceding Tables.—In the first of these Tables, the vertical line of figures on the left hand, indicates the temperature of the air in degrees of Fahrenheit's thermometer. The upper horizontal line shews the difference between the dry and wet thermometer, also in degrees of Fahrenheit. The temperature of the air, and difference between the dry and wet thermometer, being given at the intersection of the horizontal and vertical lines corresponding to these, the dew-point will be found, provided the barometer stands at 30 inches.

In the second Table, the two vertical columns on the left hand contain different heights of the barometer, greater and less than 30 inches, while the upper horizontal line is the same as in the preceding Table. The other columns contain the correction to be applied when the observed pressure is greater or less than 30 inches: the height of the barometer, and the difference between the dry and wet thermometer, being given, the correction is found at the intersection of the corresponding columns, in the same manner as was described respecting the dew-point. The correction itself is expressed in degrees of Fahrenheit's thermometer, and, when the barometer is under 30 inches, is to be *subtracted* both from the observed temperature of the air, and from the observed difference between the dry and wet thermometer: when the thermometer is above 30 inches, it is to be *added*. As an example, suppose the temperature of the air is 63°.0, the difference between the dry and wet thermometer 7°.0, and the pressure 24.0 inches. In order to find the dew-point, it is necessary first to ascertain the correction corresponding to 24.0 inches, and 7°.0 of cold, which is accordingly 1°.01, or simply 1°.0. The corrected temperature of the air is therefore 63°.0 — 1°.0 = 62°.0; and the corrected difference between the dry and wet thermometer is 7°.0 — 1°.0 = 6°.0. It is then found by means of the first Table, that the dew-point corresponding to temperature 62°.0 and 6°.0 degrees of cold is 50°.7. These Tables were calculated by means of formula (6) mentioned in the accompanying paper.

As it is often an object to ascertain the weight of moisture contained in the air, it may be remarked that t, t'' and B being given, the actual weight of moisture contained in a given volume of air, is *nearly* the same as is sufficient to *saturate* the same volume at the temperature, $t'' - (.062\,(t - t'') + 1.12\,(30 - B))$, under a pressure of 30 inches. Hence, by the assistance of two small tables, together with Dr Anderson's, much trouble may be saved.

AN ACCOUNT OF PROFESSOR EHRENBERG'S MORE RECENT RESEARCHES ON THE INFUSORIA. *By WILLIAM SHARPEY, M. D., Lecturer on Anatomy and Physiology. Communicated by the Author.* With a Plate.

In a former number of this Journal an able analysis was given by Dr M. Gairdner of the discoveries which had been recently made by Professor Ehrenberg of Berlin, respecting the structure and economy of Infusory Animalcules, and of a new method adopted by that naturalist for their systematic classification. Since the period to which that paper refers, Professor Ehrenberg has published the results of additional researches made by him on the same subject, of which I purpose now to give a short account.

By referring to Dr Gairdner's paper, it will be seen that Professor Ehrenberg's discoveries are calculated to bring about a complete revolution in the views entertained by scientific men in regard to the infusoria; and they serve more especially to prove that these animals have hitherto been assigned too low a place in the scale of organized beings. Previously to his researches, it was, with few exceptions, very generally believed, that the infusoria were totally devoid of internal organs, that, in short, they were little more than mere animated masses of gelatinous matter; they were supposed to be destitute of a stomach or internal alimentary cavity, the possession of which is regarded as the most universal characteristic of animals; and though a mouth or sucking orifice had been observed in some species, yet in the greater number, the process of nutrition was believed to consist simply in an imbibition of the surrounding fluid by the surface of their bodies. Our imperfect acquaintance with the structure of these animals, has been due chiefly to their smallness, and to the transparency and want of colour of their principal internal organs. Dr Ehrenberg endeavoured to overcome the difficulties thence arising, by the use of a microscope of a very superior construction, and by the ingenious device of feeding the animals with different colouring substances, which, when swallowed, render apparent the stomachs or alimentary cavities previously hidden from view by their want of colour and opacity. In this manner he has demonstrated the existence of one or more stomachs and an alimentary canal, with a mouth and teeth, or masticating organs, of a wonderfully perfect description; he has farther discovered in these animals, a system of muscles, special organs of generation, and other structures which he considers, not without probability, as constituting a vascular and a nervous system.

Professor Ehrenberg pointed out to me, when in Berlin in 1831, the anatomical structure of some of the infusoria, such as he had made it out, more particularly that of the *Hydatina senta*. In that animal it is easy to perceive the different organs which he has described and figured, and their characters are, for the most part, so well marked as scarcely to admit of doubt as to their nature. With regard, however, to those structures which he considers as the vascular and nervous systems, more especially the latter, it may be observed, that though his descriptions and drawings of these parts are very exact, his opinion regarding their nature and functions, though not improbable, must yet be allowed to be somewhat doubtful, and to stand in need of further confirmation.

The more recent researches of Dr Ehrenberg embrace several different subjects of inquiry relative to the infusoria.

I. *Of the Duration of Life and of the Development of the Infusoria.*

This part of Professor Ehrenberg's inquiries is of interest, not only in relation to the natural history of the animals in question, but also because the results he has obtained are, in his opinion, calculated to correct the views entertained regarding the constitution and production of organic bodies by those philosophers who have adopted the theories of spontaneous generation and of an indestructible living organized matter. While it is universally admitted that all the more perfectly organized beings, whether animals or vegetables, are propagated from parent beings similar to themselves, the phenomena which attend the production of some of the simplest tribes, led many physiologists to believe that they might take their rise from various animal and vegetable matters independently of pre-existing parents, by a process which has been named *spontaneous* or *equivocal* *generation.* In regard to the infusory animals, in particular, though it was known that when once existing they could propagate their species by ova, or by the separation of the parent into two or more new individuals, yet their appearance in infusions of animal and vegetable substances, so circumstanced that the presence of parent animals or ova could with difficulty be conceived, has induced many eminent physiologists to have recourse to the hypothesis of spontaneous generation to account for their origin in such circumstances. It will be seen as we proceed, how far Professor Ehrenberg's observations tend to confirm or to invalidate this theory. According to another general view of the constitution of organized beings, it is maintained that the material particles of which every plant or animal consists, are themselves endowed with an inherent vitality possessed by them independently of the life of the individual plant or animal of which they form part. Accordingly when a plant or animal dies, its constituent particles still retain their vitality, and may be employed again in the formation of new organized bodies, which can be formed only from such organic particles. There are, therefore, two sorts of matter in the universe, organic and inorganic; and organic matter may exist in two states, either as forming a part of individual organized bodies or not, in both of which states it retains its vitality, though in the latter state this property is possessed only in its lowest degree or most simple condition, being the property of life in general without the special modifications which it exhibits in individual organized bodies. By the partizans of this theory, the simplest forms of infusory animalcules, or monads as they are termed, were regarded as nothing more than mere organic particles or molecules, which being separated from one another, were impressed with movements and exhibited other phenomena indicative of their inherent vitality. Hence they were sometimes named simple vital bodies, in contradistinction to animals and plants which were conceived to be formed by the aggregation of them in a number and manner depending on the size and perfection of the individual which they constituted. This is nearly what is meant by the theory of an *universally diffused vital matter*, or of living organic molecules.

Without meaning to combat this theory, it must be admitted that Professor Ehrenberg's observations have overthrown one great argument adduced in its favour, that which was drawn from the supposed identity of the simplest infusoria with mere organic molecules, since these infusoria have been shown to possess a much more complex structure than had previously been imagined, differing only in degree from that of the more perfect animals, and totally inconsistent with the notion of their identity with simple organic molecules, an opinion founded on imperfect and erroneous observation.

The method of observation adopted by Professor Ehrenberg, in conducting the present part of his inquiry, was the following. He poured into a watch-glass a small quantity of water containing some of the larger kinds of infusoria, which, by a little practice, may be perceived with the naked eye. Of these he took out a single one with the end of a feather, cut into a convenient shape, and placed it under the microscope, in order to ascertain whether it contained perfect eggs, and, if any were present, to note their number. This being done, he put the animal into a narrow glass-tube, closed at one end like a small test-tube, and filled with water, in which he had previously satisfied himself, by careful examination with the microscope, that no similar animals were present. A blade of the *lemna* was laid on the top of the water, to preserve it from dust, and prevent it from becoming putrid by stagnation. By this contrivance he was enabled to carry on his observations on several separate individuals at the same time.

He first made choice of the *Hydatina senta*, which he selected as an example of the infusory animalcules belonging to the class of Rotatoria; this animal being about one-sixth of a line in length, and therefore well fitted for examination. In the month of November 1830, twelve different individuals of the *Hydatina senta* were subjected to observation in the manner described, and the following were the results:

1. One individual survived eighteen days. As it was full grown when put into the tube, and then probably two or three days old, and as it did not die a natural death, but was destroyed by accident, the duration of life in this individual may, with great probability, be estimated at more than twenty days.

2. The hydatina is propagated by eggs: they were observed first within the body of the parent animal; then deposited in

the water; lastly, they were repeatedly seen after the young had been excluded from them, and when nothing remained but the outer covering or shell.

3. The rate of increase is very rapid, but varies according as the animals are sparingly or abundantly supplied with food. Dr Ehrenberg put into some of the vessels in which the animals were kept, a small quantity of the green matter which collects in stagnant water, and which itself consists of a species of infusoria (*Monas pulviscului*), having satisfied himself that it contained none of the hydatinæ. This substance was readily eaten by the hydatinæ, and produced a marked increase in their fecundity. In one glass, for example, the original animal had, in the course of nine days, produced only one young one and one egg; but on adding some of the green matter, the number increased, in about twenty-four hours, to nine animals, besides one egg. From this and similar instances, he reckons that, on the most moderate computation, a single individual may, in twenty days, increase to a million, and in twenty-four days, very nearly to the enormous number of seventeen millions; a rate of increase far exceeding any thing observed in the rest of the animal creation.

The remarkable effect of food which was observed in these cases, affords a striking illustration of the general law, that the propagation and increase of the lower tribes of animals are greatly influenced by external circumstances. Another remarkable instance of the same truth is furnished by the history of the fresh-water polypi, in which animals Trembley found the rapidity of propagation to be greatly dependent on the supply of food, and on the degree of temperature to which they were exposed. Cold invariably diminished their fecundity, and heat, within certain limits, as constantly increased it. It is to be regretted, that Dr Ehrenberg did not direct his attention to the effect of temperature on the propagation of the infusoria.

He next proceeded to make similar observations on the class of Polygastric infusoria, of which he selected *Paramecium aurelia* and *Stylonychia Mytilus* as examples. The results obtained with these species are as follows:

1. Propagation took place by a transverse division of the parent animal into two. He did not meet with instances of longi-

tudinal division, or of propagation by gemmæ, which he had observed in the same species of animals in other circumstances. The animals remained a few days without change; their bodies then appeared somewhat contracted in the middle, which appearance was an indication of commencing division; when this had once begun, they increased very rapidly, so that, in one case, a three-fold division was observed to have taken place in the course of twenty-four hours, a single animal having multiplied to eight.

2. Individuals, after undergoing division several times, were observed alive for ten days, to which time, at least, the duration of their life must therefore extend.

Dr Ehrenberg lastly infers, as a general result of his inquiry, that the origin of infusory animalcules can be, in all cases, satisfactorily accounted for without the necessity of having recourse to the doctrine of spontaneous generation, which he regards as a mere hypothesis, not required to account for known facts, and unsupported by any trustworthy observations.

Without undertaking to advocate the theory of spontaneous generation, we may be permitted to remark, in opposition to his conclusion, *first*, that the supporters of the doctrine by no means deny that animals which owe their origin to spontaneous generation may and do afterwards continue their species by propagation, whether by ova or otherwise; that the fact of the increase of existing infusoria by propagation, which is the chief argument furnished by Dr Ehrenberg's observations, was previously known, and therefore forms no new argument against the doctrine.

2dly, It might be objected, that the animals submitted to observation in the cases related, belong to the larger and more perfect species of infusoria, and are therefore less likely to be produced by spontaneous generation.

3dly, That although Dr Ehrenberg, in refuting the notion of the extreme simplicity of these animals, has overthrown one great argument in favour of their spontaneous origin, yet he has offered no explanation of their production in infusions which have been subjected to a heat sufficient to destroy any parent animals, or even ova, supposed to be present. In these cases, as is well known, the adversaries of the theory ascribe the origin of infusoria to ova conveyed by the air; an assumption which the supporters of the doctrine regard as highly improbable, and which, if admitted as true, they consider inadequate to explain the production of infusoria in all the conditions under which it is reported to have taken place by observers worthy of credit. It is true, that Dr Ehrenberg never witnessed the spontaneous origin of infusoria; but before denying the possibility of its occurrence, and discarding the theory of spontaneous generation, as unnecessary to account for the facts, it was incumbent on him to have subjected anew to a rigid examination the observations of those who have arrived at an opposite conclusion from himself, and either exposed the fallacy of their experiments, or shown how they were to be explained on a different view from that adopted by their authors. It is the more to be regretted that he has not favoured us with such a critical examination, as, from his extensive knowledge of the different species of the animals in question, his intimate acquaintance with their mode of life, and his superior methods of observation, he is singularly well fitted for the task.

II. *On the Eyes of the Infusoria.*

Many of the infusoria have one or more coloured spots on the surface of their bodies, which Dr Ehrenberg regards as their eyes. These spots, which are mostly of a red colour, were noticed in a few of the infusoria by preceding observers, by some of whom they were even designated by the name of eyes; but it seems probable that that term was used merely by way of comparison, and was not intended to imply that such spots were really the eyes or organs of vision of the animals in which they were observed. Professor Nitsch of Halle, however, who had discovered them in some species of *Cercaria*, endeavoured to prove that they were eyes in a real sense; and he has therefore the merit of first pointing out in a distinct and explicit manner the existence of such organs in the infusoria. Dr Ehrenberg, in his former memoirs, described the eyes in several of the Rotatoria. He has since found them in two-thirds of the known genera belonging to that class, and in all the species of these genera without exception; and what is more remarkable, he has discovered them in many of the smaller and less perfect animals of the class of Polygastrica. According to his observations, these organs are constantly and invariably present in those species which have been discovered to possess them, even under very varied circumstances, insomuch that he has derived from them distinctive characters of much value in his systematic arrangement.

The eyes of the Rotatoria appear as one, two, often three, or even more spots, usually of a red colour, placed at the fore-part of the animal, either before the rotatory organs on what might be named the forehead, or immediately behind them, on a part of the body which might be compared to the nucha or nape of the neck in other animals; or they may occupy both these situations (Plate I. Fig. 11.) They appear, according to Dr Ehrenberg, to be immediately connected with the nervous system; for the posterior one is always placed either at the point where the summit of the nervous arch or loop, arising from the cerebral ganglion, touches the skin, or, when the loop is wanting, directly over the ganglion itself, and the anterior or frontal eyes always occupy a situation which corresponds with the points where, as is seen in the *Hydatina senta*, two filaments proceeding from the nervous loop in the neck reach the region of the forehead.

That these organs are in reality the eyes of the infusoria, is rendered extremely probable by the fact of their being so extensively prevalent among those animals,—by their great regularity and constancy,—and by their obvious connexion with what appears to be a nervous apparatus. This opinion is corroborated by the fact that, in most cases, they contain a very highly coloured pigment, which, on crushing the little animals between two plates of glass, is effused in the form of a finely granulated mass, bearing much resemblance to the pigment in the eyes of other animals.

As a further proof that the infusoria are provided with an organ of vision, Dr Ehrenberg adduces the great precision with which they execute their movements, seize on their prey, or otherwise direct themselves towards particular objects; nay, these actions seem so decidedly to require the aid of vision for their performance, that he is induced to think that faculty may be probably possessed by those species which are destitute of coloured eyes, and that the function may in such cases be exercised by points of the skin, which, though not exhibiting any colour, are furnished with nerves corresponding in origin and distribution with those which supply the coloured eyes of other species.

Lastly, he conceives that all doubt as to the nature of these organs is removed on attending to the analogy which subsists between them and the eyes of the Entomostraca. No one has any doubt as to the nature of the organs named eyes in the larger crustacea, and there is little doubt that the analogous organs in the Entomostraca are also eyes. But these exactly correspond in substance, colour, and position, with the supposed eyes of the Rotatoria.

He mentions a singular peculiarity which he has observed in regard to the eyes of *Melicerta ringens* and *Megalotrocha alba.* The young of these animals possess distinct red eyes, which are not observable in the adult animals; they seem to be absorbed or otherwise removed during the growth and extension of the rotatory apparatus, which is very large in these animals.

Dr Ehrenberg was no less successful in discovering the existence of eyes in several infusoria of the class Polygastrica. The animals of this class, in which he first discovered them, belong to the family of Astasiæa, and constitute the genera *Euglena, Amblyophis,* and *Distigma.* The first of these consists of seven species, all distinguished by a single dark red eye placed on the fore part of the body. They formerly belonged to the genus *Cercaria* of Müller, and it was in these animals that Nitsch, as already mentioned, discovered the presence of eyes. The *Amblyophis*, of which he knows but one species, has a large bright red eye in the same position as *Euglena,* from which it differs, in being destitute of a tail. The eyes of *Distigma,* of which he has discovered three species, consist of two small black points, (Fig. 16.) He next found one animal belonging to the family of Kolpodea, which possesses a distinct eye, and he has formed it into a separate genus, under the name of *Ophryoglena flavicans.* Further, in the family of Epitricha he has discovered an eye in a very singular animal, which seems to have been confounded by previous writers with the *Volvox morum* of Müller, but which Dr Ehrenberg names *Eudorina argus (elegans?).* It is remarkable that in this genus the eye is perceptible only in the young animals; the body of the parent consists of a transparent sac or capsule, in which several young ones are inclosed, and each of these is provided with a single red eye and a long bristle, which it exserts through the transparent envelope (Fig. 12.)

In further prosecuting his researches on the eyes of the Polygastric Infusoria, Dr Ehrenberg, who had naturally expected to meet with these organs chiefly among the larger kinds of infusoria, found to his surprise that they are a far more general attribute of the smallest sort. For instance, in the family of the Monads, he discovered two genera with evident eyes. One of these, *Microglena*, consists of two species, the smallest individuals of which do not exceed $\frac{1}{192}$ of a line in diameter (Fig. 13 and 14.) The other belongs to the Loricated Monads. Its body is bright green, contained in a transparent shell, and furnished with a large bright red eye. He has named this genus *Lagenula*, from its shell, which is shaped like a bottle (Fig. 15) *. The presence of eyes, both in the naked monads, and those provided with a shell, serves as an additional proof of the correctness of the view which induced Dr Ehrenberg to arrange the infusoria in two parallel series, the *Nuda* and *Loricata*, the latter of which differ from the former chiefly, and in many cases solely, in possessing a shell.

III. *Of the External Parts of the Body, and External Organs of the Infusoria.*

In order to obtain appropriate characters for the systematic arrangement of the numerous forms of infusoria, which, chiefly through his own researches, are now known to exist, Dr Ehrenberg has found it necessary to examine, with greater care than has hitherto been done, the external parts of these animals, and to define them with greater accuracy. I shall endeavour to give some connected account of the more interesting results of his investigation, without entering into details, which rather belong to the terminology of the subject, and possess no general interest.

* By means of an improvement in his microscope, he has lately discovered two additional loricated monads with eyes, which he names *Cryptoglena pigra*, and *Cryptoglena agilis*, the former $\frac{1}{250}$ of a line in diameter, the latter not exceeding $\frac{1}{500}$ of a line, being little more than half the diameter of a globule of human blood.

A. General coverings of the body.

The body, in many infusoria, is naked; in others it is protected by a covering or *lorica*, of which there are several varieties, differing from each other in form and substance. Sometimes it resembles the shell of a tortoise, surrounding the animal completely in the middle, with an opening before and behind, through which the head and tail project. This form is named a *testa* or shell. In other cases, it covers only the back of the animal, being open below; it is then named *scutellum*. The *urceolus* is a covering or case, shaped like a bell or like a cylinder closed at one end, within which the animal can withdraw itself at will. The *lacerna*, or mantle, is a very curious provision. It is a sort of dense gelatinous covering, which would seem to be formed out of the most external layer of the animal's body. Within it the substance of the animal separates into several young ones, which are for a time enclosed, but at length escape by the bursting of the envelope (Fig. 12.) The parent animal would therefore seem to lose its individual existence, and to be at length converted into a mere capsule, containing the young. This form is found in *Volvox*, *Eudorina*, *Pandorina*, and *Gonium*. Lastly, the covering sometimes consists of two pieces, when it is named *Lorica bivalvis*.

B. Exterior divisions of the body.

In the greater number of infusoria, the body presents a pretty obvious division into head, trunk, and tail. There is seldom any well-marked indication of a neck.

The head is very obvious in the Rotatoria, it is that part of the body which bears the rotatory organs and the eyes. Within it are contained the large cerebral ganglions, the cavity of the mouth, and masticating apparatus. The limit between the head and trunk, which is sometimes marked by a slight constriction, is named the nucha, or nape of the neck; its position is further marked by the attachment of the nervous loop to the skin, and often more conspicuously by an eye here situated. In the Polygastric Infusoria, the head is seldom capable of being pointed out as a distinct part.

The trunk is well defined in those infusoria which possess a distinct head. In the Rotatoria it may be defined the part of the body placed between the head and anus.

The part named the tail is an elongation of the body behind the anus; it differs from the tail of other animals in being as it were a prolongation of the ventral and not of the dorsal part of the body, so that the anus is placed above its base, and not below as usual. It is sometimes truncated, at other times forked at its extremity, and is, in most cases, furnished with one or more suckers, by which the animals can fix themselves to surrounding objects.

C. External organs or appendages of the infusoria.

These Dr Ehrenberg classes under three heads, viz. 1. Simple; and, 2. Compound organs of motion; and, 3. Other appendages and organs which do not serve for motion. Of the first sort, there are none more remarkable than what are called *variable processes*, which are observed in some of the Polygastric infusoria, and which are altogether temporary and transient in their existence. They are the result of a faculty which the animals possess of elongating the substance of their bodies at one or more points, in the form of a tube or lobe-like process, and consequently of giving rise to many proteus-like changes of figure, for which preceding observers have often been puzzled to account. The mode in which this phenomenon takes place may be well seen in the *Amœba:* the animal allows a small part of the parietes of its body to become relaxed, while it contracts them forcibly in the rest of their extent; by this means the internal contents, or viscera, are urged against the relaxed part and distend it into a bag or hollow process of variable form, the cavity of which they occupy. In this manner, the whole granular substance within the body and the stomachs, with their contained food, are sometimes forced into such a protrusion, which, in its mode of formation, might not inaptly be compared to a hernia. In the *Amœba* such variable processes may be formed at any point; in other cases, as in *Arcellina*, they are observed to occur only on the fore part of the body, and do not receive any part of the alimentary canal, but seem to be protruded by means of a pellucid fluid. The next kind of simple organs of motion are the *setæ* or bristles. These appendages are im-planted in the substance of the body by their base, which is not jointed. They, therefore, never perform any rapid movements, but they are capable of being slowly erected and depressed, and seem to assist in the progressive motion of the animal, somewhat in the same manner as the prickles of the sea-urchin. They are found in but a few species. *3d,* The *cilia*, or hair-like organs: these, either separate or combined together into a special apparatus, form the principal instruments of motion in the infusoria. By an attentive examination of the larger forms of them, Dr Ehrenberg has discovered that they are furnished with a bulb at the root, to which minute muscles are attached. A slight degree of rotation impressed on the bulb causes a much more extensive motion in the rest of the organ, which, in its revolution, is made to describe a cone whose apex corresponds with the bulb. In the Rotatoria, the cilia are always combined to form the compound rotatory organs peculiar to that class, to be afterwards described. In the Polygastrica, they are in a few instances entirely absent, or at least not observable; in other instances they are placed round the mouth, or spread over the body generally, in which case they are usually disposed in regular rows. *Uncini,* or hooks, are setaceous appendages, curved at the point, which serve for seizing or clinging to surrounding objects. *Styli,* or styles, are articulated at their base, and more moveable than the setæ or bristles; they differ from cilia in being destitute of a bulb, and in not performing a revolving motion.

The compound organs of motion are found only in the Rotatoria, in which they constitute the very singular rotatory apparatus peculiar to these animals which we have next to consider. The structure of the simple cilia, and the mechanism and manner of their movement, have been already described; but in the animals of the class Rotatoria, the cilia are always combined to form one or more organs of a more complex structure, which are named the rotatory or wheel-like organs. Dr Ehrenberg has established the primary systematic divisions of that class of infusoria on differences observed in these organs, of which he reckons four different forms. In the most simple form the cilia are disposed round the mouth in the figure of a horse shoe, or of a circle interrupted at one part of its circumference, the mouth occupying the interruption, and the cilia being not set in single file but several deep. The animals possessing this form of organ are subdivided into two groups, in one of which the margin of the circle formed by the rotatory organ, though interrupted by the mouth, is otherwise entire; in the other the margin is indented or divided into lobes, the first are named *Monotrocha*, the second *Schizotrocha*. In its third form the rotatory organ is double, consisting of two circles of cilia, between which the mouth is placed (Fig. 1.) The animals with this form constitute the group of *Zygotrocha*, to which the common wheel animal (*Rotifer vulgaris*) belongs. In its fourth and last form, the rotatory apparatus consists of several small wheel-like organs set near to one another, the group in which it so exists are named *Polytrocha*. The rotatory apparatus of the *Hydatina senta* affords a good example of this form of organ, and a good representation of it will be found in the plate accompanying Dr Gairdner's paper. Since his first account of the hydatina, however, Dr Ehrenberg has discovered a thickly set circle of curved cilia surrounding the whole rotatory apparatus, also delicate muscular bands which connect the small rotatory organs with each other.

Such are the chief varieties in the form of these singular organs, but by far the most remarkable circumstance in regard to them, is the appearance which they present when in motion. The single and double rotatory organs when set in motion resemble a toothed wheel turned rapidly round on its axis, first in one direction, then in the opposite, and currents are at the same time produced in the surrounding water, in a regular and determinate direction. In the *polytrocha*, the wheel-like motion is not obvious, and the currents are excited in no regular or fixed direction, which circumstance serves to distinguish the animals belonging to this group, in cases where, from their smallness, the form of the rotatory apparatus can with difficulty be determined.

It has been often a question what actually takes place during this apparent rotation. Baker* supposed that the organ was really constructed like a wheel, and moved freely round on an axis which formed its sole connection with the rest of the body;

* Of Microscopes and the discoveries made thereby. London, 1785; vol. ii. p. 284.

a view which few adopted, from the difficulty of conceiving such a mode of connexion to subsist between the parts of organized beings. Nevertheless, the distinction which he was led by this view to establish between the motion in question, which he named Rotation, and that of simple cilia which he called Vibration, has prevailed till now, and the animals exhibiting these two motions have been distinguished from each other by the names of Infusoria Rotatoria, and Vibratoria. Dr Ehrenberg considers that there is no essential difference between the two motions, being both produced by cilia which move individually in the same manner, but from their different arrangement in the two cases produce a different general effect. The apparent rotation or turning round of the whole circle, is obviously an optical deception which he endeavours to explain thus: The cilia composing the rotatory organ have the same structure, and move in the same manner as the single cilia already mentioned, that is, they are moved round by minute muscles attached to their bulbous roots, in such a way as at each revolution to circumscribe a conical space. When viewed sideways in performing this revolution, they must necessarily pass at one moment a little nearer, at another a little more distant, from the eye, or in other words, alternately become more and less distinct to the view at very short intervals, and this alternation occurring over the whole circle, gives rise to a seeming change of place in every point of its circumference and a consequent appearance of rotation. Other explanations of this singular phenomenon have been offered, of which I may refer, on account of its ingenuity rather than its probability, to that suggested by Dutrochet, in the *Annales du Museum d'Histoire Naturelle*, tom. xx.

In regard to the use of these organs, Dr Ehrenberg observes, that they are chiefly employed by the animals in catching their food by the currents which they occasion, and in swimming; they therefore serve as organs of prehension and of locomotion. He supposes also that the currents which they produce must be subservient to the respiratory function, by constantly bringing a new portion of water into contact with the surface of the animal, a supposition which appears to me highly probable, when we compare these currents with those which I have elsewhere shewn to take place along the surface of the respiratory organs in many of the higher aquatic animals, in which their purpose is no ways doubtful.

The remaining external appendages of the infusoria are such as are not employed as organs of motion; they possess but little interest, except as affording distinctive characters to the systematologist. They consist of *Cornicula; Cirrhi; Patellæ*, or suckers, which are placed at the extremity of the simple or forked tail, and serve for fixing the animal; the *Proboscis* or trunk, which not unfrequently projects from the fore part of the head; lastly, the *Calcar* or spur (Fig 1.) This last organ is a retractile process, which projects from the neck in some of the Rotatoria, especially the two-wheeled species. It resembles much in appearance the male exciting organ of the hermaphrodite mollusca; Dr Ehrenberg has, however, satisfied himself that in the infusoria, mutual impregnation by the concurrence of two individuals, is not necessary to the generative act, as is the case with the mollusca alluded to; and he is therefore of opinion that the organ in question must serve some different purpose which has not yet been found out.

IV. *On the Alimentary Canal of the Infusoria.*

The Digestive apparatus of the infusoria presents two principal forms. In the Rotatoria it consists of a simple canal, as in insects; in the Polygastrica, on the other hand, there is either a canal with numerous sacs or stomachs opening into it, or several stomachs unconnected by a canal.

Again, the simple alimentary canal of the Rotatoria exists under four subordinate forms (Fig. 2–6.) In the *first*, it is destitute of masticating organs, with a very long œsophagus, and a simple or undivided great intestine (Fig 2.), as in the genera *Ichthydium, Chætonotus*, and *Enteroplea.* In the *second*, it is furnished with masticating organs, with a very short œsophagus, and a simple great intestine (Fig. 3.), as in *Hydatina* and *Synchæta.* In the *third* form, there are masticating organs, a very short œsophagus, and a great intestine, divided by a constriction into an anterior or gastric portion, and a posterior portion, or proper great intestine (Fig. 4, 5.), as in *Euchlanis, Brachionus*, &c. Lastly, in the *fourth* form, there is a pharynx with masticating organs, behind which the alimentary canal continues narrow till near the anus, where it is dilated into a sort of cloacal enlargement, being surrounded through most of its length by a cellular apparatus, composed of a number of small recesses or pouches, which probably serve for absorption (Fig. 6); they are not stomachs, for stomachs receive the food immediately after it is swallowed, whereas these recesses are never filled in the first instance. This form is found in the naked Zygotrocha, the *Rotifer*, *Actinurus*, *Philodina*, and others.

These differences in the alimentary canal of the Rotatoria are so constant and so well defined, that they might afford characters for subdividing the class, and the four principal divisions thence resulting might be designated, from the peculiarities of their alimentary canal, by the terms, 1. Trachelogastrica, 2. Cœlogastrica, 3. Gasterodela, and, 4. Trachelocystica. Such a mode of arrangement is, however, objectionable on two grounds, first, because, as a general rule in arranging organized bodies, it is preferable to take the characters of the more subordinate divisions from external and not from internal parts; and, secondly, because, in adopting the form of the alimentary canal as a principal ground of subdivision, animals are brought together which differ widely from each other in their general structure and habit. The above is therefore given merely as a physiological view of the alimentary organs, and is not brought forward as a principle of arrangement.

The Polygastric infusoria might also be divided into four groups, distinguished by the peculiar form of their alimentary organs, and designated accordingly, namely, 1. Anentera, 2. Cyclocœla, 3. Orthocœla, 4. Campylocœla (Fig. 7–10). In the *Anentera* the several sacs or stomachs, the plurality of which characterizes the class, are unconnected by a canal, they all open by a common orifice or mouth, and there is no anus (Fig. 7). In the *Cyclocœla*, the alimentary canal, into which the stomachs open, forms a circle or loop, having both an entrance and an exit, or a mouth and anus, but these open externally by a common orifice (Fig. 8). The union of the mouth and anus into a common orifice at the anterior part of the body, forms an external character by which the *Cyclocœla* may be always distinguished. The *Orthocœla* have a straight alimentary canal, with a mouth and anus placed at opposite ends of the body (Fig. 9).

In the *Campylocœla* the canal is serpentine, with two separate orifices, which are seldom placed opposite to each other in the axis of the body (Fig. 10). This circumstance will generally serve to distinguish the *Campylocœla*, which have, moreover, a certain want of regularity in their external form. It is difficult to trace the course of the canal itself.

V.—*On Glands and other Appendages of the Alimentary Canal in the Rotatoria.*

In his former memoirs, Dr Ehrenberg took notice of two glandular bodies attached to the œsophagus in some of the rotatoria, which he considered analogous to the pancreas of higher animals, and he gave a particular description and representation of them, as they are seen in the *Hydatina senta*. He has subsequently found them in all the rotatoria which he has examined, except the genera *Ichthydium* and *Chætonotus*. Having frequently observed these organs to be much smaller in those animals which had laid a considerable number of eggs, and which were therefore older, he imagined that they might be testicles; but not being able to trace any anatomical connection between them and the generative apparatus, he is still inclined to his former opinion, that they are glands subservient to the process of digestion.

Besides these pancreas-like bodies, he has in certain species discovered organs resembling biliary vessels, and in others cœcal appendages connected with the alimentary canal. In the *Enteroplea Hydatina*, several delicate vessels are connected with a dilated portion of the œsophagus not far from the stomach, (Fig. 4). They are transparent and colourless, but in other respects bear much resemblance to the biliary vessels of insects. The cœcal appendages are found in several species; in the *Megalotrocha alba* they are two in number, short, and situated near the bottom of the stomach. In the *Notommata clavulata*, there are four, which are long and filiform, equalling in length the elongated pancreas, and are attached to the middle of the stomach. In *Diglena lacustris* (Fig. 5), they are also long and filiform, and are connected with the middle of the stomach; they are in some instances four in number, in others five. These cœca are all transparent; their function is still doubtful.

VI. *Of the Dental System of the Rotatoria.*

The discovery of the teeth in the infusoria, affords a striking proof that the smallest organized beings are not necessarily also the most simple in structure. This truth becomes still more manifest when we learn that these organs exist under several forms, which are so constant and regular, that the infusoria might almost, like quadrupeds, be arranged according to their teeth. However, in giving a systematic view of the principal varieties in the form and structure of the teeth, Dr Ehrenberg does not propose to found on it a system of arrangement, to which he admits there would be serious practical objections.

The pharynx of the Rotatoria is surrounded by four hemispherical muscular masses, placed opposite one another like the limbs of a cross, which become very obvious when in motion. Two of these are armed with the maxillæ and teeth, which being formed of a hard substance, may be disengaged from the soft parts, and rendered distinctly visible, by crushing the animal between two plates of glass. In the greater number of Rotatoria, each maxilla consists of an anterior and a posterior portion or process, which are joined together at an angle (Fig. 17, 19). The posterior process is sunk in the muscular substance, and thus fixed, the anterior is directed towards the opposite maxilla, and at its free extremity bears one or more teeth.

In a smaller number of genera the structure is somewhat different. Each maxilla is shaped like a stirrup or like a bow with a double string, and the teeth are laid across it in the same position as arrows across a bow, being fixed at both ends (Fig. 21, 23). The bow is directed outwards and placed horizontally; the pieces representing the strings are situated inwardly next to the opposite maxilla; they are not straight, but form two arches connected by their extremities, and placed in the same vertical plane. The lower arch gives insertion to the muscles, the upper one supports the teeth, which are fixed to it at their inner extremity, the outer resting on the bow.

According to these two principal forms of the teeth and jaws, the Rotatoria might be divided into two groups, distinguished by the names of Gymnogomphia, or those in which the teeth are free, and Desmogomphia, in which they are fixed. Each of these groups is again divisible into two.

The two subdivisions of the Gymnogomphia are the Monogomphia and Polygomphia. The first (Fig. 19, 20.) have only one long tooth in each jaw, which they can push out a considerable way, the teeth of the opposite sides then appearing like a pair of nippers. The animals with this form of teeth are for the most part very rapacious, and prey on other infusoria; they form, as it were, the feræ and carnivora of the tribe; they are more lively and quick in their movements than other rotatoria, and, with one exception, they all possess eyes. The *Polygomphia* (Fig. 17, 18.) have more than one tooth in each jaw, some have two, others from three to six. When there are several, they, along with the maxilla, form the figure of a hand. The animals of this division are less rapacious in their habits than the former, and live chiefly on vegetable substances, or the smaller infusoria which they attract by the currents which they excite in the water; they are never seen to attack the larger Rotatoria, or to show other signs of a ravenous disposition.

The group of Desmogomphia is less numerous than the foregoing, but includes, as would appear, the most highly developed Rotatoria. Its two subdivisions are the Zygogomphia and Logogomphia. The animals of the first division (Fig. 21, 22.) have in each of their stirrup-shaped jaws two teeth, alongside of which the surface of the jaw is finely streaked in a parallel direction, as if it contained more teeth not perfectly formed. The *Logogomphia* (Fig. 23, 24.) have always more than two teeth in each jaw, which in other respects resemble those of the *Zygogomphia*, the collateral streaks on the jaw being well marked. In respect of their mode of life, the animals of both these divisions agree with the Polygomphia, living on vegetable matter.

Lastly, a few of the Rotatoria are destitute of teeth. These might be named Agomphia.

Besides the proper jaws and teeth just described, some of the Rotatoria are provided with an additional masticating apparatus, which consists of indurated folds or ridges on the inner surface of the pharynx, of a firmer consistence than the surrounding substance, but yet not hard like the true teeth.

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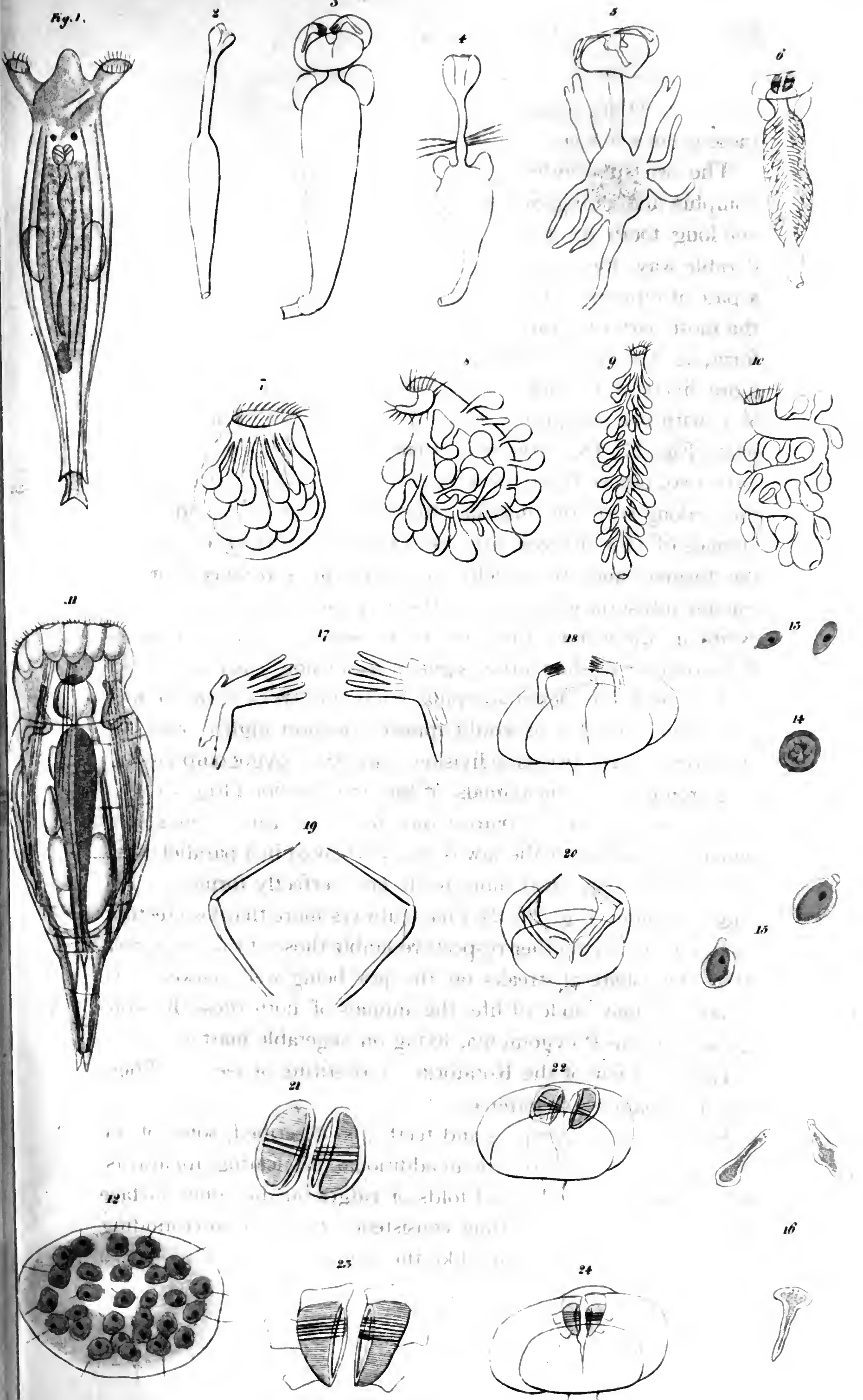

Such are the principal forms of the teeth of the Rotatoria, to which class of Infusoria, until lately, Dr Ehrenberg supposed them to be confined. By a recent improvement of his microscope, however, he has succeeded in discovering a distinct pharynx and teeth in the *Loxodes Cucullulus*, which belongs to the Polygastrica.

Explanation of Plate I.; the figures are all much magnified.

Fig. 1. *Philodina erythrophthalma*, showing the double rotatory organ, behind which is the process named *calcar* or spur, and the two eyes.

2–6. Show the forms of the alimentary canal in the Rotatoria, viz.

2. Trachelogastrica from *Chaetonotus maximus*.
3. Cœlogastrica from *Euchlanis macrura*.
4, 5. Gasterodela, viz.
4. From *Enteroplea Hydatina*, showing the supposed biliary vessels connected with the œsophagus.
5. From *Diglena lacustris*, *a*. œsophagus, *bb*. two pancreas-like bodies, *ccccc*. five cœca connected with the stomach.
6. Trachelocystica from *Philodina roseola*.

7–10. Show the forms of the alimentary canal in the Polygastrica, viz.

7. Anentera from *Monas Atomus*.
8. Cyclocœla from *Vorticella citrina*.
9. Orthocela from *Enchelys Pupa*.
10. Campylocœla from *Leucophrys patula*.
11. *Eosphora Najas*. The three red spots placed anteriorly are the eyes, two being on the fore part of the head, and one in the neck. The alimentary canal is filled with carmine.
12. *Eudorina elegans*, with the young inclosed, their eyes appearing as a red spot.
13. *Microglena monadina*, and
14. *Microglena volvocina*, showing the eye, which appears like a red spot.
15. *Lagenula euchlora*, with its transparent covering or *lorica*, and single red eye.
16. *Distigma viride*, seen in three different shapes; its eyes resemble two black points.

17–24. Show the principal varieties in the form of the teeth of the Rotatoria.

17–20. Gymnogomphia.

17, 18. *Polygomphia ;* 17. jaws and teeth separate ; 18. pharynx and teeth of *Hydatina senta.*

19, 20. *Monogomphia ;* 19. jaws and teeth ; 20. pharynx, jaws and teeth of *Diglena forcipata.*

21–24. Desmogomphia.

21, 22, *Zygogomphia ;* 21. jaws and teeth ; 22. ditto with pharynx of *Rotifer macrurus.*

23, 24. *Logogomphia ;* 23. jaws and teeth ; 24. pharynx, jaws, and teeth of *Megalotrocha alba.*

ABSTRACT OF A COMPARATIVE REVIEW OF PHILOLOGICAL AND PHYSICAL RESEARCHES, AS APPLIED TO THE HISTORY OF THE HUMAN SPECIES. *By J. C. Prichard, M. D., F. R. S.*

The object of this essay is to furnish a survey of the progress of knowledge in relation to ethnography, with a critical account of the attempts which have been made to distribute the human species into departments constituting what are termed Families of Nations, and especially of that classification of races which has been adopted by Baron Cuvier, and is now very generally received. The author commences with preliminary remarks on the resources of knowledge available in researches of this kind, and states it to be his principal design to consider and estimate the means of information respecting the history of mankind which are furnished by two different methods of inquiry, viz. by philological and physical investigations ; the former including those researches into the structure and affinity of languages which have been undertaken with a view to elucidate the relations of tribes and races to each other ; the latter, the attempts which have been made to classify nations by their mutual resemblances in figure, complexion, and other physical peculiarities.

"Philology, in this point of view an important study, dates its origin from an era glorious in the history of modern discovery and the achievements of science. It begins with the voyage of Malgalhaens, who first led the way in the circumnavigation of the globe, and whose fame has been recorded by the gratitude of posterity upon the heavens as well as upon the earth. While Malgalhaens was employed in tracing in the sky nebulæ, and new seas and oceans on the globe, his companion Pigafetta bethought himself of acquiring the means of rendering intelligible, and of comparing with each other, the various dialects of the new races of men, whose existence this voyage was destined to make known. He began the practice of collecting vocabularies which might furnish specimens of the idioms spoken in distant islands of the ocean. His example has been followed by succeeding navigators, and has led by degrees to results of great interest. The native tribes found in remote groups of islands in the great southern ocean, looked upon themselves as the offspring of the sun and moon, or of the soil; they knew nothing of other branches of the human family; their whole world and sphere of existence was limited by their shores, or by the small circle of their imperfect navigation. Accordingly, by some writers it has been confidently assumed that these tribes of men, like the bread-fruit and cocoa-nut trees by which they are fed, are the indigenous produce of the coralline or volcanic soil on which they exist. This notion might have been strenuously maintained, if researches into the structure and affinity of languages had not furnished its refutation, and displayed, in the idioms of these insular tribes, sufficient evidence of their mutual relationship, and of the derivation of the whole stock of people from a common centre."

The author proceeds to give a brief survey of the history of philological inquiries, and of the various collections exemplifying the diversity and affinity of languages which have been made since the year 1555. "In 1555 was published the first general essay on this subject,—the *Mithridates* of the learned Conrad Gessner, which may be considered, however, as an abortive attempt, the author having aimed at more than it was possible to attain in his age. The *Mithridates* of Adelung and Vater, which followed 130 years afterwards, is the last general history of languages which has appeared. Particular portions, however, of the field of philology have been cultivated with great success, either by private individuals or by societies of learned men.

"1. Much light has been thrown on the languages of Asia, their affinities and relations, by M. Julius Klaproth, who, in various journeys in Caucasus, Siberia, and the provinces of the Russian Empire bordering on China, has enjoyed extensive opportunities of acquiring information: he is likewise acquainted with the Chinese and Mongolian languages, and has made diligent use of the historical information extant in the works of Chinese annalists and literary compilers. The principal results of his studies are contained in his great work, entitled *Asia Polyglotta*, to which is appended a *Sprach-atlas*, containing comparative tables of vocabularies.

"2. A great mass of information was collected by Dr Seetzen, in reference to the languages of the African nations. On the geographical discoveries of this traveller in Palestine, the eastern parts of which he was the first among modern travellers to explore, I have no occasion for remark. The principal theatre of Seetzen's researches was Africa, where he spent a long time in collecting vocabularies and historical and geographical information from intelligent men whom he met with among the woolly-haired races. Such of his papers as reached Europe were either put into the hands of Professor Vater of Königsberg, or were published by Baron Von Zach, in the *Monatliche Correspondenz*. I shall briefly advert to one point, in reference to which he has illustrated the ethnography of Africa. The origin of the Felatahs, in the interior of that continent,—a red or copper-coloured race, who have lately made extensive conquests over the Negro nations,—was, for some time after that people became known, a matter of uncertain conjecture. It is now known that the Felatahs are a branch of the same race who have for many centuries inhabited the high lands of Guinea, where the Gambia and the Rio Grande have their sources, and who have been visited in their mountainous capital of Teembo by more than one European adventurer. They are the Foulahs of English travellers, and the Red Poules of M. Mollien. Seetzen obtained a vocabulary of the Felatah language, which was published in the *Könisberg Archivs für Philosophie*; and this led to a discovery of the real origin of the people.

"3. In reference to the languages of America, which are known to be very numerous and complex in their structure, much information was collected by Hervas, the result of his own personal researches, and those of other Jesuits. Baron Alexander Von Humboldt brought back with him from America a large collection of vocabularies, dictionaries, and devotional offices, and other books, prepared by the Catholic instructors, in different parts of that Continent, for the use of the native tribes who came under their spiritual jurisdiction. These were put into the hands of Professor Vater, the continuator of the *Mithridates*. Since the publication of that work, the Historical Committee of the Philosophical Society of the United States have devoted their attention to the languages and history of the aborigines of the Western Continent. The names of Hecklwelder and Zeisberger, and that of Mr Duponceau, the learned Secretary of the Committee, stand highly distinguished among those of contributors to this department of human knowledge."

The author then states the most important results in reference to the history of languages, which he considers as established by these inquiries.

"1. It appears that the number of human idioms, widely differing from each other, is very great—much greater than many persons supposed. Mr Jefferson, President of the United States, used to argue, from the great number of distinct languages found in America, and the comparatively small number existing, as he supposed, in the Old Continent, that America was the most anciently peopled. Most persons will be of opinion that this conclusion requires further proof; but the fact is undoubted, that a great variety of languages are spoken in America. According to Hervas, who relied on the information given him by Lopez, 1500 languages, which are said to be '*notabilmente diverse*,' are spoken in different parts of America. According to Dr Seetzen, the number of distinct languages in Africa amount to 100 or 150. If these calculations are nearly correct, we may, without much danger of exceeding the truth, consider the probable number of languages spoken in all the world to be not less than 2000.

"2. We may observe, in the second place, that a comparison of various languages displays two different relations subsisting between them. These relations may be termed those of Affinity and of Analogy. I shall give a few examples of each.

"(1.) The relation of affinity, or, as it has been termed by German writers, the *Stammverwandschaft*, or family relation of languages, subsists between idioms which have a great proportion of their elements or roots common to all of them, together with a general resemblance in grammatical structure. It is generally allowed that nations, whose idioms have this sort of affinity, are allied in origin. Groups of idioms thus related are termed Families of Languages.

"One strongly marked family of languages consists of the dialects termed collectively the Semitic. To this belongs the Hebrew, the Chaldee, the Aramean or Syriac, and the Geez or Ethiopic.

"Another family of languages is the Indo-European, in which are included various idioms both of Europe and Asia, whose near affinity has been thought to prove a kindred origin in nations long ago separated from each other. It has been chiefly during the last twenty years that the near affinity of this class of languages has been discovered. They form a most extensive group, including, 1*st*, the Sanskrit and all its dialects in India; 2*d*, the ancient Zend or Medo-Persian language, and all the idioms now spoken in Persia and Arminea; 3*d*, the Greek and Latin languages, and all the dialects sprung from them; 4*th*, the Sclavonic, the origin of the Russian, Polish, and Bohemian languages; 5*th*, the Teutonic languages; 6*th*, the Celtic dialects, which belong, if I am not mistaken, to the same family, though on this subject there is some dispute.

"We have next to consider *analogy* between languages. Many idioms which are entirely distinct from each other, being completely different in their vocabularies, and having few or perhaps no words in common, are yet found to bear to each other a striking resemblance in their grammatical structure. This resemblance is such as to admit of no other term than that of analogy, and such languages cannot be said to belong to the same family; they constitute particular classes of languages. I shall mention some examples of this relation.

"1. A strongly-marked class of languages are those termed monosyllabic, the words belonging to which are monosyllables, uttered without any inflection of termination, and with merely a sort of intonation to express the relations of words to each other.

Idioms of this description are spoken by the Chinese, Tibetans, Burmans, Cochin-Chinese, Siamese, and nearly all the nations of the further Indian Peninsula. The particular languages I have now mentioned are quite distinct from each other; even their numerals and their most familiar and common elements of speech are different.

"Another class of languages are those termed Polysynthetic, consisting in long-polysyllabic words, and abounding in modes of inflection, refined and elaborate, admitting almost infinite varieties of termination and changes of structure; such varieties of structure and termination expressing numerous modifications in the original ideas which the words were intended to convey. To this very remarkable class of languages belong all the idioms of America, from that of the Esquimaux at Behring's Straits, to the dialects of Patagonia and Terra del Fuego.

"I shall now terminate what I have to say on this branch of my subject, viz. on philological researches, by one remark, of which the application will hereafter be very obvious. It is, that although we may not be authorised in a positive conclusion, that all nations whose languages belong to the same *class*, are of one race, as, for example, all the nations of the New World, the resemblance between their respective idioms being only analogy, and not amounting to affinity, yet we may determine upon regarding such nations as more nearly connected than those whose idioms belong to different classes; and we may assert, that any pretence for including in one race or lineage, nations whose idioms belong to classes totally different, must be arbitrary, and in opposition to all probability. Such, for example, would be an attempt to include some of the American nations whose idioms are polysynthetic, in the same race or stock with tribes who speak monosyllabic languages.

"From the survey I have now taken of the progress of philological information, and from the conception which this survey is calculated to produce of the nature and extent of such information, we are entitled to conclude that it is a department of knowledge which ought by no means to be neglected by those who wish to elucidate the history and affinity of nations, or of different races of men; and that any conclusions which may be drawn by such writers from other sources, as, for example, from anatomical and physical inquiries, pursued separately, will be liable to error if reference is not occasionally made to the results deduced from philology. Notwithstanding this almost palpable fact, we shall presently perceive that the most popular systems with respect to the history of mankind, and the classifications of nations, are not only built on premises altogether distinct from those which depend on affinity in languages, but are completely at variance with the most obvious conclusions derivable from this source of information."

The author, after these general remarks on the application of philology, proceeds to give an account of the attempts which have been made to distinguish and classify the races of men by their physical characters.

"Many late writers on the history of mankind, have attempted to distribute the human species into several races, distinguished from each other by peculiarities in the form, structure, and colour of their bodies. Varieties of form have generally been thought to afford a better groundwork for this division than those of complexion; and since it has been known that there exist national diversities in the shape of the skull, this circumstance has been generally selected as furnishing the most permanent distinctions, and those which admit of the most extensive comparison and classification. Several writers, both French and German, have differed from each other as to the number of human races which they constitute; but the most generally received system is that which has been adopted by Baron Cuvier, though it did not originate with that celebrated writer. Professor Camper had thrown out the first hint of a triple division of the forms of the skull. He distinguished the facial angles as found by his measurement in European, Kalmuc, and African skulls. But a more important view of the diversities of form in the human skull seems also to have originated with Camper; for we are informed by Soemmering, that in his unpublished commentaries, Camper remarked the difference in breadth which exists between the three classes of skulls above mentioned, and observed that the skulls of the *Kalmucs* have the *greatest* breadth, those of *Europeans* a *middle* degree, and that the skulls of *African Negroes* are the *narrowest of all.*

"Nobody ever possessed means of observation and comparison sufficient for establishing any conclusions of importance as to the different forms of the human cranium, until Blumenbach had made his admirable collection of skulls. The results of his long continued study of this collection have been published by himself at different times.

"Blumenbach distinguished, in the first place, three principal varieties of form in the human skull,—the *oval form*, which is that of Europeans; the *narrow and compressed*, which is that of Negroes; and the *broad-faced skull*, with *laterally projecting cheek-bones*, belonging to Kalmucs and Mongoles. It happened, as I think, unfortunately, that Blumenbach named these varieties of the skull, not from their characteristic forms, but from some nations, in whom they in a conspicuous manner occur, or from the supposed primitive abode of such nations. Thus *the broad-faced* form is termed by him *Mongolian;* the *compressed*, *Æthiopic*, meaning *African;* and the *oval form*, *Caucasian*. The inconvenience which has arisen from the terms thus used is the hypothesis to which it has given rise, that these three varieties of form are characteristic of three distinct races of mankind. This is not Blumenbach's opinion, but it appears to be that of Cuvier, who, in his *Règne Animal* and other works, has adopted Blumenbach's terms and divisions. Relying on the diversity of physical characters, which yet he does not consider sufficiently marked to constitute differences of species, Cuvier proposes to divide mankind into three distinct races. One of these races had, according to his hypothesis, its original seat on Mount Atlas, and its branches are spread over Africa. These are the narrow-skulled, woolly-haired African nations. But there are woolly-haired tribes of men, equally black with the Negroes of Guinea, and resembling them in form and general appearance, in other equatorial countries besides Africa. Such are the black savages who inhabit the mountains behind Malacca, termed Samang; the woolly-haired Papuas of New Guinea, and nearly all the larger islands of the Indian Archipelago; and the natives of Mallicollo, and some other isles in the Pacific Ocean. These must belong to the same race as the African Negroes, if races are constituted on the principle of physical analogy; and Cuvier accordingly resorts to the hypothesis, that some Negroes from Africa lost their way—*se sont égarés*—in the great Southern Ocean, in order to account for the existence of woolly-haired people in the countries above mentioned. A second human race in his system are the Mongolians or Kalmucs, whose origin he thinks may be deduced from the high mountains of Altai. The other great division of mankind, consisting of men with *oval* and symmetrical skulls, to which European nations belong, are in like manner supposed to have drawn their first breath on Mount Caucasus, and are hence termed the Caucasian race.

"On surveying the manner in which nations are distributed and associated together in these three departments, we met with some facts which are staggering anomalies to those who judge of the affinity of races by that of languages. We shall take, for example, the enumeration of tribes reckoned by Baron Cuvier as belonging to the Mongolian race. He says:—

"'To the eastward of what has been termed the Tartar branch of the Caucasian race; that is, to the northward of the Caspian, is found the commencement of the Mongolian stock, which prevails from thence as far as the Eastern Ocean. Its branches, still nomadic, the Kalmucs and the Kalkas, wander over vast deserts. Their ancestors three times—under Attila, under Genghis, and under Tamerlane—carried far the terror of their name. The Chinese are the branch, the most anciently civilized, not only of this race, but of all nations that are known. A third branch, the Mantschoos, have lately conquered China, and still govern it. The Japanese and the Coreans, and most of the hordes reaching to the north-east of Siberia under the domination of the Russians, belong, in great part, to this stock: except some of the Chinese literati, the whole Mongolian race is addicted to the worship of Fo.'

"Here we find two classes of nations, identified and represented as branches of one stock, who differ from each other in the most decided and remarkable manner, in every respect in which one nation can differ from another, with the single exception, that they bear a degree of resemblance in the shape of their skulls. The Mongoles and Kalmucs are tribes of nomades or wandering shepherds, who roam about the lofty saline plains of Central Asia, living in waggons and under moveable tents, as their ancestors are said to have lived in the time of Æschylus. They are incapable of changing their habits for those of settled and agricultural people. They are all one nation, strictly so termed, and have one language, which is *polysyllabic* in its structure, admitting inflections and conjugations of nouns and verbs. On the other hand, the Chinese are ever known as a people of settled, uniform, and changeless habits; their historical records deduce them as a separate nation from the earliest ages of antiquity, and especially establish their perpetual enmity and discordance with the Mongolian Nomades, who are the very people to exclude whom from their borders the famous Chinese wall was erected in a remote age. The Chinese and the Indo-Chinese nations appropriate to themselves, as we have before observed, one entire class of languages, constituting one of the most strongly marked examples of a distinct assemblage of human idioms, widely differing from all others. It is to these nations that the *monosyllabic* languages belong, consisting of monosyllables, incapable of reflection or variation, in which a mere change of intonation and juxtaposition alone serves to indicate the relations of words to each other. Before we can admit of an hypothesis which derives one of these nations from the other, we must resolve to shut our eyes against all the evidence that can be brought to bear upon such a subject, excepting merely that afforded by physical resemblances, which, if we are not mistaken, will admit of a different explanation.

"The only other connective link between the Mongolian and Chinese nations, is the circumstance that they are all worshippers of Fo. This can scarcely be thought an argument for their unity of race. The religion of Buddha, indeed, called in China Fo, is well known to have taken its rise in India, among the Hindoos, who belong to the division of nations termed by Cuvier the Caucasian race. It was established at a remote period in Tibet, and thence propagated to China, where, however, it is but one of the several prevailing superstitions. The Mongoles and Kalmucs received it not until A. D. 1250. It is not, therefore, a peculiar and ancient distinction of the Mongolian race.

"Many writers have thought fit to associate the native American tribes with the Mongolian race. Cuvier hesitates on this subject; but the excellent naturalists Von Spix and Martius, who some years ago visited South America, were struck by the great resemblance between the Chinese, in the form of their skulls and features, and the American tribes near Brazil. Many tribes in the Western World have flatter features, more approaching to the Mongolian, than the nations of North America; and if we were to adhere to a classification founded entirely on the principle of physical peculiarities, it would be difficult to discover a precise line of discrimination, by which all the native tribes of Americans are to be distinguished from the groups of nations which constitute Cuvier's '*race Mongolique.*' If the triple division of skulls is maintained, those of the American nations must be referred to the Mongolian form. Here, then, we have a wide extension of this family, which thus comes to include a greater assemblage of nations beyond the limits of Asia, whose languages, though multiplied, have some common characters; and it is worthy of notice, that those common characters are the very reverse of the peculiarities, which, as above mentioned, distinguish the Chinese and Indo-Chinese languages from all others. The latter are monosyllabic, and hardly inflected; the American languages, as we have observed, abound in long polysyllables, and in their modes of inflection are refined and elaborate, admitting almost infinite variety of termination and change of structure. As a class of languages, they have obtained the distinguishing term *polysinthetic.*

"The Malays, a people whose original seat, or, as I would rather say, earliest known position, is the island of Sumatra, and from whom were descended, as it appears, all the Polynesian tribes of the great Southern Ocean, associate themselves more nearly with this department of nations than any other; and if referable to either of the three divisions, must be included in the Mongolian department. The history of these tribes will present us with many physical phenomena very adverse to the fundamental principle on which the tripartite division of races can alone be maintained. This principle is the assumption that all physical characters are permanent and immutable. Now, we have reason to believe that some of the tribes of Polynesian islanders have deviated in a most remarkable manner from the physical character most generally prevalent in their stock. Individuals are seen among the natives of the Society Islands of fair and sanguine complexion, and the Marquesans are among the finest races of men existing; their skulls have the oval, or, as it is termed, Caucasian form. We thus find that the division of mankind termed the Mongolian race, includes several groups or classes of nations distinguished by the most permanent and indelible characters which are known to separate the great families of the human race from each other. They are associated by no common circumstance whatever, except a resemblance in physical characters, and these are plainly subject to great varieties.

"We now come to Baron Cuvier's Caucasian race, of which he gives the following account:—'The stock from which we are descended has been termed the Caucasian race, because the traditions and filiations of tribes seem to carry it to that group of mountains situated between the Caspian and the Black Sea. He goes on to say, that '*the principal branches of the Caucasian race may be distinguished by the analogy of their languages.*' Here he enters upon the ground of philological investigation, and it is important to observe how far it affords a firm basis for his conclusions. The branches of the Caucasian race are thus mentioned:—'1*st*, The Aramean branch, or that of Syria, directed its progress southward; it produced the Assyrians, the Chaldeans, the Arabs, always unconquered, who, after Mohammed, expected to have become lords of the world; the Phœnicians, the Jews, and the Abyssinians, colonies of the Arabs; it is very probable,' he adds, 'that the Egyptians belonged to the same division.' Before we proceed to the account which is given of other branches of the Caucasian stock, we may take an opportunity to observe, that some historical paradoxes have been already brought under our view. Both Jews and Arabs are allowed to have ancient traditions; yet none of these, written or oral, represent either people as descended from Mount Caucasus. Again, it is not a little startling to find the red or copper-coloured Egyptians considered as Caucasians, and as belonging to the Semitic stock of nations. How is this to be reconciled with the statement of Herodotus and Manetho, and all the historians who so strongly contrast the Egyptians with the Jews, and even of Moses, who represented them as speaking different languages as early as the time of the patriarch Joseph? And how, indeed, are we to get over the fact, that the Egyptian language which remains to our time, is entirely of a different structure, and has a totally different vocabulary, from the Hebrew? We shall pass on to the next branch of the Caucasian race.

"'The Indian, German, and Pelasgic branch,' says Cuvier, 'is much more extended, and was more anciently divided. We can, however, recognise a multitude of affinities between the following four languages. 1. The Sanskrit, which is now the sacred language of India, the mother of all the idioms of Hindostan. 2. The ancient language of the Pelasgi, the common mother of the Greek, the Latin, and many of the extinct languages, and of all our idioms of the south of Europe. 3. The Gothic or Tudesque, from which are derived all the languages of the north and north-west,—the German, the Dutch, the English, the Danish, the Swedish, and their dialects. 4. Lastly, The language called Sclavonian, from which are derived all the languages of the north-east,—the Russian, the Polonese, the Bohemian, the Wendish. It is this grand branch of the Caucasian race which has carried to the highest pitch philosophy, science, and the arts, and which has for more than thirty ages been the depositories of them.'

"There is indisputable proof in support of the assertion, that the nations now enumerated may be identified by means of their languages. But how far are they to be connected with the Arabs, Jews, and Egyptians, already referred to the same race, or with the third branch of the Caucasian race, who yet remain to be mentioned?

"'The Scythian and Tartarian branch,' it is added, 'extend towards the north and north-east, ever wandering forth through the immense deserts of these regions, and only returning to overthrow the more happy settlements of their brethren. The Scythians, who so early made an irruption into the higher parts of Asia; the Parthians, who destroyed the Greek and Roman empires; the Turks, who overthrew that of the Arabs, and subdued in Europe the miserable remains of the Grecian nation, were swarms from this horde. The Finlanders and Hungarians were a colony of them, wandering among the nations of the Sclavonic and Teutonic races. Their original country to the northward and eastward of the Caspian Sea, preserves yet traces of people of the same stock; but they are intermixed with an infinite number of other small tribes, of different origin and languages. The Tartar people have remained more unmixed in all this space. They long menaced Russia, and have at length been subjugated by her from the mouths of the Danube as far as those of the Irtisch.

"We are here, in the first place, struck with the circumstance, that the Tartar race is joined with the Finlanders and the Hungarians. Now, the nations last mentioned are two branches of a stock spread through the northern parts of Europe and some regions of Asia from very early times, and are strongly distinguished by physical character and by manners from the Tartar or Scythian race. What is still more important, the Finnish nations are always to be identified among themselves, and clearly distinguishable from the Tartars by their dialects. The Fenni and Scritifenni, belonging to the stock of the Finns and Laplanders, are described by the Roman writers Tacitus and Pliny, as inhabitants of the north of Europe. They are mentioned by King Alfred in his curious transcript of the *Voyage of Ocher the Northman;* and, according to the most learned investigators of northern antiquities, the Finns are the people who, under the name of Jotuni, or Giants, had occupied Scandinavia and the shores of the Baltic before the arrival of Odin and his Teutonic followers from the east. It is said, indeed, that some of the noble families among the Northmen or Normans, were descended from these aborigines of Scandinavia. Even Rollo, the conqueror of Normandy, and the ancestor of the royal dynasty of England, claimed his descent from a Jotune family, who had dwelt from time immemorial near Drontheim in Norway. The history of the Finns has been traced among all the writers of the middle ages. It has long been known that all the Finnish and Hungarian tribes are allied by the resemblance of their dialects; but a few years ago this subject was profoundly investigated by a learned native of Hungary, Gyarmathi, who availed himself of his intimate acquaintance with one of those dialects—his own mother tongue.—and applied himself to the investigation of the cognat languages. The result has been to establish a connection in speech, and therefore in race and origin, between the Laplanders, the Finns, the Hungarians, the Ostiaks in Asia, and many tribes scattered on both sides of the great Ouralian chain, which separates the north of Europe from that of Asia. Many of these nations are distinguished for flat faces and red hairs, in which characters they are contrasted with the Tartars. Their language unequivocally separates them from that people.

"But still less can the Tartar or Turkish nation itself be identified with the other members of the supposed Caucasian race. It has never been pretended that any affinity subsists between the language of the Tartars and the Indo-European nations. The dialects of the Tartar tribes are not much varied; all the clans belonging to this great nation, though spread far and wide, and reaching from Constantinople to the Irtisch and Lena, speak one language.

"Every thing that we can collect as to the ancient history of the Tartar nation, seems to run counter to such an hypothesis. The only ground, indeed, on which it is pretended to associate the Tartars with the European, or, as they are termed, Caucasian nations, is the fact that the skulls of the Turks have a form which belongs to the European type. But even this is by no means universal. Many of the Tartar nations approach nearly to the Mongoles and Kalmucs in their features, and in the shape of their heads; and this is particularly the case with those branches of the Turkish stock who have long been settled in the north of Asia, in climates inhabited of old by people to whom the Mongolian characters were, from early periods, appropriate. These deviations from the more general traits of the Turkish race, and approximations to those of the Mongoles, are attributed by writers who maintain the permanent transmission of physical characters to intermixtures of race. But this is altogether gratuitous. If we may judge of the purity of race by purity of language, the Yakuts, who inhabit the shores of the Lena, must be considered as of unmixed Turkish race. Their speech, as M. Julius Klaproth has proved, is nearly that of the Osmanli themselves; and it has been said that a Turk of Stamboul would be understood among the Yakuts on the Lena. Probability is in favour of the opinion of Blumenbach, that a long residence in the climate of North-eastern Africa has changed the features of the race. The language of the Yakuts, being unmixed, we may be allowed to infer from this circumstance the purity of their stock, though their features are those of the Mongoles and Kalmucs.

"Before I take leave of the Caucasian race, I shall offer some further remarks on this designation. It is applied, as we are informed, to nations of this class, because their traditions deduce them from Mount Caucasus. But is this really a fact? The mountains of Asia Minor, of Thrace, and of Hellas, are all famous in Grecian story. Mountains were of old, in the simple and primitive age, which long preceded the erection of temples consecrated to the worship of the unseen powers, which all nations venerated. The tops of Olympus and Mount Meru, in the poetry of Greece and India, were the resting-places where Father Zeus and Indra descended from the clouds to converse with mortals. Caucasus came in for its share in the general respect paid to high places. According to a story, of which it is difficult to conjecture the meaning, it was the dwelling-place of Prometheus, where that ambiguous personage, by turns a Titan, a teacher of mechanical arts, and a maker of man, and then a natural philosopher, is said to have watched the movements of the heavenly bodies. I cannot remember any tradition among the fabulists or historians of Greece, which admits of a construction answering to the hypothesis of M. Cuvier, or deducing the human race from Mount Caucasus. Nor can any thing more to the purpose be traced in the mythology of the oriental nations. The authentic narrative of the Hebrews lead us certainly to Mount Ararat, in Armenia, for the resting-place of the ark; but that is far from Caucasus.

"Another objection to the term Caucasian, as applied to an assemblage of nations consisting principally of the Indo-European and Semitic tribes, arises from the fact, that the chain of Caucasus has been from immemorial time the seat of nations who are proved by their languages to be entirely distinct from both of these celebrated races. The idioms of the real Caucasian nations have been carefully examined by Julius Klaproth. The result has been a reduction of these numerous dialects to a few original languages, all of which, except that of the Ossetes, are destitute of any analogy to the Indo-European idioms. The Ossetes, indeed, speak a dialect resembling some of the languages of that stock; they are an inconsiderable tribe, who appear to have found their way incidentally into the midst of races foreign to their lineage; and it would be absurd to regard them as the ancestral stock of so many great and anciently civilized nations.

"3. The Negroes of Africa, and the woolly-haired natives of the Malayan Mountains, and of New Guinea, and many islands in the Pacific, at no great distance from New Holland, are referred by M. Cuvier to his third race, which he supposes to have originated in Mount Atlas. The languages of these tribes are multifarious, and the migration of one part of them to the Eastern Ocean is improbable and difficult to imagine. It is evident, that the attempt to identify the African Negroes with the Papuas of the Eastern Ocean, rests on the physical peculiarities of these tribes, and that every other species of evidence is against it. But it is certain, that no other principle can be found to account for the existence of nations resembling the Africans in New Guinea and the Eastern Islands. Are not the torrid climes of these countries similar to that of Old Guinea? and do not all the other productions of nature likewise resemble those of Africa? It is not to be wondered at that the human species should assimilate in these parallel latitudes and analogous situations. The black and woolly-haired variety of the human species is that which has ever thriven best in equatorial countries; and there is probably something in the nature of the torrid clime which favours its rise and propagation. If physical agencies produced it once, similar agencies may have produced it wherever their influence has been exerted with a certain degree of intensity, and under favourable circumstances."

The following are the general inferences which the author has deduced from the preceding statement:

"It appears, on the whole, that the attempt to constitute particular families of nations, or to divide the human species into several distinct races, upon the principle of a permanent and constant transmission of physical characters, is altogether impracticable. In the first place, such divisions of races do not coincide with the divisions of languages. We shall find one class of men as distinguished by physical character, including several races entirely distinct from each other, when reference is made to their languages. Thus, the Turkish or

Tartar race are separated by their languages from the Indo-European nations, and the distinction is not less when we go back to the earliest ages. How distant, indeed, must have been the period when the Celtæ and the German nations, and the Greeks, Latins, and Sclavonians, were separated from the Hindoos! Yet all these nations have preserved from that period strong proofs of the identity of their speech! Nor can we imagine why the Tartars alone should have lost all traces of their former language, if they had once partaken of the same idiom with the nations just mentioned, or had a dialect allied to it! The distinction of races, according to the same principle, will, besides, separate nations who are shewn to be connected by their language, when they happen to have acquired a different character, diversities of figure and complexion. I have already alluded to particular instances which exemplify this remark.

"2dly, A second objection to the distributing of men into different races on the ground of physical diversities, is, that it is contradictory to the very principle which has been always professed by the most enlightened writers on the philosophy of natural history, and which, it may be added, had been admirably maintained and illustrated by Cuvier himself, in regard to the nature and distinction of species. The clear and broad line which he lays down as constituting the distinction of species in natural history, is that of permanent and constant difference. We are under the necessity of admitting the existence of certain forms which have perpetuated themselves from the beginning of the world without exceeding the limits first prescribed. All the individuals belonging to one of these forms constitute what is termed a species. 'Varieties,' he adds, 'are the accidental subdivisions of species.' This is his own account of the laws constituting species. By himself the diversities found between different races of men are clearly laid down as *varieties*. To regard these afterward as permanent, is to contradict what has previously been established. In fact, we must either concede at once that there are several distinct human species,—an hypothesis which would be immediately opposed by a number of insuperable objections,—or we must allow that no permanently distinct races, as constituted by physical characters, exist in the one human species.

"If these general observations are allowed to be well founded, they will lead towards the conclusion—*that the various tribes of men are of one origin.* The diversities of language carry us, indeed, very far back towards the infancy of our race, and are, perhaps, much more ancient distinctions than the varieties of form and colour. But these diversities require no such explanation as that of a separate origin, or a distinct creation of the several races who are so characterised."—*Trans. of British Association, Second Report*, p. 529.

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1. METEOROLOGICAL OBSERVATIONS MADE AT EDINBURGH DURING THE GREAT SOLAR ECLIPSE OF JULY 17. 1833.—2. A METHOD OF FREEING THE DETERMINATION OF THE LATITUDE OF AN OBSERVATORY, AND OF THE DECLINATION OF A STAR, FROM THE CONSIDERATION OF ATMOSPHERIC REFRACTION. *By* EDWARD SANG, *M. S. A. S., Teacher of Mathematics, Edinburgh. Communicated by the Author.*

1. *Meteorological Observations made at Edinburgh during the Great Solar Eclipse of July* 17. 1833.

The clouded state of the atmosphere, which completely prevented any astronomical observations at Edinburgh, gave, perhaps, additional interest to photometric experiments made during the eclipse.

After rising through a narrow belt of cloud, the sun entered upon a horizontal zone of perhaps two degrees in breadth, entirely free from interruption, and thus afforded me an opportunity of determining the error of the clock: he then disappeared behind the superior mass of dense cloud, and remained totally invisible till nearly the conclusion of the experiments; at that time his disc became faintly visible, and, as the clock had only been erected the previous evening, opportunity was again taken to determine her rate. The altitudes of the sun were observed by means of a ten-inch Theodolite and Troughton, divided to every tenth-second, and having three horizontal wires in the field-bar of the telescope, so that the corrected times may be depended on to a degree of accuracy far beyond the necessity of the case.

During the eclipse, and for some time before and after it, the indications of an excellent Leslie's Photometer, prepared by Lindsay, were noted at apparent intervals of five minutes. The corrected times with the corresponding indications of the photometer are given in the following table.

N. P. D. 34° 02′ 40″ Long. West 12m 44s July 17. 1833.

Mean Time. h	m	s	Photom. °	
4	06	43	19.8	Clear sunshine.
	16	39	10.2	Sun just concealed.
	26	36	4.6	Sun entirely concealed.
	31	34	4.6	
	36	32	6.5	
	41	30	6.9	
	46	29	7.3	
	51	25		Commencement of eclipse.
	51	27	7.4	
	56	25	7.8	
5	01	23	8.6	
	06	21	9.1	
	11	20	9.2	
	16	18	8.9	
	21	16	8.7	
	26	14	8.6	
	31	12	7.3	
	36	11	6.1	
	41	09	4.4	
	43	35		Greatest lunar obscuration.
	46	07	3.9	
	51	05	3.5	
	56	03	4.0	
6	01	02	5.2	
	06	00	6.3	
	10	58	8.2	
	15	56	10.5	
	20	54	14.1	
	25	53	16.8	
	30	51	19.2	
	35	49	22.3	Clouds becoming thinner.
	38	46		End of eclipse.
	40	47	23.8	
	45	45	27.8	Bright spots seen in the clouds near to the sun's place.
	50	44	30.7	
	55	42	32.6	
7	00	40	36.5	Sun's disc barely visible.

The times of the commencement, middle, and end of the eclipse are put down from Mr Innes's determination given in a former number of this Journal.

The remarkable steadiness of the clouds in the eastern hemisphere, to which alone the photometer was exposed, favoured very much the experiments.

As the sun rose behind the mass of clouds, his rays, traversing a thinner atmosphere, acquired a greater illuminating power;

and this increase, even after the commencement of the eclipse, was greater than the diminution arising from the concealment of his disc by the moon; speedily, however, the lunal obscuration acquired the ascendancy, and the photometer rapidly sunk to reach its minimum 7^{m} 30^{s}, after the computed time of greatest obscuration. Under such unfavourable circumstances the fidelity of the instrument was more than could have been anticipated, and may, perhaps, induce other meteorologists to give this hitherto neglected instrument a place among their apparatus. Convinced of its extreme precision, I have projected a complete course of experiment for the purpose of comparing its indications with the degree of illumination as computed astronomically, the above is the meagre substitute which circumstances have compelled me to give instead.

1*st August* 1833.

2. *A Method of freeing the determination of the Latitude of an Observatory, and of the Declination of a Star, from the consideration of Atmospheric Refraction.*

That element which enters most frequently into astronomical calculations, is the latitude of the place; next, indeed, to the taking up of the meridian line, comes the determination of the latitude of the observatory. Let us conceive ourselves to be deprived of all astronomical data, and to be bent on determining them all anew, and we will then be able to view the determination of the latitude in all its bearings.

The fixing of the transit instrument, and the regulation of the clock, are easily accomplished; tables of the differences of right ascension of the fixed stars are of simple though laborious construction; but when we seek their declinations, a new and complicated difficulty meets us; for, without a knowledge of terrestrial refraction, we cannot determine, by any of the hitherto known methods, the latitude of the place, while, without a knowledge of that latitude, we cannot settle the declination of a single star. And, to add to the difficulty, the refraction is subjected to continual variations, arising from changes in the temperature, humidity, and pressure of the atmosphere. Santini, in his elaborate Ricerche sulla Latitudine dell 'Osservatorio in Padova, has endeavoured to free his computation from the elements of refraction and the star's altitude; but his success in that attempt is only ideal. The north polar distances of the stars were extracted from astronomical tables; and thus, though his determination was freed from the errors of his own instrument of altitude, and from a knowledge of refraction at the instant of his observations, it yet involved the errors of other instruments, and the knowledge of refraction at other places. His method, in fact, can only be adopted at secondary observatories. Where-ever the normal instrument exists, a method entirely independent of the labours of other astronomers must be followed, since, to adopt any determination made by means of instruments of inferior delicacy, would be to reject all the advantages which the possession of the superior instrument confers.

I submit the following method to those astronomers who are possessed of good altitude and azimuth circles, as a means of rectifying the determination of their altitudes, and of ascertaining, by a direct procedure, the actual amount of refraction.

Using merely the azimuthal part of the instrument, let the azimuths a_1, a_2, &c. and the corresponding hour-angle h_1, h_2, &c. of a star be observed: Denote by O the N. P. D. of the observatory, by S that of the star, then have we

$$\cot a_1 . \sin h_2 = \cot S . \sin O - \cos h_1 . \cos O$$

$$\cot a_2 . \sin h_2 = \cot S . \sin O - \cos h_2 . \cos O.$$

Whence

$$(\cos h_2 - \cos h_1) \cos O = \cot a_1 . \sin h_1 - \cot a_2 \sin h_2 .$$

Or

$$2 \sin . a_1 . \sin a_2 . \cos O = \sin (a_1 + a_2) \cot . \frac{h_1 + h_2}{2} - \sin (a_1 - a_2) . \cot \frac{h_1 - h_2}{2};$$

If we put $\frac{\cot a_2 . \sin h_2}{\cot a_1 . \sin h_1} = \cos \varphi^2$, we obtain the easy calculation,

$$\cos O = \tfrac{1}{2} \cot a_2 . \sin h_2 . \operatorname{cse} \frac{h_1 + h_2}{2} \operatorname{cse} \frac{h_1 - h_2}{2} \tan \varphi^2 .$$

The latitude of the observatory being thus determined, it is easy thence to compute the declination of the star; and, if the passage of the star across the horizontal wires had also been noted, by comparing the computed with the observed altitude, to determine the amount of refraction at each observation.

When the latitude of the place is once known, the N. P. D.'s of all the stars which pass between the pole and the zenith can readily be found, by observing their greatest east and west azimuths. Observations, then, on their greatest and least altitudes will readily give the refractions, but when the latitude is much above 45°, this method will not enable us to determine refractions near the horizon. A judicious selection of pairs of observations will enable the astronomer, in a single day, to obtain correctly the latitude of his observatory; and he will thus avoid the trouble of applying the corrections for nutation and aberration, which would become necessary if the period of his experiment were much extended.

12*th August* 1833.

ON THE LONGEVITY OF TREES AND THE MEANS OE ASCERTAINING IT. *By Professor* DE CANDOLLE.

A TREE may be considered in two points of view; it may either be said to be a collection of as many individuals united as are developed by buds on its surface, or as a simple individual, analogous to what is so called in speaking of animals. In the first mode of expression, probably the most rational, we cannot be surprised, that new buds being constantly added to the old ones, the aggregate which results from it has no necessary limit to its existence. In the second, which is the more common, it must be admitted, that as a new woody layer is formed every year, and generally new organs in the greater number of trees, in vegetables this gradually increasing hardness (ossification) and obstipation in old and permanent organs ought not to occur, in which death from decrepitude, properly speaking, consists, and that of course trees should not die unless from accidental causes. By either of these hypotheses we arrive at the inference, that trees do not die of old age in the real sense of the word, and that, in consequence, we might find some which have attained an extraordinary age.

It is not enough, however, to conceive this opinion, we must endeavour to establish it. Two remarkable instances have been adduced of it,—that of the Baobab, which Adanson has proved, by ingenious and plausible calculations, to be 5150 years old, and that of the Taxodium *(Cupressus disticha, Lin.)*, which analogous reasoning might induce us to believe was even older. (See a notice of these trees by Mr Alph. D. C. *Bibl. Univ.* April 1831.) Other examples, less worthy of notice, seem to confirm the idea, that there are at present some trees in the world of immense antiquity, witnesses, perhaps, of its later physical revolutions. We can easily conceive that errors may happen in calculations of this kind, and that they cannot be considered as the expressions of exact truth, till examples of this vegetable longevity are multiplied to such an extent as to support one another *. I have been engaged on this subject for a considerable time, as appears from the publication of the Principles of Botany, inserted, in 1805, in the first volume of the Flore Fran-

* *On the Growth of Timber.*—In the year 1827, a large lot of hemlock timber was cut from the north-eastern slope of East Rock, near New Haven (in America), for the purpose of forming a foundation for the wharf, which bounds the basin of the Farmington Canal on the east. While inspecting and measuring that timber at the time of its delivery, I took particular notice of the successive layers, each of which constitute a year's growth of the tree; and which in that kind of wood are very distinct. These layers were of various breadth, indicating a growth five or six times as full in some years as in others, preceding or following. Thus, every tree had preserved a *record of the seasons*, for the period of its growth, whether 30 years or 200,—and what is worthy of observation, *every tree told the same story.* Thus, if you began at the outer layer of two trees, one young and the other old, and counted back 20 years, if the young tree indicated, by a full layer, a *growing season* for that kind of timber, the older tree indicated the same. My next observation was, that the growing seasons *clustered together*, and also the *meagre seasons*, came in companies. Thus, it was rare to find a meagre season immediately preceding or following a season of full growth,—but, if you commenced in a clustre of thin and meagre layers, and proceeded on, it gradually enlarged and swelled to the maximum, after which a decrease began and went on, until it terminated in a minimum.

A third observation was, that there appeared nothing like *periodicity* in the return of the full years, or the meagre, but the clusters alternated at irregular intervals; neither could there be observed, in comparing the clusters, any law by which the number of years was regulated.

I had then before me, therefore, two or three hundred *meteorological tables*, all of them as unerring as nature; and by selecting one tree from the oldest, and sawing out a thin section from its trunk, I might have preserved one of the number to be referred to afterwards. It might have been smoothed on the one side by the plane, so as to exhibit its record to the eye with all the distinctness and neatness of a drawing. On the opposite side might have been minuted in indelible writing, the locality of the tree, the kind of timber, the year and month when cut, the soil where it grew, the side and point which faced the north, and every other circumstance which can possibly be supposed ever to have the most remote relation to the value of the table in hand. The lover of science will not be backward to incur such trouble, for he knows how often, in the progress of human knowledge, an observation or an experiment has lost its value by the disregard of some circumstance connected with it, çaise; but the life of man is too short for similar researches, opportunities are very rare, and examples should be sought for in countries neither exposed to frost nor the destructive hand of man. The very means of ascertaining the age of old trees are perhaps not sufficiently known by travellers, or those who are interested in such inquiries. This has induced me to call the public attention to them by this particular article.

The longevity of certain trees is truly interesting, were it merely from motives of curiosity. If we prize every document of antiquity, why should we not attach a higher degree of importance, to know whether such a tree be the contemporary of the oldest generations? In certain cases, this knowledge might throw light on the history of monuments, as that of monuments on the history of the trees in their vicinity. This discussion may be useful in a history of the very globe we inhabit. If the known number of veterans in vegetation increases in time to come, if we succeed in determining their age with greater precision, may we not find in such facts some means of fixing the approximate date of the last revolutions of the globe? If researches of this kind were made respecting volcanic or madreporic islands, might we not draw some inference respecting the date of their origin? But leaving the consideration of questions of such magnitude, if we reflect on the means of obtaining a solution of our question, we shall see that they are all founded on

which, at the time, was not thought worthy of notice. Lastly, there might be attached to the same section a written meteorological table, compiled from the observations of some scientific person, if such observations had been made in the vicinity. This being done, why, in the eye of science, might not this *natural, unerring, graphical* record of seasons past deserve as careful preservation as a curious mineral or a new form of crystals?

If you should think fit to make such a suggestion, it might lead, in fact, to the preservation of sections from aged trees in different parts of the country, and a comparison of their lines of growth with the history of the weather as far back as our knowledge extends. If the observations just related, with respect to a particular lot of timber, should be found to hold true of trees in general, drawings of these sections, on a reduced scale, would soon find their way to the pages of scientific journals. It would be interesting, then, to make comparisons of one with another,—to compare the sections of the one kind of tree with that of another from the same locality,—or to compare sections of the same kind of tree from different parts of the country. Such a comparison would elicit a mass of facts, both with respect to the progress of the seasons and their relation to the growth of timber, and might prove, hereafter, the means of carrying back our knowledge of the seasons through a period coeval with the age of the oldest forest-trees, and in regions of country where scientific observation has never yet penetrated, nor a civilized population dwelt.—*Mr Twining in Silliman's Journal,* vol. xxiv. p. 391.

a more exact appreciation of the ordinary laws of the growth of trees, and that this direct knowledge may throw light on many parts of vegetable physiology and the art of forestry. I therefore believe, that these inquiries may turn out to be useful; but were they merely curious, I would still think that they might not be unworthy of being presented to the public, for curiosity is one of the desires which the mind is more inclined to gratify the more it is enlightened, and we have a thousand examples of unexpected advantages having arisen in consequence of this noble feeling.

Every one knows, that the vegetables designed for the formation of trees may be ranged under two great series. The first, which is the more numerous, has a trunk composed of a woody body and bark: it grows by the annual addition of a new ligneous layer on the outside of the preceding layers under the bark. In consequence of these new layers being the youngest and the most outward, they have been called *exogenous* in reference to their increase, and *dicotyledonous* when we allude to their germination. The second series, on the contrary, is composed of vegetables whose trunks, very cylindrical, and seldom branching, merely present a woody body, properly speaking without bark, whose outer fibres are older and harder, and the inner younger and softer. They have been called *endogenous* in consequence of this latter circumstance, which term is employed when we allude to their growth, which is synonymous with that of *monocotyledonous*, by which they are distinguished when we speak of their germination. We shall succinctly examine the means of determining the age of individual trees of both these classes, and conclude with a few words on vegetables more humble in their appearance, but whose longevity presents some singular ambiguities.

1. Almost all the trees in temperate, and of course in the most civilized, countries of the globe, belong to the exogenous class; and its history having therefore been more carefully studied, can supply us with the most valuable information. It is known, however, by means, of the truth of which there can be no doubt, that exogenous trees grow each year by a new woody layer, and that, in consequence, the number of concentric zones which are seen on the transverse or horizontal cut of a trunk, may give

an idea of the number of years which have rolled on since the moment at which the portion of the tree where this section was made, commenced to grow. Of course, a cut at the base of a branch gives the age of that branch; that which is made at the base of the trunk, or at the neck, proves the age of the tree. If, as some maintain, there may occasionally be seen irregularities, it is a very debateable point; and it may, at least, be affirmed, that possible errors, if there be any, are so rare and so trivial, that one may confidently argue on the hypothesis, that the known number of layers indicates the number of years: of course, whenever we can procure a clean cut of a trunk, this very simple criterion is sufficient to determine the age of the tree. But the inspection of these concentric zones should be made more carefully than it has been hitherto. These zones prove the age by their numbers, but the rate of the tree's growth is discovered by the proportion of their thickness. They must not only be counted, but measured. For this object I employ the following plan, which is very simple, whenever I meet with a clean cut of an old tree, which is sufficiently sound to enable me to discover its layers. I place a slip of paper on the branch from the centre to the circumference; on it I mark with a pencil or pen the junction of each zone, noting the side of the pith, of the bark, the name of the tree, its native country, and the particular observations which it has suggested. The collection of these slips, not unlike those in the shops of tailors, gives me an exact appreciation of the growth of trees and the means of comparing them. I am in the practice of marking, in a more striking manner, the lines which indicate the tenths of years, and also of measuring the increase from tenth to tenth. My measures being taken from the centre to the circumference, give me the radius. I double the figures if I require the diameter; I sextuple them if I wish the circumference of the ligneous body. It is almost useless, except in certain cases, to make similar researches concerning young trees, because in operating on the oldest trees of each species which can be obtained, we possess the advantage of judging of trees at all the stages of their growth. As it would be inconvenient to publish an engraving of these slips, which are sometimes several feet long, I give an idea of these results by means of the following table:—

TABLE of the Periods of Increase in Diameter of some Exogenous Trees, expressed in lines.

	Oak tree with pendiculated acorns, 130 years old.	Oak tree with sessile acorns, 210 years old.	Oak tree with sessile acorns, 333 years old.	Larch tree, 255 years old.	Elm tree, 335 years old.	Fir tree, 120 years old.	Yew tree, 71 years old.
1 to 10 years.	54	10	18	48	16	41	8
10 ... 20 ...	62	16	33	61	44	54	11½
20 ... 30 ...	54	22½	39½	58	58½	52	12
30 ... 40 ...	60	12	38	72	72	45	10½
40 ... 50 ...	48	13½	23	46	88	35½	7
50 ... 60 ...	44	14	12½	57	74	36	12½
60 ... 70 ...	56	10⅔	9	46	78½	18	8
70 ... 80 ...	44	11	9½	29	66	17	
80 ... 90 ...	32	9½	8½	30	59	13	
90 ... 100 ...	32	9½	8	24	45	13	
100 ... 110 ...	30	9½	7½	32	30	22	
110 ... 120 ...	36	9	8½	26	30	22	
120 ... 130 ...	30	9	8	20½	24		
130 ... 140 ...		9½	10	22	24		
140 ... 150 ...		10	8	23	18		
150 ... 160 ...		8½	8½	21	19		
160 ... 170 ...		9	9	20	17½		
170 ... 180 ...		10	8	19	23		
180 ... 190 ...		9	8	18	30		
190 ... 200 ...		9	7	21	34		
200 ... 210 ...		9	8	22	34		
210 ... 220 ...			7	22½	26		
220 ... 230 ...			6	21	36		
230 ... 240 ...			8	22	28		
240 ... 250 ...			8	20½	26		
250 ... 260 ...			7½		24		
260 ... 270 ...			8		17½		
270 ... 280 ...			8		26		
280 ... 290 ...			8½		28		
290 ... 300 ...			8½		29		
300 ... 210 ...			9		16		
310 ... 320 ...			8		16½		
320 ... 330 ...			8		21		

On an inspection of these figures, we will find, that trees at advanced periods of life continue to form layers which do not yield in thickness to those of a moderate age; that each species, after increasing rapidly in youth, seems at a certain age to grow at a regular rate; that, in short, we can give a tolerable explanation of such a difference, by supposing that at an early period, *i. e.* before fifty or sixty years, the roots and branches of forest-trees not being embarrassed by those near them, increase at liberty, but on exceeding this age, that they do not grow so much, because they encounter the roots or branches of their neighbours; that the cause of inequalities in growth, is generally owing, either to the middle root of the tree meeting layers of good or bad soil, or because at certain periods the tree, being disincumbered of its neighbours, is able to grow at more liberty.

Similar tables of a great many species, and of individuals of each species, would afford excellent evidence of the progress of vegetation. First, we might be enabled to establish in every species its average increase annually, and thus, on finding out the circumference of an exogenous tree, we might discover its age almost to a certainty; and it should be observed that the principal differences occur during the first century; and that afterwards its growth is more uniform. Secondly, A knowledge of the average growth and solidity of one kind of wood being attained, we could form an opinion of the layers of each trunk by their thickness, if it depart less or more from the qualities peculiar to its species. We may thus be certain, that the oak No. 1. in the table is very inferior to those of Nos. 2. and 3, because the thickness of its layers is too great for the wood to have acquired its proper degree of hardness. Thirdly, If the law which I suggest be correct, that at a certain age (sixty to eighty years in oak-trees), every tree ceases to grow so rapidly, and progresses more regularly, we might deduce precise rules as to the period when we should fell certain trees. I therefore presume to believe, that tables of horizontal cuts would be of peculiar advantage, and I recommend their preparation to travellers, and those who live near extensive clearings of woods or dock-yards.

2. If we are unable to get a transverse section of trunks, there is another mode of judging of their growth, viz. to find out old individuals of each species, the date of which is known, to measure their circumference, to deduct from that, their average increase, and make use of it in calculating the age of other trees of the same species, always keeping in view, that, local circumstances excepted, the average taken of a younger tree always gives a result too great for the increase, or too small for the age of old trees. I read in Evelyn, that a Dane, called

Henry Ranjovius, planted a certain number of trees in 1580, in Ditmarsen, of various kinds, and placed stones near them, on which he engraved their dates, that posterity, as he said, might be aware of their age. It would be curious to know whether these trees are still in existence, and, in such a case, to get their circumference. It is a question that I address to Danes who are fond of science, and, in general, it would be curious to have the circumference of every tree whose date is known, and is upwards of a century old. I would even venture to invite all those who have similar documents, either to publish them, or communicate them to me, as these facts are very useful by their comparison with others.

3. As to trees 100 years old, it is useful to get their circumference at various known periods, in order to compare them with each other, or with other measurements of the same tree, which may have been made at an earlier or a later period. These comparisons would afford means for a more accurate calculation of the law of the growth, and appreciating the influence of the difference of age. Thus the cedar, in the Jardin de Paris, for example, measured when eighty-three years old, was 106 inches in circumference, which would indicate a mean increase of five lines annually; but it had been measured at the age of forty years, and at that time was above 79 inches round. We are thus aware that, during the first forty years, it increased 7½ lines annually, and only 2½ for the succeeding forty-three; consequently, if we were going to calculate the age of a very old cedar, we should not be very far wrong did we take the latter as the multiplier. Thus the cedars measured at Lebanon in 1660 by Maundrel and Pococke, which were 12 yards and 6 inches round, English measure (it may be about 1527 lines in diameter royal measure), should be about 609 years old, and nearly 800 in 1787, when they were revisited by Mr Labillardière. This calculation is doubtful, however, as it is founded on a single example; it would be much more certain were the number of examples increased.

4. It would also be useful to take the circumference of some very old trees which we may meet, even though we are ignorant of the time when they were planted. Such measurements repeated at stated intervals, would inform us of the law of the

diametrical increase of old trunks, and, compared with other measurements, would give approximate averages for estimating their ages. Thus, in Evelyn, we find, that in 1660 there was an immense oak in Wellbeck Lane, which was 33 feet 1 inch round, about 11 feet perhaps in diameter. The same oak, though greatly mutilated, existed in 1775, and was 12 feet in diameter; of course, it had increased about 144 lines in 120 years, a little more than one line annually. From this we may conjecture that the law of increase indicated by the oak of 333 years in my Table, is followed by this one, though evidently older. If, therefore, we calculate the age of the oak in Wellbeck Lane, we see by the thickness of that of 333 years, that it must have been about 1300 years old when Evelyn lived, and more than 1400 in the year 1775.

5. Lastly, in cases where it is impossible to obtain a transversal cut of an old tree, it may happen that we may have an opportunity of making a lateral cut in the tree, in order to ascertain how much it has increased in a given number of years, and in this way find out the minimum of its mean increase. It was by this process that Adanson discovered the age of the Baobabs; he saw the extent of the growth of these trees in three centuries, and also knowing the growth of young trees, he was enabled, by striking an average, to establish the general law. The age of the Taxodium of Chapultepec in Mexico should be carefully investigated by this plan.

By means of the five plans, either singly or connected, which I have just pointed out, we may arrive at a knowledge of the age of old exogenous trees in a manner sufficiently accurate for the object of this inquiry. Let us now point out the trees to which it is principally to be directed. The greatest longevity in the vegetable kingdom ought to be found, 1*st*, In trees which, by their hardness, incorruptibility, or size, should most powerfully resist inclement seasons; 2*d*, In countries which are not exposed to ice, or to other causes which too frequently tend to destroy large plants.

Among European trees we may mention the following:

1. It is well known that the elm *(Ormeau)* attains a great size, although it grows very quick. The individual in which I have observed the greatest increase, is near Morges. A note of its layers

and the account of its fall was obligingly communicated by Mr Alexis Forel. Its cut indicated 335 years of age; at its fall it was perfectly sound, and had grown in a light moist soil; its trunk, at the neck, was 17 feet 7 inches diameter, Swiss measure (the foot being equal to 3 decim.), 30 feet in circumference below the branches, 12 feet from the ground, and one of the five thick branches was 16 feet in circumference: the tree fell during a calm season, the soil having been probably washed away by the waters of the Lake Leman. Its mean increase was $3\frac{1}{2}$ lines annually; but on a division by centuries, it was observed, that it had grown 6 lines annually in the first, $2\frac{1}{2}$ in the second, and $2\frac{3}{4}$ in the third century; these figures agreed with those which are generally found in the elms which were planted by order of Sully before the churches in France. We ought carefully to distinguish between the rate of increase in large and small-leaved elms; the latter is longer lived, and seems to grow more slowly *.

2. I saw an ivy *(Lierre)* in 1814 at Gigeau, near Montpellier, whose trunk near the base was 6 feet in circumference, which astonished by its immense size: another ivy of forty-five years old was only $7\frac{1}{2}$ inches in circumference. If this is to be taken as a model, the ivy of Gigeau should have been 433 years old in 1814, and about 450 at present, if, as I hope, it is still in existence. It is probable, that if there be a mistake in this, as also in the following examples, it is owing to my having calculated the age of the individuals at the very lowest rate.

3. Above I have given the measurement of a larch-tree *(Meleze)* of 255 years old. Assuming this example to be a law of nature, we may believe that there are some between 500 and 600 years old, but it is of consequence to multiply the measurements of their layers.

4. The lime *(Tilleul)* is the European tree which, in a given time, seems capable of acquiring the greatest diameter; that which was planted at Fribourg in 1476, on account of the battle

* The treaty which William Penn made with the natives in 1682, was negotiated under a large (American) *elm*, which grew on the spot now called Kensington, just above Philadelphia. It was prostrated by a storm in 1810, at which time its stem measured 24 feet in circumference.—*Memoirs of Hist. Soc. Pen.*

of Morat, is actually 13 feet 9 inches diameter, which gives an annual increase of about 2 lines. This quantity, equal to that of the oak, seems, in my opinion, to indicate that it was not in a favourable soil; and I should be induced to believe, that it would be more correct to admit an average increase of 4 lines annually. As there are a good many large lime-trees in Europe, it would be important to have the circumference of those whose dates are known. I may mention, on account of their thickness, that of the Castle of Chaillé, near Melles, in the department of the Deux-Sèvres, which, in 1804, was 15 metres in circumference, at that time, I imagine, 538 years old: that of Trons in the Grisons, famous even in 1424, which, in 1798, was 51 feet in circumference, and, I suppose, 583 years of age; that of Depeham, near Norwich, which, in 1664, was 8½ yards mean circumference; that of Neustadt in Wurtemberg, which, in 1580, was so thick as to require props, and in 1664 was 37 feet 4 inches in circumference. In studying the lime-tree more minutely, we ought carefully to distinguish between those of large and small leaves; the former seem to increase more quickly than the latter.

5. The evergreen cypresses are certainly among the trees of Southern Europe which reach the greatest age, and the custom of planting them in church-yards has rendered them an object of respect, and afforded means of measuring them. Hunter says that, in 1776, there were a few in the garden of the palace at Grenada, which had some celebrity at the time of the Moorish kings, and which were still called *Cupressos de la Regna Sultana,* because a Sultana was found there with Abencerrages. I can find no precise information, however, respecting the increase of these trees, which I point out to naturalists *.

6. The chestnut-trees appear capable of attaining a great age, but I do not found this opinion on the famous tree of a hundred horses on Mount Etna. Messrs Simond and Durby have communicated details respecting it, which seem to establish that this tree, which is 70 feet in circumference, is an amalgamation of many. We ought, indeed, to estimate the growth of this tree by trunks of extraordinary size; there are many very large ones on Mount Etna. Pœderlé mentions having seen one 50 feet in circumference in Gloucestershire, which was believed to be 900

* Cypress, mentioned about 350 years old.—*Organographie.*

years old. Bosc cites one which is near Sancerre, 30 feet in circumference, and was known, it is said, by the name of the great chestnut-tree, for 600 years. It would be desirable to have precise information as to the growth of this species.

7. The oriental plane-tree *(Platane)*, (if it can be numbered among European trees), is certainly one of the largest, but we are ignorant of the law of its growth. There is a plane-tree in the valley of Bujukdéré, three leagues from Constantinople, which reminds us of the one which Pliny has rendered so celebrated; it is 160 feet round, and has formed a cavity of 80 feet in circumference. I should wish travellers to ascertain,—1. If it be a single tree, or the amalgamation of many; 2. How much it has increased in a given time, which might be discovered by a lateral nick, which would enable us to count the layers; and, 3. By what law the growth of plane-trees of a century old is regulated *.

8. I would also direct the attention of observers to the walnut-tree *(Noyer)*. Scammozzi, the architect, says that he saw, at St Nicholas, in Lorraine, a table of a small piece of walnut-tree of 25 feet in size, on which Frederick III. gave a celebrated repast. We cannot determine the ages of similar trees, as we do not know the rate of their increase: when they are aged, it would be easy to ascertain it.

9. The orange and citron trees which are cultivated in Europe increase most slowly, and become the oldest. It is asserted that the orange-tree of St Sabine at Rome was planted by St Dominick in 1200, and that of Fondi by St Thomas of Aquinus in 1278. The measurement of these trees, and the verification of these traditions, might give an approximation of the annual increase of the *Agrumi* (bitter orange trees) of Italy.

9. The cedars of which I formerly spoke, though they appear to me less aged than they are supposed to be, merit the attention of observers †.

10. The oak is undoubtedly one of the most long-lived trees of Europe; but its study is involved in great ambiguity, either because it is a tree which, by the admission of foresters, is principally modified by soil, or because the wood of the *Quercus pe-*

* Oriental Plane, 720 years and upwards.—*Organ.*

† Cedars of Lebanon, about 800 years old.—*Organ.*

dunculata, which grows quickly, and to a great height, has been very generally confounded with the *Quercus sessiliflora,* which grows more slowly, becomes harder, and is more tortuous; in consequence of this confusion, it is impossible to compare the documents which have been obtained. There are many instances to be seen of the thickness which oak-trees may attain, in the Sylva of Evelyn, a valuable work, from which I have frequently obtained useful information. I have reason to believe that there are oaks, even in France, of 1500 or 1600 years of age, but it would be proper to verify these dates by more careful investigations.

11. The olive-tree is also capable of attaining an astonishing age, in countries where it is not exposed to the axe. M. Chateaubriand mentions, in his Itinerary, that the eight olive-trees in the olive garden in Jerusalem, only pay a *medin* each, $\frac{1}{33}$ of a piastre, to the Grand Seignor, which proves that they existed at the invasion of the Turks, because, of those planted since, the half of their fruit is paid. The largest olive-tree in Italy, mentioned by Picconi, is at Pescio; it is 7696 metres in circumference. If the calculation of Moschettini is to be relied on, that the olive-tree grows a line and a half annually, it would be about 700 years old; but this estimation, compared with younger trees, must be below the truth.

12. Of all the European trees, the yew *(If)* appears to have reached the most advanced age. I measured the layers of one of 71, Oelhafen one of 150, and Veillard one of 280 years old: these three measurements agree in proving that this tree grows a little more than one line annually in the first 150 years, and a little less from 150 to 250 years. If we admit an average of a line annually for very old yews, it is probably within the truth, and that in reckoning the number of their years as equal to that of the lines of their diameter, they are younger than they actually are. Now, I find four measurements of celebrated yew trees in Great Britain.

Those of the ancient Abbey of Fontaine near Rippon, in Yorkshire, known in 1133, were in 1770, according to Pennant, 1214 lines in diameter, or upwards of 1200 years old.

Those in the church-yard of Crow-hurst, in the county of Surrey, were, according to Evelyn, 1287 lines in diameter in

1660. If, as we are informed, they are still in existence, they ought to be fourteen centuries and a half old.

That of Fotheringall in Scotland * was, in 1770, 2588 lines in diameter, and therefore, twenty-five or twenty-six centuries old.

That in the churchyard of Braburn, county of Kent, was, in 1660, nearly 2880 lines in diameter, and if it be existing at present, should be 3000 years old.

I venture to point out these trees to the foresters and botanists of England, that they may verify them, and if possible ascertain the law of their growth, for it is very probable that the oldest specimens of European vegetation are to be found there †.

For the same reasons, I recommend to those who may have it in their power, to study the law of the growth and dimensions of the *Celtis* or nettle-tree, box-tree, carob-tree, beech-tree, *phillyrea* ‡,

* The yew-tree here alluded to, stands in the church-yard of Fortingal, at the entrance to Glenlyon in Perthshire. It was described by the Hon. Daines Barrington in 1769, (Phil. Trans. vol. lix.): he mentions that, at that period, on one side of the trunk the outward bark only remained, the centre having decayed; that the fresh portion was then 34 feet in circumference; but that he could then measure the entire bole, and had in fact measured it twice over, and ascertained it to be 52 feet. This ancient tree still lives, and was visited, in July 1833, by Mr Neill, Secretary to the Caledonian Horticultural Society. From him we learn, that considerable spoliations have evidently been committed on the tree since 1769; large arms have been removed, and masses of the trunk itself carried off by the country people, with the view of forming *quechs* or drinking-cups and other relics, which visitors were in the habit of demanding. The remains of the trunk now present the appearance of a semicircular wall, exclusive of traces of decayed wood which scarcely rise above the ground. Great quantities of new spray have issued from the firmer parts of the bark, and a few young branches spring upwards to the height perhaps of 20 feet. The side of the trunk now existing gives a diameter of more than 15 feet, so that it is easy to conceive that the circumference of the bole when entire should have exceeded 50 feet. Happily, farther depredations have been prevented by means of an iron-rail, which now surrounds the sacred spot; and this venerable yew, which in all probability was a flourishing tree at the commencement of the Christian era, may yet survive for centuries to come.—Ed.

† A *Ficus Indica*, on the banks of the Nerbudda, is celebrated throughout India, on account of its vast size and great antiquity. It answers to the tree described by Nearchus, and therefore cannot be less than 2500 years old.—Ed.

‡ There are some specimens of *Phillyrea latifolia* in the garden of Montpellier, planted in all probability in the year 1598.

Cercis or Judas-tree *, Juniper †, &c. respecting which there is a want of information.

Among the exogenous trees in countries between the tropics, the Cheirostemon has been cited (because there is a tree at Toluca known since 1553), and the Ceïba, which astonishes by its thickness; but it is improbable that trees, the wood of which is so soft, should be among the number of those that are very old. I confess, however, that the example of the Baobab, which, without being very hard, attains, according to Adanson, more than 5000 years of age, ought, in this respect, to render me circumspect. I shall rather call the attention of travellers to large trees of hard wood; such as the mahogany, which is generally seven feet thick; the Courbaril, which it is said attains, in the Antilles, a diameter of twenty feet, and whose hardness is such that its growth is very slow; the various trees known under the name of Iron-wood; the *Pinus lambertiana* of California, which is said to be from 150 to 200 feet high, and from 20 to 60 feet in circumference; the fig-tree of the pagodas of India, &c. I shall advise them, especially, to verify what is connected with the Taxodiums of Mexico, *Cupressus disticha, L.* Is the immense tree of Chapultepec, which is said to have attained a circumference of 117 feet, 10 inches, really a single tree, or the amalgamation of many? Has it a hollow cave at its base like those of Louisiana, said to belong to the same species? I venture to recommend another examination of this gigantic tree: it may be the most ancient vegetable production in the globe.

It is more difficult to find out the age of endogenous than of exogenous trees, either because their native country has not been so thoroughly examined, or because the absence of woody layers, and the preservation of the same diameter at different stages of existence, actually render this investigation more difficult. Endogenous trees generally present themselves under two aspects; the first, such as the palm-trees, have almost the whole

* In the same garden at Montpellier, there is the largest Judas-tree which is in Europe, and perhaps in the world. Its exact measurement should be registered.

† I have seen a gigantic juniper tree at Draguignan, which possesses this peculiarity, that it is at the side of an ancient monument, called a Druidical stone; but from what I know of the increase of this tree, I doubt whether it be more than 380 years old.

of the trunk bare, and marked with circular rings, nearly at regular distances, at least during the greater period of their life; the others, like the Dracæna, have the trunk branching, without rings. The age of the palm-trees may be estimated in two ways, very analogous to one another:—1. By the height to which they reach, compared with the empiric knowledge of the time which each species requires in growing; 2. By the numerous rings and their mean distance, compared with the height of the trunk. Both of these modes are principally based on a knowledge of the height of the trees, just in the same way as the study of the age of exogenous trees is founded on their thickness. It is therefore of essential importance, to advise travellers to take a correct note of the extreme length of the trunk of every kind of palm-tree. They should also be requested to measure the height of every tree whose age is known, and to ascertain, by an examination, if the rings seen on the outside really indicate, as it is said, the annual growth, or any other period.

The first method, on being applied to the date-tree, seems to afford results in conformity with truth. There was a date-tree in 1709 at Cavalaire, in Provence, 50 feet in height, which had been planted in 1709. The greatest height of those in Egypt and Barbary is 60 feet, and the Arabians reckon that their age rarely exceeds two or three centuries. It is unnecessary to ascertain in what proportions the rapidity of the growth of the date-tree decreases at different periods.

Assuming that the external rings of the trunk indicate the years, we may estimate the approximate age of the Brazil palm-trees, according to the principles laid down by M. de Martius, in his magnificent work, as follows:

	Height of the trunk.	Diameter of the trunk.	Distance of the rings.	Probable age.
	Feet.	Inches.	Inches.	Years.
Œnocarpus Botaua	80	12	7	134
Euterpe oleracea .	120	8 to 9	4 to 5	300
Euterpe edulis . .	100	6 to 7	4 to 5	300
Iriartea exorhiza .	80 to 100	12	4 to 6	250 to 306
Guilielma speciosa .	80 to 90	6 to 8	4 to 5	250 to 300
Cocos oleracea . .	60 to 80	12	1 to 2	600 to 700
Cocos nucifera . .	60 to 80	4 to 12	3 to 12	80 to 330

I give these approximations to travellers, as indications, and to induce them to verify the data on which they are founded.

As to endogenous trees branching, and without regular rings, we are not aware of any plan for establishing their age, and the problem ought to be laid before observers without limitation. We know that some of the trees belonging to this class reach an extreme longevity, such as the famous dragon-tree *(Dracæna draco)* of the garden of Franchi, at Orotava, island of Teneriffe, which was a celebrated tree in 1402, at the discovery of the island, and at that time an object of veneration among the people. Mr Berthelot *, who has published an accurate description of it, says, that on comparing the young dragon-trees which are in the vicinity of this gigantic tree, the calculations which he has made as to the age of the last have more than once astonished his imagination. In 1796, according to Mr Ledru, it was 20 *mètres* in height, 13 in circumference at the middle, and 24 at the base; since that time, the hurricane of 21st July 1819 has destroyed a great portion of the top of it.

I am induced to think that, among perennial plants and small shrubs, there are some which are older than we are accustomed to believe, but on this point there have been no inquiries. I shall here mention some incomplete facts, which may encourage observers to direct their attention to the duration of these humble vegetables. In vegetable organography, I have taken notice of the singular willow, called herbaceous, which, when it grows on the mossy ground of the Alps, in places below the declivities, the soil of which moves away slowly, is gradually covered, and stretches itself out to an extent absolutely necessary to reach the surface, in such a manner that it presents the appearance of a green turf many yards in extent, and is in reality the top of a subterraneous tree. I have attempted to uproot this singular kind of tree, but never could reach its inferior extremity, though the length which I dug out, compared with the extreme slowness of its spreading, indicated a very advanced age. It would be curious to reach the lower end of this tree, which, owing to its subterranean existence, escapes the inclemencies of the atmosphere.

I have seen Eryngiums and Echinophoras in the downs of the

* Mem. Cur. Nat. vol. xiii. p. 781.

south of France, whose crawling stem extends itself as the downs rise; I attempted to tear them up, but never could reach the genuine root; *i. e.* the descending portion. I should almost think that these vegetables are sometimes cotemporary with the downs themselves. The rhizomas of the Nymphæa, Equisetum, and ferns, should also afford examples of extreme longevity, though I am not aware of any mode of discovering it with accuracy.

I shall even descend to vegetables still more humble. Mr Vaucher has traced a lichen for forty years, without seeing any apparent change in its size. For aught I know, it may be possible that, among the specks which cover the rocks, there may be some whose origin goes back to the period when this rock was first exposed to the air. It may be possible that, among the mosses which line the bottom of certain rivers, some of them may have been in existence when they began to flow.

If we set aside these plants, too obscure perhaps to attract general attention, and confine ourselves to trees, the history of which is an object of universal interest, we shall find the solution of a truly curious problem in the inquiries which I propose. Let us hasten to solve it while there is time. On the one hand, the progress of industry, the calculations of the art of forestry, which are now thoroughly understood, the frequent change of owners, the general spread of civilization, have caused the destruction of trees a hundred years old, in the most remote districts; whilst, on the other, changes in religious opinions, and the decay of some notions worthy of respect, though superstitious, tend to diminish the veneration which certain trees formerly inspired in the people. Let us hasten to ascertain the dimensions of those which do exist, and if possible to preserve those monuments of ages now no more. If my isolated voice could reach the proprietors of such trees, the municipal governments of the districts where they are, I should like to induce them to take measures which might tend to their preservation. Where is the town which does not take an interest in the preservation of coins, which refer to ages that are gone? Old trees are coins of a different kind, which deserve to be saved from destruction. I should wish the oldest tree in each district to be recognised as public property, that it should be preserved from injury, either as an historical monument, or to gratify the imagination of those who are fond of referring to antiquity.

I address these reflections to foresters, naturalists, painters of rural scenery, the local authorities of every nation. I request them to measure the old trees with which they may be surrounded, by the plans which I have proposed. All those who have any means of publishing their results will act wisely in printing them immediately, the only kind of register which at present is destined to endure indefinitely. As to those who have no facility in publishing, I offer to receive their observations, and to register them in their names, either in this collection, or in a particular work on the age of trees, materials for which I have already collected. Those travellers who may not be sufficiently acquainted with botany, so as to designate the tree by the correct name, will do well to join to their measurements a dried specimen of a branch in flower, which will serve as a label. Those people who could send some specimens of the wood along with them, which might aid in ascertaining the rate of their growth, would afford means which might be of use in verifying and comparing them.—*Bib. Un.* Mai 1831.

ON THE COLOUR OF THE ATMOSPHERE AND DEEP WATER. *By the Count* XAVIER DE MAISTRE.

THE blue colour of the heavens is usually explained on the supposition that the light of the sun, when reflected from the surface of the earth, is not entirely transmitted by the atmosphere and lost in space, but that the molecules of the air reflect and disperse the blue ray; but no reason is assigned for this ray being reflected in preference to the indigo or violet rays, which are more refrangible, and appear to be more easily reflected.

The same blue reflection is observed in the deep waters of the sea; and in those of lakes and rivers when in a limpid state.

But these fluids are not the only substances which present this singular phenomenon; it is also found in bodies of a different nature, and which appear to have no analogy to each other. Opaline substances have generally a blue reflection *, and the

* The reflected colours which confer so much value on precious opal, have

same thing is observed in some other siliceous stones, although it is still more remarkable in opaline glasses; a weak solution of soap produces the same appearance, and it is more striking in the jelly of the fish of Astracan, while an infusion of the bark of the chestnut is perfectly opaline. Newton mentions a kind of wood which he calls nephritic, an infusion of which is opaline. Lastly, the amber found in the Sicilian sea, at the mouth of the Giarreta (the ancient Simœthus) is greatly prized on account of the opaline property, which it possesses in the highest perfection *.

A blue reflection is observed in certain bodies which are white and opaque, when they are reduced to a sufficient thinness to transmit the light; a familiar example of this occurs in the skin that covers the veins, which is blue, although neither the skin nor the blood are of that colour.

Finally, the mixture of white with black, and with transparent colouring substances in painting, present numerous examples of the production of opaline blue, which shall be afterwards described.

This blue colour is the only one which admits of being explained on the theory of thin plates, supposing that the particles of opaline bodies are of the size requisite for reflecting blue. This explanation becomes probable when it is considered that the colour transmitted by these bodies is the yellow complementary of the reflected blue; but the object of this essay is only to point out the phenomenon in the substances which produce it, and to describe the effects, without admitting the truth of this theory, to which there are considerable objections.

The examination of opaline substances, and their action on the light that is reflected and transmitted, will shew clearly the analogy which exists between their colours and those observed in the air and in water, and will prove that the same cause produces the phenomenon in all bodies where it occurs.

In preparing opaline glass, the powder of calcined bones is

been attributed to natural fissures. This was the opinion of the celebrated Haüy.

* One of the tributaries of the Giarreta flows at the foot of Etna; and this modification of amber, which does not occur elsewhere, is no doubt owing to the influence of the volcano. It is likewise found in this place of a ruby red colour, as well as green and black.

mixed in the ordinary paste of white glass, in such quantity as to produce in the mass a slight bluish tinge, without altering materially its transparency; this powder appears in a state of extreme division, or as if it had undergone a slight degree of solution, which does not disperse the transmitted light.

The colour of the light transmitted by opaline bodies, varies according to their size; it is yellow if the body is thin, and becomes successively orange and red as the thickness is increased.

The analogy between the air and opaline substances is not only shewn by the blue reflection, but also by their action on the transmitted light, which becomes successively yellow, orange, and red, according to the volume of air that transmits it, and the nature of the aqueous vapours with which it is impregnated. When the sun is risen above the horizon, and his light traverses the purest and least dense part of the air, the rays are white, with a slight tinge of yellow; as he sinks by degrees, they sometimes appear yellow and orange; and when the light falls aslant on the earth, and is transmitted by air of the greatest density, and charged with the vapours of the evening, they are perceived to be of a red colour, or even purple.

But it often happens, that the colours are not observed, and the sun sets without producing them. It is not, therefore, to pure air alone that we must attribute the opaline property of the atmosphere, but to the mixture of air and aqueous vapour in a particular state which produces an effect analogous to that of the powder of calcined bones in opaline glass. Neither is it the quantity of water which the air contains that occasions these colours, for when it is very humid it is more transparent than it is in an opposite state, the distant mountains then appearing more distinct—a well known prognostic of rain—and the sun then sets without producing colours; in the fogs and vapours of the morning, the light of the sun is white, but the red colour of the clouds at sunset is generally regarded as the forerunner of a fine day, because these colours are a proof of the dryness of the air, which then contains nothing more than the particular disseminated vapours to which it owes its opaline property. In this state of the air, the disk of the sun sometimes appears like a globe of fire, and deprived of rays.

According to the nature of the vapours disseminated through the air, the sky is of a very variable blue, although the volume of air be always the same; and what renders it certain that its blue colour is caused by these vapours is, that it appears black when seen from the high eminences of the globe, above which there is not sufficient vapour to reflect the blue.

Limpid waters of sufficient depth reflect, like the air, a blue colour from their interior; it is of a darker shade, because it is not intermingled with white rays; frequently, indeed, it is not perceptible, the reflection of the surface, in which the sky and surrounding objects are painted as in a mirror, usually concealing the interior colour, or forming composite tints by combining with it.

We have seen that the property of producing colours possessed by the air, is owing to the presence of aqueous vapour; and analogy may lead us to suppose, that the same property in water is to be ascribed to its mixture with the air which it contains.

Although many causes, in general, conceal the blue colour of waters, it is occasionally displayed in all its intensity; of this an example may be seen in the Rhone under the bridges of Geneva, where the river seems to be composed of ultramarine. The spectator is then in the most favourable situation for observing the colours of water, free from the reflection at its surface, as far as is possible under an open sky.

The agitation of the water, and the difference in the form of the waves, produce a change in its colour; sometimes the tranquil sea is seen to reflect the warm colours of the horizon, and to represent all the tints of a bright sky so exactly, that the sea and the sky seem to be confounded with each other; but if a slight breeze ruffle the surface, the blue tints immediately succeed the brilliant tints in the places agitated; all the inclined surfaces of the small waves, which no longer reflect the heaven to the eye of the spectator, permitting the interior colour of the water to be seen through them.

It is this which causes the water of the Rhone to be distinguished from those of the lake Leman; the motion of the river in the still waters of the lake must necessarily produce some degree of agitation, and consequently diminish the brilliant reflection of the sky, and render the colour of the water more apparent. The green tint often assumed by the waters of the sea, may seem to render it doubtful whether the property of reflecting blue is inherent in the nature of water; but this green hue is never observed but when the sea is not of sufficient depth, that is to say, when the bottom reflects the transmitted light.

On looking at the sea from an eminence of about fifty toises, on the shore of the island of Capri, I observed some portions which were of a more beautiful green and greater brilliancy than the surrounding water; to ascertain the cause, I went to the spot in a boat. On reaching the margin of the sea, these portions were no longer distinguishable, but they soon reappeared, and I perceived that the colour was produced by white rocks, which were easily seen notwithstanding the great depth, as they lay on a bed of dark sand; the rocks, thus seen in a vertical direction, were of a less intense green than they appeared to be from above, but I could not doubt that they were the cause of the phenomenon in question.

In order to assure myself of this by direct experiment, I prepared a square plate of white-iron, 14 English inches on the side, painted with white lead. Having suspended this horizontally to a line, I sunk it in a deep part of the sea where the water under my boat was blue without any mixture of green, following it with my eyes under the shade of an umbrella held over my head. At the depth of 25 feet, it had taken a very perceptible tinge of green; this colour gradually became darker to the depth of 40 feet, when it was of a beautiful green inclining to yellow; at 60 feet the tint was the same, but of a deeper shade; the form of the plate was now no longer distinguishable, and at 80 feet I saw only a greenish glimmer which soon disappeared.

We see, therefore, that the light of the sun, transmitted by the water of the sea and reflected by a white surface, produces a green colour. The cause of this is easily perceived, by admitting the existence of the same opaline property in deep water that is found in the air. The light, after having penetrated a mass of water of 100 feet to reach the plate and return to the surface, must appear yellow like that transmitted by an opaline liquor; this colour reflected by the plate, mingling with the blue of the interior, produces the green colour. If the bottom of the sea was white, the waters near the margin would present the same green tint which the white plate produced at different depths; but the bottom is usually of a dark grey which reflects the light imperfectly, and can give rise only to dark and indeterminate shades of green; it is therefore to the reflection of the bottom that the green colour of the sea near the shores is to be ascribed. In order to leave no doubt on this matter, and to confirm an observation often made before, I took a boat and proceeded from the shore, during a fine sunshine in July, at eleven o'clock in the forenoon, with the view of examining attentively the changes which should take place in the colour of the water, while looking under the boat on the side opposite the sun.

At about fifty toises from the shore, the water was of a decided green, and this tint continued for a quarter of an hour; it then became of a bluish-green; as we advanced the blue gradually predominated; and after sailing an hour the water under the boat was of a fine blue, without the least mixture of green.

While returning, I was careful to observe the reappearance of the green, and when I found the tint well defined, I ascertained the depth, by sounding, to be 150 feet; the light of the sun which produced the green colour had thus to traverse 300 feet of water. But in this part of the gulf, another cause contributes to produce the green colour, viz. the impurity of the water for several miles along the shore. This will not excite surprise when it is considered that the sea of Naples receives no river that can give rise to any motion in its waters, and that all the filth of this populous town is thrown into it. On the shores of the island of Capri the sea is perfectly blue at the depth of 80 feet, because it is always pure; while near Naples it was green at 150 feet—a difference which can only be attributed to the impurity of the water near the town at the time the observation was made.

Water, however, may be blue at a much smaller depth than 80 feet, provided the bottom be black or of a very sombre hue, so as not to reflect the transmitted light.

If some obstacle intercept the direct rays of the sun, in such a manner that the bottom is thrown into the shade, while the water itself continues exposed to the light, the latter will be blue, because its colour will not be affected by the yellow reflection from the bottom; this may take place in deep rivers, when their banks throw a shade on the bottom.

Thus, the depth of the bottom, and its colour, may occasion variations in the colour of the sea; and it may be regarded as an established fact, that when the light of the sun, transmitted by the waters, is not lost in their depth, but reflected from the bottom, the sea will assume a tint of green.

In the high seas this effect may be produced by beds of submarine plants, or by those myriads of microscopic molluscæ which often cover a vast space, and which may act on the light, or even possess in the mass a slight permanent colour.

Colours transmitted by deep waters cannot be observed directly, like those of the air, which are depicted in the clouds. A single observation is recorded on this subject. The learned Halley, having descended into the sea in a diving-bell, observed that a ray of the sun which penetrated to him across an opening, closed with glass, tinged the back of his hand with rose-colour. The experiment would have been more conclusive for the problem to be solved, had the ray fallen on a white surface; the reddish hue of the hand must necessarily have had an influence on the observed colour. It is not probable that he had descended more than 30 or 40 feet; but at this depth the colour of the transmitted light could only be a scarcely perceptible shade of yellow, mingled with shades of white, and this, in connexion with the colour of the hand, might appear to be a rose tint. Halley observed that the under side of his hand was of a green colour, which was no doubt owing to the reflexion of the bottom. The contrast of this green light, with which he was surrounded, with the colour produced by the isolated ray on his hands, might contribute to the illusion which I suppose him to have been under.

The cause of the greenish-blue colour of the crevices in the glaciers is the same as that which renders the waters green near the shore. If the mass of the glacier were as large and homogeneous as that of the sea, the interior of the crevices would be blue; but the ice contains bubbles of air, particles of snow, and fissures, which reflect the light, and throw it from one face to another of the crevice, till it is transmitted to the opening; these opaque particles produce the same effect in the glacier as the white plate and the bottom of the sea.

On the shore of the island of Capri, there is a grotto which Nature seems to have constructed to shew the blue colour of the sea in all its beauty, and which, for that reason, bears the name of *grotte d'azur*; it is situate under a rock, on the north side of the island. As it cannot be entered by a boat of ordinary dimensions, it remained unknown till the month of August 1826, when two Prussian artists, MM. Kopitch and Frisi, swam into it, and examined it. Their description having excited the curiosity of the public, boats of suitable dimensions were constructed, for conveying amateurs into the interior.

The entrance to the grotto is four feet five inches English in height, and about the same width, nearly in the shape of an equilateral triangle, one of the sides of which is formed by the sea. The summit is rounded, and by no means wide, so that it is passed by a slight inclination of the head, when we enter into a spacious grotto, the roof of which is remarkably regular, as well as the wall which supports it. Its extent, measured from the entrance to the landing-place opposite, is 125 English feet in the direction from north to south, while it is 145 feet from east to west. The depth of the water under the entrance is 67 feet, in the middle of the grotto it is 62, and near the landing-place 58 feet.

The rock is calcareous, of a light grey colour in the fracture, and there is no appearance of stratification.

On entering all appears obscure, except the water, which is bright and of a brilliant blue, contrasted with the general obscurity. Our constant experience of seeing the light come from the sky, is no doubt one of the causes of surprise produced by this peculiar blue light issuing from the depths of the sea. Advancing towards the end of the cave, while the boat is still in the direction of the entrance, the end of the white oars shines in the water with a bright blue light, which disappears as soon as they are raised. This is the most remarkable phenomenon which the azure grotto presents; for it is not easy to understand why objects are so brightly illuminated in the water, and no longer so immediately above the surface. When the hand or a cloth is plunged into the water, one would believe that it was dipt into a blue tincture; the immersed part is bright and coloured, while that out of the water is obscure and retains its local colour.

The landing-place is at the end of the grotto, on a small space level with the water, formed by the rock; it is the only spot in the grotto that could be supposed to be the work of human hands. The spectator then ascends to a second ledge of rock, about three feet in elevation, and forming a commodious station for several persons: it is from this point that the phenomena presented by the azure grotto are best observed *.

The small entrance admits a stream of white light, which resembles the reflection of the rising moon from the surface of the sea, and reaches to the middle of the sheet of water; all the rest of the surface is blue up to the feet of the spectator. This colour gradually diminishes on the right, where the walls of the grotto are most distant from the entrance. The white light alluded to illuminates the roof sufficiently to shew its natural colour; but when the entrance is obstructed by a boat, or what is better still, when it is wholly covered up by a dark curtain, the roof itself is bluish; the effect is similar to that produced by the flame of spirits of wine in a dark room: there is then no other light than that which issues from the water. The experiment with the curtain, which is very easily performed, ought to be omitted by none who wish to see the spectacle in all its beauty.

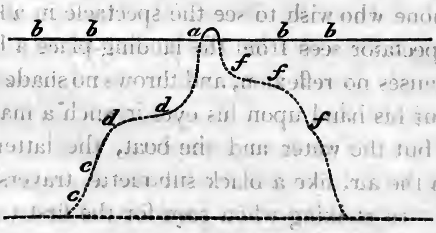
When a spectator sees from the landing-place a boat pass before him, it causes no reflexion, and throws no shade on the water. If he then put his hand upon his eyes in such a manner that he sees nothing but the water and the boat, the latter will appear suspended in the air, like a black silhouette, traversing the sky. This effect is so striking when seen for the first time, that one cannot avoid experiencing a feeling of uneasiness for the individuals who afford the spectacle.

In the dark place towards the right, which I have already mentioned, the water is not blue, but is remarkably transparent. The rock under the water is seen by a feeble light,

* Beyond this landing-place the grotto communicates with a natural gallery, about 100 feet in length before it becomes too narrow to admit of passing. From the entrance to this gallery a view of the blue water is obtained across two arcades separated by a pillar; it is from this point that many artists have taken views of the grotto.

sufficient, however, to shew the inequalities of its surface to a considerable depth, while above the water it is very obscure. The line of the level of the sea in contact with the rock is likewise well marked, and bears some resemblance to the phenomenon of the oars, which were luminous when in the water and dark above its surface; but here the feeble light has a yellowish tinge, instead of being bright and blue as in that instance. The depth seems to increase according to the degree of attention with which it is observed, and the bottom is soon discovered, although in this place it is at the depth of forty feet. The white plate which I sank was easily distinguishable on the dark sand. Its colour, instead of being green, as in the experiment made in the sunshine, was slightly yellow.

The feeble yellow light which illuminates the submarine wall, in this part of the grotto, is derived from the reflexion of the bottom, and from that part of the opposite wall which receives the light from without. This light, which has traversed a great mass of water, must be yellow, like that which is transmitted by opaline liquors; thus the opaline property of the sea explains, in a satisfactory manner, the principal phenomena to which the particular construction of the grotto gives rise. I have attempted to give an idea of this construction, by means of the subjoined figure, which represents the exterior rock in the sea, and above the surface.



The small entrance is at *a*, above the level of the water, which is represented by the line *b b b*. The eastern side of this entrance is continued almost perpendicularly downwards for 30 or 40 feet; there it appears to be cut horizontally at *d d*, and suspended in the dark blue waters of the sea; *d e c* is the supposed continuation of the eastern side of the entrance to the bottom, which, as has been seen, is 67 feet in depth. The western side of the entrance *f f f* forms an angle of 10 or 12 feet deep; it then continues in a horizontal direction for 20 or 25 feet, after which it descends obliquely, probably to the bottom of the sea, where the eyes cannot follow it beyond 30 or 40 feet.

This construction gives an immense opening for the light to penetrate into the grotto across the water, even when the small opening above the level of the water is closed, and thus occasions, in a great mass of water, that dispersion of the blue ray which always takes place in deep and limpid waters, and which appears most conspicuously in the azure grotto, because it is not mingled with any other light.*

After having considered the opaline property of the air and waters, let us make some inquiries into the production of opaline blue in opaque bodies.

We have formerly mentioned the blue tint observed in the fine skin with which the veins are covered. Leonard de Vinci alludes to this phenomenon, which is entirely owing to the opaline property of the skin. Let us examine the conditions necessary to produce it.

(To be concluded in next Number.)

NOTICE OF BOTANICAL EXCURSIONS INTO THE HIGHLANDS OF SCOTLAND FROM EDINBURGH THIS SEASON, 1833. *By Dr GRAHAM.*

IN the end of June, Mr Brand, Mr Munby, and Mr James Macnab, spent a few days in Clova, and found, in addition to the plants already known as natives of that interesting district, *Arbutus alpina*, on the top of the mountain opposite to the village of Kirkton. This is an unexpected addition to the Flora of that range, and shews still further the impropriety of hastily discarding from the natives of a particular district, plants which have not recently been found in it; for I feel convinced, that I, and others, have passed within a few yards of the station where these gentlemen found the *Arbutus*, yet never saw it there.

Favoured with the company of a number of friends, devoted to various branches of natural history, and some of them emi-

* It may be recommended to travellers to examine the colour of the water in our sea-caves, particularly those on the coast of Sutherland, some of which have the situation, form and dimensions of the azure grotto of Capri. —EDIT.

nent in such pursuits, I left Newhaven on board the steam-boat on the morning of the 30th of July, and landed at Invergordon on the evening of the 31st. From Invergordon we walked to Bonar Bridge, the place of rendezvous for those whose avocations or inclinations had carried them by different routes. Thence we proceeded by Oikel, Inchandamf, Kylestrome, Scourie, Badnam Bay, Laxford, Riconich, Durness, Erribol, Casheldhu, Tongue, and Farr; returning through Strath Naver to Aultnaharrow, Lairg, Golspie, Tain, Invergordon, and Inverness.

The following are among the plants which we observed as most rare in the district we visited—omitting many of those which I have already noticed in this Journal (1825 and 1827) as found on former excursions.

Arenaria rubella.—I found a single specimen of this plant somewhere on Ben Hope in 1827, and again in tolerable quantity on the point of one cliff this season.

Calluna vulgaris.—The hoary variety of this plant is most abundant on the hills between Invergordon and Bonar Bridge. The variety with white blossoms occurred occasionally throughout the whole route, but not more commonly than on other heaths.

Carex filiformis—we found frequent in the subalpine bogs, especially at Oikel, Laxford, Riconich, Loch Naver, and on the moor south of Aultnaharrow.

Carex panicea, var. *phæostachya.*—I found this plant on Specanconich, and think there is no doubt of its specific identity with *C. panicea.*

Carex pulla—I found at a considerable elevation on the east side of Ben More, Assynt, of its usual form, very different in size from the giant specimens of Clova.

Carex rariflora.—This *Carex*, hitherto confined to Clova, Mr Macnab first observed near Oikel. I afterwards found it by the road opposite the west side of Ben Hope; and Mr Tyacke found it at the base of Ben Loyal. In 1825, Mr Home and I found it in Batcall Moss, between Riconich and Old Shore. I then considered it to be *C. limosa*, and I still am inclined to agree with those botanists who can see no good specific distinctions between *C. rariflora, C. limosa*, and *C. irrigua.*

Cladium Mariscus.—The late Mr John Mackay found this plant in Galloway; and Mr Don found it many years ago in the Bog of Restennet, near Forfar; but it has not been known to exist in any other station in Scotland, till we found it in large quantity, but very sparingly in flower, in a marsh by the road-side, about half-way between Kylestrome and Batcall Church.

Cratægus oxyacantha.—Woody plants are rare in the west of Sutherland, and I only saw one bush of this on a rock at Loch Assynt.

Cytisus scoparius—We did not see this plant in the western parts of Sutherland, nor at all along the north coast, till we reached Borgie Bridge, above which we saw one patch. We found it again scattered sparingly through Strath Naver. It is plentiful upon the east coast.

Draba rupestris.—This plant, hitherto confined to Cairngorum and Ben Lawers, was found by Mr Macnab on Ben Hope.

Erica cinerea, flor. alb.—This variety we met with occasionally, but not more commonly than on other heaths.

Erica Tetralix, flor. alb —we found to be very common, particularly in the middle and western parts of Sutherlandshire.

Fucus Mackaii—Dr Greville first picked on the shores near Kylestrome. It exists there, and farther north on the same coast, in the utmost abundance, but was not found on the north or east coasts.

Fucus serratus, var. *laciniatus*,—was gathered by Dr Greville at Erribol Ferry.

Hieracium umbellatum.—We found this in the station where I formerly observed it, near Farr, and in much larger quantity than before. I have never seen it anywhere else in Scotland. Dr Johnston, in his excellent Flora of Berwick-upon-Tweed, mentions a peculiar swelling of the stems of this species from the deposition of the eggs of an insect. *Hieracium denticulatum* grows abundantly in this station interspersed with *H. umbellatum*, and in other parts of the country, and is very frequently so affected, but both this season and in 1827, I observed *H. umbellatum* to be wholly exempt from it.

Isoetis lacustris.—In the river Oikel, immediately above Invershin, and in several lakes in several parts of the route.

Juncus balticus.—In much greater abundance than formerly noticed, near the shore, behind Keoldale, in the parish of Durness.

Luzula arcuata,—abounds much more than former observation had led me to believe on the summit of Fonniven, and was also discovered on the ridge leading to the top of Ben More, Assynt, from Inchandamf.

Malaxis paludosa—we found on the road-side above Invershin, on the hill behind Oikel, near Free Vater, and at Ben Loyal.

Pilularia globulifera.—Road-side above Invershin, plentifully.

Pinguicula lusitanica.—This species, generally confined to the west coast of Britain, we found very abundantly a little above Invershin, and thence by the road-side nearly as far as Oikel. As another eastern station, I may mention that it has been found by Mr Stables in Strath Peffer.

Prunus Padus.—Road-side near Tongue, and by the side of Loch Naver.

Prunus spinosa.—Lower end of Strath Naver, not observed anywhere else in the west or north of Sutherland.

Salix reticulata.—Sparingly on Ben Hope, picked by Mr Macnab.

Ulex europæus.—Keoldale, Loch Erriboll, Tongue, Strath Naver, Strath Fleet, and along the east coast of Sutherland. It certainly was originally introduced at Tongue, and it may have been in all of the other stations except Strath Naver; but there, I am convinced, it is native. There seems no possible reason why it should ever have been introduced in such a place, and it occurs in detached plants throughout the whole Strath, about twenty miles long, nowhere in great circumscribed masses, as at Tongue. In Strath Fleet, and at Erribol, it is employed to form fences; and in all of the above situations, it grows either at the level of the sea, or in very moderate elevations.

Utricularia intermedia.—Very common in the lakes and bogs throughout the route.

Utricularia minor.—Much less common than the last species, but existing occasionally in the lakes. Found in flower only once in a small pool near the base of Speckanconich, Assynt, by Mr Parnell.

Vicia sylvatica.—This was picked by Mr Campbell and Mr Stables in Free Vater, north of Ross-shire, the only station in which it was observed.

Among the rare plants of the north and west of Sutherlandshire, I ought not to omit the mention of common winter Wheat. The first experiment in the cultivation of this grain has been tried this year at Balnakiel, the farm of the late Mr Dunlop, in the parish of Durness, upon the shore, ten miles east of Cape Wrath. The field was sown during last winter, is an excellent crop, and will, I suppose, be reaped about the middle of September.

NOTICE ON THE OSTEOLOGY OF THE HIPPOPOTAMUS. *By WALTER ADAM, M. D. Fellow of the Royal College of Physicians of Edinburgh, M. W. S. &c. Communicated by the Author.*

In species valuable to mankind, or in species that have become extinct, or are otherwise interesting, it may be desirable to know the relative size of each bone. But, in most animals, no very tedious investigation is required to ascertain, osteologically, the distinguishing form; in other words, those osteological dimensions, the constancy of which determines the existence of separate species.

The precision of which the arrangement of animals is susceptible, according to symmetrical measurement of such dimensions, may be exemplified in the hippopotamus, the rather that few animals are of a form so remote from elegance.

In the hippopotamus the number of dorsal vertebræ, as of ribs, is fifteen. Of these fifteen the tenth is narrower over the transverse processes than any other vertebræ in the trunk of the animal.

Four other chracteristic dimensions of the hippopotamus are identical with this smallest transverse breadth of the vertebral column. These are,—

1. The mesial height of the cranium from the surface of the palate.

2. and 3. The inial breadth of the cranium, both at the inio-coronal prominence, and at the occipital condyles.

4. The breadth of the knee-joint.

Five dimensions still more characteristic are twice the dimensions above stated :

1. In the vertebral column ; the transverse breadth of the atlas, equalled by that of no other dorsal or cervical vertebra.
2. and 3. The breadth of the cranium, at the orbits, and at the sockets of the tusks.
4. The greatest expansion of the scapula.
5. The length of the first rib.

The foregoing dimensions being as one and two, the following are as three :

1. and 2. The transverse breadth of the second and fourth of four lumbar vertebræ (the third and broadest is 1–12th broader than these two).
3. The inial breadth of the lower jaw being the greatest breadth of the head.
4. The length of the palate.
5. The length of the scapula from the glenoid cavity.
6. The greatest length of the humerus.
7. The length of the femur from the cervix to the rotular groove.

Connected probably with the uncouth figure of the hippopotamus, is the imperfect symmetry of the pelvis in relation to the cranium.

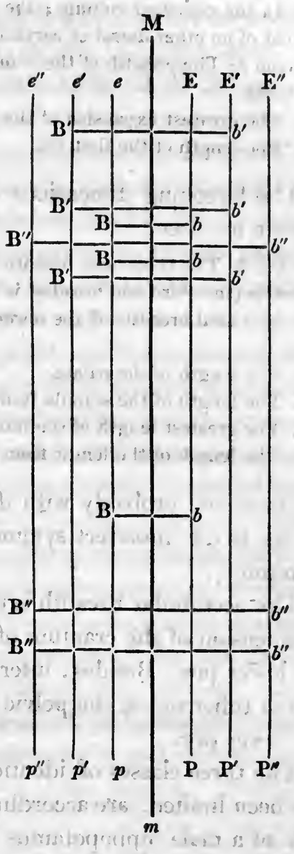
The acetabular breadth is the same as the zygomatic breadth ; a dimension of the cranium of this animal subordinate to that of the lower jaw. Besides ; intermediately to the acetabula and the ischial tuberosities, the pelvic breadth is half the inial breadth of the lower jaw.

The three classes of identical dimensions to which this notice has been limited, are according to a very fine osteological specimen of a male hippopotamus in the Museum of the Royal College of Surgeons of London. The actual dimensions are, 5.55, 11.10, 15.65 inches.

Though, owing to the multiplicity of osteological, as of other living forms, it seems hardly possible to assign any one osteological dimension as a standard of reference for the dimensions even of mammalians alone, it follows from what has been above stated, that the general comparison and precise arrangement of animals may perhaps be attained by viewing their osteological dimensions in combination. We may suppose a range of equidistant planes parallel to the mesial plane, by which planes the constant dimensions of breadth may be considered as bounded ;

while the other dimensions of breadth, that are more or less variable, terminate in the intervening spaces, or beyond.

Let the line M *m* represent the edge of the mesial plane in any animal; for example, in the hippopotamus. Let the lines E *p*, E′ *p*′, E″ *p*″, represent the edges of equidistant planes parallel to the mesial plane, on the right side of the animal; and let the lines *e p*, *e*′ *p*′, *e*″ *p*″ represent the edges of like planes on the left side. Then, the dimensions of breadth, which may be considered as constant, will be represented, those of the first class by the lines B *b*, B *b*, B *b*; those of the second class by the lines B′ *b*′, B′ *b*′, B′ *b*′; and those of the third class by the lines B″ *b*″, B″ *b*″, B″ *b*″; such lines being thus all multiples of one unit. Then also, by graduating the line M *m* to the same scale, fixing terminal points corresponding to the variable breadths, and drawing lines through the terminal points of the different breadths (constant and variable), we shall obtain curves that will shew in diagram the series of breadths in each species of animals.



The dimensions of length and of height may be given in a similar manner.*

London, *August* 1833.

* Dr Adam lately published, in the Linnean Transactions, an interesting memoir on *Osteological Symmetry*, which we recommend to the particular notice of those naturalists who are aware of the importance of the practical and theoretical views connected with such investigations. The memoir is entitled "*On the Osteological Symmetry of the Camel; Camelus Bactrianus of Linnæus*," &c.—Edit.

A SKETCH OF THE TERTIARY FORMATION IN THE PROVINCE OF GRANADA. *By C. Silvertop, Retired Brigadier in the Service of H. C. M., K. of the R. and D. O. of Charles III., and F. G. S. With Plates. Communicated by the Author.**

The tertiary deposits discontinuously spread over the province of Granada, are naturally and geographically divided into two portions,—the littoral, and the inland,—by the intervening mountainous district of primary and secondary rocks, which I have termed the Sierra Nevada Chain.

At the southern base of this chain, along the line of the Mediterranean coast from Malaga to Cartagena, wherever the older rocks that compose it do not descend to the shore, as well as in some transversal valleys that terminate in this inland sea, numerous patches and little tracts belonging to the tertiary formation may be seen. These constitute the littoral position of the deposit.

The inland position will embrace the different tracts to the north of the same Sierra Nevada chain, or in the interior of the province of Granada, where beds of similar origin have been observed, and will be subsequently noticed in the same order.

Littoral Portion of the Tertiary Deposit in the Province of Granada, or Line of Coast from Malaga to Cartagena.

Various beds full of tertiary organic remains are observed in the immediate vicinity, and in the neighbourhood of Malaga; 1*st*, contiguous to the higher part of the town; 2*dly*, between three and four miles up a mountain stream, called the Guadamedina, which separates Malaga from its suburb, and then enters the Mediterranean; and, 3*dly*, up a transversal valley or estuary, which I shall call the Valley of Malaga, that terminates in the Mediterranean between this city and the village of Churiana, about eight miles distant towards the south west. For the sake of perspicuity, I shall divide these beds into two

* This memoir was read before the Geological Society of London, but withdrawn, by permission of the President and Council, for publication in this Journal.

groups; 1*st*, or lowest group; 2*d*, or superior group. (See section 1. Plate II.)

1. Lowest group: consists of a brownish yellow and dark bluish-grey coloured tenacious clay.

2. Superior group: consists of alternating horizontal beds of sand, coarse sandstone, sandy loam, marl, and conglomerate.

1. *Lowest Group.*—Contiguous to the northern higher part of Malaga, and confined towards the east and north by the mountainous district which borders the Mediterranean, and towards the west by the Rio Guadamedina, there is a small open tract, in a portion of which, near the convent of La Vittoria, extensive excavations for brick-earth have been made in the argillaceous deposit belonging to this group. The upper part of the deposit consists of a light-coloured brownish-yellow argillaceous marl, from 12 to 16 feet thick, the lower portion of a darkish bluish-grey coloured tenacious clay, which has been penetrated to the depth of 50 feet. There is an admixture of fine sand throughout the deposit, in the lower part of which it is in a small, but in the upper in a considerable quantity. A waving irregular line, distinguishable from the different shades of colour of the upper and lower part of the deposit, may be distinctly followed by the eye; but at other points near Malaga, where this argillaceous group is seen, the upper portion is of variable thickness, and sometimes entirely wanting, so that the subjacent dark-coloured clayey mass is exposed at the surface. Irregular veins of selenite, from two inches to half an inch thick, are occasionally seen passing in straight or undulating lines through both portions of the deposit, from the base to the top of the escarpments formed by the workings.

The most abundant and characteristic shell of this argillaceous mass, is the Pecten Pleurenectes *, of various sizes of from three inches to half an inch in diameter. One resembling P. corneus, but longer, Dentalia natica, *Triton nodiferum*, identical with

* Mr Deshayes, who did me the favour to examine some of the fossils from this bed, identified Pecten pleurenectes, Dentalium sexangulare, Natica canrina, Natica Rillwgrii-payr.

Mr Sowerby identified, amongst other specimens, Pecten cornus, varietas, and Triton nodiferum.

that now existing in the Mediterranean, and many fragments of Ostrea. No vegetable or animal remains could be discovered, nor, as I was informed, had any such been found at this locality.

Part of the town of Malaga is built upon this argillaceous deposit, through which wells are sunk into a subjacent bed of sand, where water is found.

This member of the tertiary may also be seen in some escarpments on the left bank of the Guadamedina, which, as above stated, bounds the little tract under consideration towards the west; and two miles up this stream from Malaga, there is a considerable patch of it, in which vertebral bones (probably of the Delphinus, as will afterwards be seen) were discovered in making an excavation for a pond.

On the left bank of the Guadamedina, I have not observed this argillaceous bed at any other point. The remaining higher undulating ground of the little tract immediately under consideration, belongs to the tertiary beds of group 2d, (see sect. 1. Pl. II.) But, on the opposite or western bank of this stream, it is extensively developed over an open, hilly, ravined tract that borders the mountainous country towards the north, and terminates southwards in a large horizontal flat, along the Mediterranean shore, between Malaga and Churiana. From this tract, which may be stated to be enclosed by the Guadamedina and Guadalhorce rivers, it may be followed, in an irregular manner, for sixteen miles up the estuary or Valley of Malaga, to a village called Alaurin el Grandè, where, in consequence of its being worked for brick-earth, another fine opportunity is presented of observing the organic remains that have been entombed in its mass. (See sect. 2. Pl. II.)

Alaurin el Grande, a remarkably neat clean little village, surrounded by orchards of fruit-trees, is situated at the base of the Sierra de Mijas, which bounds the Valley of Malaga towards the W. S. W., and contiguous to the village, which is about eighteen miles distant from Malaga, and, between 900 and 1000 feet above the level of the Mediterranean, there is a small tract on the slope of the adjoining mountain-ridge to the valley, where the excavations for brick-earth, just alluded to, have been made. The workings are carried on by perpendicular shafts, generally

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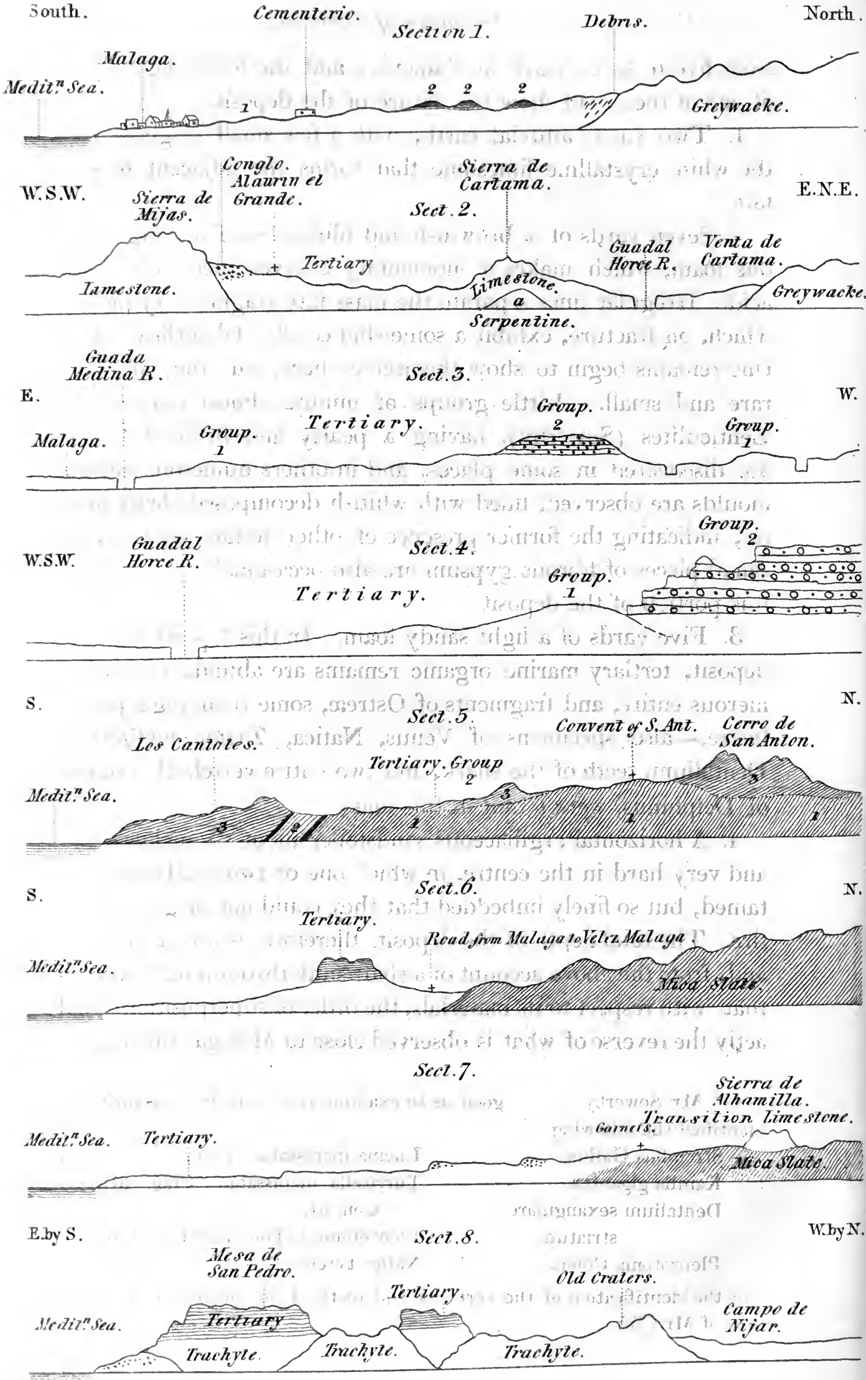
... the left bank of the Guadalmedina, I have not observed this argillaceous bed at any other point. The remaining higher ... ground of the little tract immediately under consideration belongs to the tertiary beds of group 2d. (see sect. 1. Pl. 17.) ... this stream, it is ... tract that borders ... the north and terminates ... along the Mediterranean ... between Malaga and Torremolinos. From this tract, which ... to be ... by the Guadalmedina and Guadal- ... rivers, it may be ... in an irregular manner, for ... two miles up the estuary ... Valley of Malaga, to a village called ... Grande, where, in consequence of its being worked ... brick-earth, another fine opportunity is presented of observing the organic remains that have been entombed in its mass. (See sect. 2. Pl. 17.)

... el Grande, a remarkably neat clean little village, surrounded by orchards of fruit-trees, is situated at the base of the ... de Mijas, which bounds the Valley of Malaga ... and contiguous to the village, which is about eighteen miles distant from Malaga, and, between 900 and 1000 feet above the level of the Mediterranean, there is a small tract on the slope of the adjoining mountain-ridge to the valley, where the excavations for brick-earth, just alluded to, have been ... The workings are carried on by perpendicular shafts, ...



E. Mitchell Sculpt.

from five to seven yards in diameter; and the following section of one of these will show the nature of the deposit.

1. Two yards alluvial earth, with a few small fragments of the white crystalline limestone that forms the adjacent mountain.

2. Seven yards of a brownish and bluish tenacious argillaceous loam, which makes a momentary effervescence with nitric acid. Irregular lines separate the mass into fragmentary pieces, which, on fracture, exhibit a somewhat conchoidal surface. Marine remains begin to show themselves here, but they are very rare and small. Little groups of minute almost microscopic Lenticulites (Sowerby), having a pearly and brilliant lustre, are discovered in some places, and in others numerous minute moulds are observed, lined with whitish decomposed shelly matter, indicating the former presence of other testaceous remains. Small pieces of fibrous gypsum are also occasionally met with in this portion of the deposit.

3. Five yards of a light sandy loam. In this * portion of the deposit, tertiary marine organic remains are abundant, viz. numerous entire, and fragments of Ostreæ, some retaining a pearly lustre,—also specimens of Venus, Natica, *Triton nodiferum*, Dentalium, teeth of the shark, and two entire vertebral columns of Delphinus, were found in this mass.

4. A horizontal argillaceous sandstone, about six inches thick, and very hard in the centre, in which one or two shells were obtained, but so finely imbedded that they could not be got out entire. The total depth of the deposit, therefore, is about 36 feet; and, from the above account of a shaft sunk through it, it appears that, with respect to its materials, the order of superposition is exactly the reverse of what is observed close to Malagá, the argilla-

* Mr Sowerby was so good as to examine the fossils from Alaurin and identified the following:

Strombus Gallus.	Lucina incrassata. Lam.
Kanilla gigantea.	Turritella incrassata. Crag. Min. Con. 51.
Dentalium sexangulare.	
striatum.	Pleurotoma Colon, var. M. C. 146.
Pleurotoma Colon.	Natica tyrena ?

For the identification of the vertebræ and teeth, I am indebted to the kindness of Mr Clift.

ceous ingredient forming the lower part of the deposit at the latter town, and the upper or superior portion at Alaurin. Dentalia, *Triton nodiferum*, Ostrea, and Natica, are found at each locality. The Pecten pleurenectes, so abundant at Malaga, I did not find at Alaurin, nor the Venus, which abounds in the deposit at Alaurin, in that at Malaga; nor in the latter any shark's teeth, or vertebral remains of delphinus. Before I conclude the description of this lower group, I think it necessary to allude to the difference in level between the beds at Malaga and Alaurin el Grande. At the former locality, the strata are not more than 50 feet above the level of the Mediterranean, while at the latter they are at the height of 900 or 1000 feet. This difference of level, I conceive, is connected with the highly crystalline character of the limestone of the ridge on which the tertiary beds rest, and the subjacent mass of serpentine which occurs at the N. N. W. end of the ridge, or Sierra de Mijas.

2d or Superior Group (see Sect. 1. and 3. Pl. II.)—In the higher and undulating part of the little tract first alluded to contiguous to Malaga, there are several low eminences (2. 2. 2. in sect. 1), where the horizontal bed of sandy loam and marl, and the masses of conglomerate that belong to this group, are well seen. The immense size of the ostreæ found in these beds is worthy of attention (*Ostrea crassissima?* of Lamarck), and particularly when compared with the small ones met with in the subjacent or lower part of the tertiary deposit. The predominating shells, however, are pectens of various undescribed species, but very similar to those now found along the Mediterranean shore. The balanus is also frequently found in these beds. As the argillaceous deposit of the group 1 A is at a considerably lower level than these beds, and as it is seen forming the left bank of the Guadamedina Rio that bounds this tract towards the west, I presume that it extends under the beds of the second group, and has once filled up the whole of the area under consideration. The section 3. (Pl. II.) of ground on the opposite or western side of the Rio Guadamedina will also, I believe, prove its subposition, although I have never seen an instance where the beds of group 2. overlie the deposit or group 1. Each group, however, appears to be distinguished by peculiar or characteristic organic remains.

The shelly conglomerate masses that belong to this group are often seen in the form of short interrupted projecting banks, one of which may be observed near a path road that leads from Malaga to a high hill called El Cerro de los Angeles, about a mile from the town. But the principal conglomerate beds exist several miles up the valley of Malaga, first, near the village of Alaurinejo, on the road to Alaurin el Grande, and secondly, in the vicinity of the villages of La Pirrara and Arola. A hilly band of this conglomerate, in which tertiary shells are met with, extends from near Alaurinejo to the south-eastern end of the Sierra de Cartama (a short insulated ridge of transition rocks in the central longitudinal course of the estuary of Malaga). About a mile distant from it, the argillaceous deposit of group 1. forms the banks of a deep ravine at a much lower level than this conglomerate band, and thus brings nearly into contact the two groups of the tertiary formation, so as to prove their order of superposition. In the high insulated hills of conglomerate near La Pirrara and Arola, I did not observe any organic remains, but the superposition of these beds to the argillaceous deposit of group 1, which may be seen near La Pirrara, countenances the belief that they belong to the superior portion of the tertiary formation in the neighbourhood of Malaga. (See Section 4. Pl. II.)

The argillaceous deposit, or group 1, of the tertiary beds, has been noticed at Alaurin el Grande. Zoological evidence exists to prove that the superior beds of this formation, or those belonging to group 2, have also extended as far as this village. Ostreæ in great abundance, of the same extraordinary size, and with similar long hinges as those stated to be found in the upper tertiary beds near Malaga, are met with close to Alaurin el Grande on the slope from the base of the Sierra di Mijos to the valley. They are seen in groups in the superior stratum of alluvium about a mile to the east of the village, and it is evident, from their high state of preservation and their position, that they belong to a deposit superior to, and more modern, than that in which the various marine remains described were discovered at about an equal distance to the west of Alaurin. In several of the small islets along the coast to the east of Malaga, as well as on the banks of some of the ravines by which torrents in the rainy season descend to the Mediterranean from the contiguous mountainous district, small patches belonging to the superior portion of the tertiary formation, or to group 2, may be observed.

About a mile from Malaga, on the Velez-Malaga road, there is a little inlet or ravine called La Caleta, which forms the bed of a stream that descends from the mountainous country towards the north, and here enters the shingle of the Mediterranean shore. Proceeding up this ravine for a few hundred yards, its low banks being first of all composed of detritus, with an occasional projecting rock of greywacke, a path leads from it to an old fort constructed on a hill at a short distance from its left bank. The bank at this point, little elevated above the bed of the ravine, is formed of gravelly sandy marl, containing pectens. Fifty yards up the ascent towards the fort, a mass of sandy marl is observed full of pectens, balani, and fragments of ostreæ. This mass takes in places a conglomerate character, from an admixture of fragments of different rocks consolidated in the former by a ferruginous cement, and contains similar shells, but they are generally broken. Tertiary beds were not observed higher up than this point, the path in the ascent beyond the fort getting upon secondary red sandstone crowned by nummulite limestone. Descending to and proceeding higher up the ravine, a little circular basin is soon reached, filled up with a deposit of yellowish sandy marl full of tertiary organic remains, bounded on one side by the high hill upon which the castle of Malaga stands, and on the other by a still higher hill termed El Cerro de San Cristobal. In an escarpment this low tract forms to the ravine testaceous remains in abundant, and in an excellent state of preservation, some of them partially retaining their colour. The predominating shells are small pectens, but a Dentalium, a Trochus, and some fragments of ostreæ were also collected.

The road from Malaga to the point where this ravine was entered, is bounded towards the north by the hill upon which its old castle stands, and towards the south by the beach of the Mediterranean. In passing this road, which leads to Velez-Malaga, and for the next two miles is confined towards the north by a hill composed of red sandstone, containing a thick bed of gypsum, resting upon greywacke, and capped by secondary nummulite limestone, a considerable semicircular open space is crossed that slopes down from the more retired mountainous district to a horizontal flat contiguous to the shore. In the higher part of this open tract several patches were observed, composed of beds of soft marly sandstone, and of arenaceous marl, full of pectens; but they are insulated, and without continuity for more than twenty or thirty yards. Another patch of the upper tertiary deposit was observed in ascending from this tract to the Convento San Anton, situated at the base of a high hill of nummulite limestone, characterised by two projecting peaks. This is the most elevated patch of the tertiary formation I have met with in the immediate neighbourhood of Malaga, and it contains many perfectly preserved shells of the Cardium genus, identical with those now found in the land of the Port of Malaga. The section 5. Pl. II. will give an idea of the situation of this fragment of tertiary origin, the line of section being nearly from south to north, and intersecting, in the first part of its course, a group of hills called Los Cantales, formed of nummulite limestone, resting upon red sandstone, in which the open tract above alluded to terminates towards the east.

In this patch-like manner little fragments of the tertiary order continue to be seen along the line of coast between Malaga and Velez-Malaga, on the slope of the mountainous district to the Mediterranean shore; but, before reaching the latter town, which is twenty miles distant from Malaga, there is a more continuous little tract belonging to this formation which will soon be noticed.

The last locality in the vicinity of Malaga I shall cite, where beds belonging to this superior part of the tertiary formation, or to group 2, have been observed, is about two miles from the town, up the Rio Guadamedena, and they may be traced for a couple of miles farther into the mountainous district towards the north. They appear to be the discontinuous prolongation of those stated to form the higher part of the tract contiguous to Malaga, where excavations have been made in the subjacent argillaceous deposit for brick-earth, and contain ostreæ, balani, and pectens, like the former.

In terminating this slight notice of the tertiary formation in the vicinity of Malaga, it is important to mention, that the sea, for many years, has been retiring from the line of coast. Within the memory of men now living, vessels anchored where a portion of the town of Malaga, and its beautiful Alameda, bordered by two lines of splendid houses, are situated. The site of the old sea-gate, El Puerto del Mar, and parts or fragments of the Moorish wall, formerly washed by the waters of the Mediterranean, are still more retired from the present shore.

Velez-Malaga.—In following the coast-road easterly from Malaga, this is the first little town met with, at the distance of about twenty miles from the former. Five miles before reaching Velez-Malaga, the road passes a fort called El Castillo del Marquez, built upon the beach, between which and the mountainous district towards the north, there is a little low intervening tract belonging to the tertiary formation. The beds that form it consist of a hard quartzose sandstone, often taking a conglomerate character, and abounding in pectens, fragments of ostreæ, balani, and some other shells, which is quarried, and supplied the material for building the great mole at Malaga. Other tertiary beds near Velez-Malaga are made up of sand and comminuted shells loosely consolidated together, shelly conglomerate and sandy loam.

Pursuing the road to Velez-Malaga, a group of mica-slate hills, which here come down to the beach, is crossed, after which the latter is bordered for some distance by a considerable and high eminence, formed of tertiary beds, from whose summit there is a long gradual slope inland, or towards the north. Along a sort of hollow, consequently, formed between this tertiary eminence towards the south, and the mountainous district of mica-slate, progressively increasing in elevation towards the north, the road proceeds towards Velez-Malaga, and at a point where it makes a bend, and commences its descent to the Rio de Velez, a curious instance of the immediate contact of two varieties of conglomerate rocks of very different ages and composition was observed, which seems to argue the very modern date of the uppermost or superior tertiary beds, or of group 2, along this line of coast.

The under portion of the escarpment consists of an indurated earthy argillaceous conglomerate, made up of fragments of mica-slate, talcose and other slates and quartz, in which there is not a single shell; while the upper part of the escarpment rests upon the conglomerate of old rocks, composed of a loamy mass, with rounded pieces of tertiary sandstone, pebbles, and numerous tertiary shells, mostly Pectens, Chamæ, Balani, and fragments of Ostreæ. To the right, or towards the south, is the last part of the slope of the high tertiary hill alluded to.

This hill, which occupies a considerable area, and stands insulated along the coast line, rises to the height of about 250 feet above the level of the sea, and is something less than a mile distant from the shore, to which it presents a high and singularly water-worn escarpment, worked out into recesses, caverns, and overpending rocks, of the most grotesque and capricious forms. It is composed of thick horizontal beds of comminuted shells, mixed with quartz-sand, occasionally passing into conglomerate, and alternating with others of sandstone conglomerate. The quantity of shells that have entered into the composition of this mass is immense, but they have been so triturated that few entire ones can be collected. Those I was able to obtain are a large Chama, small Pectens of various sizes, a *Cardium edule*, Balani, and fragments of Ostreæ.

The slope of the hill terminates towards the north in a waving and gradually rising district of primary slate, upon which, inland, no further vestige of these tertiary deposits is observed.—(See Sect. 6. Pl. II.) Towards the east, it also presents considerable escarpments, from the base of which there is a rapid slope to a cultivated flat along the right bank of the Rio de Velez. On the opposite or left bank of this stream, there is a low open undulating tract, which has the appearance of having been, at some ancient epoch, a semicircular port or bay, surrounded by an amphitheatre of primary mountains. In this tract is situated the ancient town of Velez-Malaga, about one mile from the Rio de Velez, and three miles from the Mediterranean. The general cover of this open area is composed of alluvium, but the subjacent mica-slate occasionally projects into little hillocks, and a few small patches of tertiary origin were observed. The tract is termed the Vega or Valley of Velez, and it is one of the favoured spots along the southern Mediterranean coast of Spain. Protected from the winds by its amphitheatre of mountains, which gradually rise towards the north to the height of 8000 feet above the level of the sea, and irrigated by the waters of the rivulet above alluded to, vegetation assumes all the rapidity and luxuriance of meridional climates; and little woods of olive trees and fields of the finest wheat, alternate over its undulating surface with groves of the orange-tree and plantations of the sugar-cane, surrounded by fences of the bamboo, the aloe, and the nopal. The harvest of the sugar-cane was about to commence on my passing through Velez-Malaga in the month of February 1832—the Sierra de Tejeda, not twenty miles distant towards the north, but the highest mountain in this portion of the Sierra Nevada chain, was clothed in snow, and presented a singular and interesting contrast *.

In following the Mediterranean coast from Velez-Malaga eastward, few or no well characterized tertiary beds are observed until we arrive in the neighbourhood of Almeria, primary or transition slates immediately bordering the shore as far as Adra, with the exception of two little alluvial inlets or creeks cultivated with the sugar-cane, in which the seaport villages of Nerja and Almuñejar are situated, and a more extensive flat surrounding the town of Motril. The large low horizontal tract or bend near Motril is formed of a sandy loam, cultivated principally with the cotton plant, with a few interspersed sugar-cane plantations. This deposit may perhaps be partially of tertiary origin, but no regular beds nor shells were observed. In all these instances, the immediate subjacent rock is mica-slate, or some variety of transition slate.

It may be remarked here, that the mica-slate in all the interval between Velez-Malaga and Almuñejar is characterized by the presence of andalusite, generally imbedded in highly crystalline glassy quartz. I collected some beautiful crystals of this mineral, as well as a few of kyanite, in the neighbourhood of Almuñejar.

* Mr Deshayes identified Pecten benedictus and a Pecten, nov. spec., which is also found at Perpignan, among the fossils from Velez-Malaga.

From the little seaport of Adra, in the centre of which a group of highly inclined mica-slate may be observed, celebrated in the day for its extensive establishments connected with the lead trade, to the village of Roquetas, twenty-five miles distant, the Mediterranean is bounded by an open flat tract, between three and four miles broad, which terminates, to the north, in the bold escarpments of the Sierra de Gador, formed of transition limestone, containing the richest veins of lead-ore in Spain. It was an incessant rain when this barren tract was crossed, and the atmosphere so thick and foggy that no satisfactory observation could be made. Irregular beds of conglomerate, forming a sort of superficial incrustation, and sandy argillaceous loam, generally constitutes the superstratum; and on once approaching the coast, in consequence of having lost the road, some sandstones, which appeared modern, but in which I could perceive no shells, were remarked.

Roquetas is a very wretched little fishing village, possessing but one good house, in which I was fortunately lodged, and most hospitably received. My landlord informed me that a month rarely passed without some slight shock of an earthquake being experienced; the sea being often so violently agitated in consequence that boats ready to sail for Almeria were obliged to delay their voyage for several hours.

The road from Roquetas to Almeria crosses the south-east portion of the Sierra de Gador, to which it ascends by a pass or puerto, from the easterly termination of the open tract just noticed. In some little escarpments of the dark blue semicrystalline limestone of this mountain, at the base of the puerto, the strata run nearly from east to west, and dip to the north at 23°. Hence to Almeria is about ten miles, for eight of which the road is continually upon the limestone rock that forms the Sierra de Gador; but about two miles before reaching this pretty little seaport town, at a point where a bridge is crossed and there is a redoubt perched on a rock overhanging the sea, the tertiary formation again appears with the character of a whitish earthy coarse limestone, or fine calcareous conglomerate, containing minute rounded fragments of the subjacent dark-blue transition limestone. The organic remains collected in this tertiary calcareous deposit, which appears to form an unstratified mass, are large and small pectens, cardia, balani, and fragments of ostreæ. From this point it may be followed continuously to Almeria, whose ancient extensive castle is built upon an eminence it forms within the walls of the town on its northern side; but it does not extend inland above two or three miles, constituting a hilly broken tract, two or three hundred feet above the level of the sea, along the eastern slope and base of the Sierra de Gador. In a long subsequent descent to Almeria, an older conglomerate rock, of a dark brown colour, with numerous large and small fragments of transition limestone, is observed to come out from under the tertiary deposit, and shortly after the fundamental limestone of Gador makes its appearance from under the conglomerate.

The fundamental limestone is much decomposed, and of an ochreous tinge; but a few undecomposed strata of a dark grey colour alternate with the former in a little escarpment bordering the road, and dip to the north at 30°. It would appear from the above fact, analogous to what was noticed near Velez-Malaga, that an alluvion had been formed upon the surface of the transition limestone of the Sierra de Gador, previous to the epoch when the tertiary deposit took place.

Almeria.—This is one of the most agreeable, cheerful, little seaport towns along the southern Mediterranean coast of Spain, containing about 12,000 inhabitants. To the east of Almeria there is an extensive flat bordering the Mediterranean as far as the Cabo de Gata, distant about eighteen miles, when the coast line, winding round towards the north, is bounded as far as the village of La Carbonera by a ridge of volcanic rocks, partially concealed in the latter part of its course under tertiary deposits. This open tract, contiguous to Almeria (see section 7. Pl. II.), rises gradually and in step-like manner towards the north, terminating at the southern base of a mountainous district termed La Sierra de Alhamilla, composed of mica-slate. Towards the west it is bounded by the Sierra de Gador. Probably the whole of this tract, which chiefly consists of sandy, marly, argillaceous loam, capped irregularly, as it approaches the mountainous district, by thin beds of conglomerate, are of modern origin: however this may be, indisputable proofs of the epoch to which a portion of it at least belongs, may be seen near the base of the Sierra de Gador, and on the road from Almeria to Guadiz, a city in the province of Granada about fifty miles inland towards the north from the former seaport. This western part of the tract is filled up variously with a coarse quartzose reddish sandstone, often taking a conglomerate character; loose and semi-indurated gravel; and earthy and indurated argillaceous marl; in all of which, except the last, the usual tertiary shells are observed; pectens*, balani, fragments of ostreæ, and echinital spines, existing in great abundance in the gravelly beds. The argillaceous and superjacent gravelly beds dip towards the west south-west at an angle of about 20°, which would apparently carry them under the unstratified tertiary calcareous deposit noticed on approaching Almeria from the west, and upon an eminence of which its old castle is situated. How far these tertiary beds may be traced inland, up a sort of fissure or irregular valley in the chain of mountains that border the Mediterranean, extending from Almeria to Guadiz, or from S.S.E. to N.N.W., will be ascertained by future inquirers; I followed them about four miles inland on this line.

Before leaving Almeria, I may perhaps be allowed to observe, that the Mediterranean Sea has apparently, at some remote epoch, washed the base of the primary Sierra de Alhamilla, in which the low tract to the east of this town terminates towards the north, as to the west of Almeria the same sea has advanced to the foot of the bold escarpment of the transition limestone of the Sierra de Gador, which confines towards the north the long open tract along the Mediterranean shore from Adra to Roquetas. These two tracts have probably been elevated and added to the mainland by some of those subterranean agencies, whose power has been manifested from immemorial time, and is so frequently felt at the present day, in this part of Spain.

(To be continued.)

* Mr Deshayes identified,

Pecten benedictus Pecten dubius Pecten striatus	from Almeria.

CHARACTERS OF NEW OR LITTLE KNOWN GENERA OF PLANTS.

By *Robert Wight*, Esq. M. D. F. L. S. Hon. E. I. C. S., and G. A. *Walker Arnott*, Esq. A. M. F. R. S. E. and L. S. Communicated by the Authors.

(Continued from p. 181.*)*

[The following communication on *Lepidadenia* and *Horygryza* is from our friend Professor Nees von Esenbeck of Breslaw, April 8. 1833. We prefer publishing it in the original Latin, although our wish is in general to give the remarks in English :]

" In Wallichii viri clarissimi Catalogo, p. 79, n. 2587, *Lauri* species enumeratur *Macranthæ* nomine appellata, eidemque in Supplemento, p. 239, sub eodem numero lit. B adscribitur arbor, quam ill. Wightius in Neelgherry legit. Illam autem *Laurum macrantham*, primo loco relatam, quam in eadem cum Wightiana E. Notan invenit regione, Wallichiusque noster *Lauro semecarpifoliæ* similem esse docet, l. c., inter plantans Laurineas curis meis olim ab amico commissas non inveni, quo factum est, ut in Synopsi Laurinearum Indicarum, ' Plantarum rariorum' secundo volumini insertæ, silentio præterire istam speciem necesse esset. Hunc autem clariss. Wightii benevolentia specimen videre contigit ex illorum saltem numero, quæ posteriori loco, littera *B* inscripta, adnotavit Wallichius. Quod cum accuratius observarem, non solum sui juris esse speciem didici eamque ab omnibus, quotquot vidi, characteribus luculentissimis diversam, sed et alia quædam in eadem deprehendi, quæ generis proprii altiora discrimina nisi omnino probare, indiciis saltem prodere haud spernendis videbantur. Quæ vidi, fideliter jam enarrabo; imponam nomen genericum; rem omnem autem dijudicandum iis relinquam, quibus meliora completioraque aliquando videndi specimina et fructuum naturam explorandi oblata fuerit occasio. Nomen '*Macranthæ*,' Notanianis illis speciminibus ab illust. Wallichio impositum, donec Wightiano quod coram est, illorum aliquod componere liceat, in re tam difficili suspendere, quam incautius, si forsitan hæc atque illa diversæ fuerint arbores, transferre in alterum malui.

Gen. 9. LEPIDADENIA, *Nees ab Esenb.*

Lin. Syst. DODECANDRIA MONOGYNIA.
Ord. Nat. LAURINEÆ, *Juss.*

Hermaphrodita (?) *Perianthium* 6-partitum. *Stamina* 12, quorum 6 interiora a tergo laminis geminis sessilibus obvallata. *Fructus* non notus.—Inflorescentia *umbellata;* umbellis *involucratis, pedunculatis.*

Est genus, inter *Dodecadeniam* et *Tetrantheram* versans, flore pro familia eximio, diversum ab utroque illorum generum laminis petaloideis planis obtusis subsessilibus, loco glandularum terga staminum interiorum stipantibus, ita ut seriem quasi exhibeant petalorum, stamina 6 exteriora ab interioribus separantium. Quod ad partium numerum proxima igitur accidit *Dodecadeniæ,* sed quod ad inflorescentiam, *Tetrantheræ* est propinquior; hæc autem, ubicunque perfecto hexasepaloque guadet flore, nunquam pluribus quam novem staminibus est prædita, glandulisque senis. Accedit florum amplitudo quædam, et foliorum singularis in hoc ordine obliquitas, plure forsan et alia, quæ tempora futura docebunt.

1. L. *Wightiana, N. ab E. in Prod. Fl. Penins. Ind. Or.* (ined.); *Wight. Cat.* n. 944.—Tetranthera macrantha, *Wall. List of E. I. Plants,* p. 239, N. 2587, *b.*
Hab. In montibus 'Neelgherries' dictis; *D. Wight.*

Folia adsunt et ramuli particula cum racemulo umbellularum. *Cortex* fuscus, pubescentia subtilissima rarissimaque conspersus. *Gemma* inter folium et pedunculum stipitata, capitulo ovato acuto angulato subtiliter strigiloso. *Folium* majus 10 pollices longum; minus 6½ pollicum est; unum 3, alterum 3¼ pollices latum, utrumque ex ovato oblongum, obtusum cum mucrone, basi cuneatim acutum, obliquum, altero latere infra medium productiori et quasi in angulum obtusum elevato, reliquo ambitu leniter repando. Supra lævissima sunt folia et nitida, subtus a pubescentia subtilissima appressaque veluti sericantia et opaca; substantia chartaceo-coriacea. Rami costales plures (12–16) tenues, subsimplices, reti interjecto obsoleto; costa media subtus prominens, lata, sulcata. *Petiolus* brevis, crassus; supra depresso-canaliculatus, subtiliter puberulus. *Pedunculus* axillaris, 1¼ poll. longus, erectus, crassus, tomentoso-strigilosus, angulosus, inferne subquadrangulus, prope a basi florens. *Umbellulæ* racemosæ, brevissime pedicellatæ, 5-floræ; alabastrum globosum, pisi magnitudine. Involucri foliola (4 ?) subrotundal strigiloso-tomentosa, grisea. *Flores* breve-pedicellati, 3 lineas lati, patentissimi; laciniæ subæquales, ovales, obtusæ, obsolete trinerves, confertim minutimque pellucido-punctatæ, extus pubescenti-strigilosæ. Faux hirsuta. *Stamina* 12, quatruplici serie, centrum versus decrescentia; exteriora 6 perianthio duplo fere longiora; filamenta linearia, hirsuta; antheræ lineari-oblongæ, quadriloculatæ, omnes introrsum dehiscentes, loculis oblongis, duobus superis paullo minoribus, inferioribus magis lateralibus. Intimi circuli antheræ duplo minores reliquis, subovatæ, uno alterove loculo sæpe abortiente. *Glandulæ* 12–15, per paria circa basin staminum interiorum dispositæ, intimisque saltem eorum evidenter a tergo incumbentes; exteriores autem modo minus regulari distributæ, filamenta interiora longitudine subæquantes, ovales, compressæ, oblique truncatæ et rotundatæ, pleræque sessiles, nonnullæ brevissime unguiculatæ, glabræ. *Pistillum* longitudine staminum interiorum, glabrum; *ovarium* lanceolatum, in stylum crassum brevemque abiens; *stigma* latum, irregulariter lobatum (?) Forsan abortivum exstat in nostris speciminibus pistillum. Fructus latet.—Quod ad habitum in universum accedit hæc species *Tetrantheræ semicarpifoliæ*, et si sui generis novi typus non arrideat, hic eam illi vicinam ponat, necesse est. Differt autem *Tetradenia* illa *semicarpifolia* a *Lepidadenia* nostra, floris structuram ut taceam: foliis non obliquis, evidenter venuloso-reticulatis magisque hirtulis, pedunculis umbellularum longis pedunculoque communi gracilibus, umbellulis minoribus nutantibus.

HYGRORYZA, *N. ab E.*

Lin. Syst. TRIANDRIA DIGYNIA.

Ord. Nat. GRAMINEÆ, *Juss.*

Spiculæ unifloræ, hermaphroditæ; superiores ramificationum inflorescentiæ sæpe abortivæ. *Glumæ* duæ subæquales, chartaceo-membranaceæ; interior caudato-setigera; superior acuta (nervis raucioribus, quam infera, prædita). *Flosculus* unus univalvis; valvula brevissima tenerrima, apice dentata, genitalia amplectens. *Lodiculæ* nullæ. *Stamina* 3, filamentis capillaribus; antheris linearibus, utrinque bifidis. *Ovarium* lineari-oblongum, stipitatum, compressiusculum: *stylus* ad basin fere bifidus; *stigmata* crassa, plumosa, ramulis pinnatis. *Caryopsis* subcylindrica, compressiuscula, lævis, altero margine sulcato angustissimo insculpta, pedicellata, mucronata.

Inflorescentia: racemuli *aliquot approximati, subfastigiati et quasi digitati, a basi florentes, oligostachyi.* Spiculæ *solitariæ, pedicellatæ, quam pro statura plantæ grandiores, pallidæ.*

Genus proximum sane *Zizaniæ*, ejusdemque tribus, ac ista, sed notis allatis evidenter distinctum, multoque magis etiam habitu proprio. Valvulam flosculi, sive glumellam, nec lodiculus esse involucrum illud florale interius exiguum, inde patet, quod stamina intra fines ejus, nec extra nascuntur. Monendum autem, hoc singulari casu transitum quendam ab involucris floralibus e vaginarum ordine (glumellis ad perianthia rudimenta (lodiculas) palam fieri.

1. H. *aristata, N. ab E. in Prod. Fl. Penins. Ind. Or.* (ined.)—Pharus aristatus, *Retz Obs.* 5. p. 23 (descr. opt.); *Willd. Sp. Pl.* 4. p. 397; *Kunth Syn.* p. 10; *Wight Cat. Gram.* n. 218.

Gramen vix semipedale, basi repens natansve, radiculis pinnatis. *Rami* adscendentes, ad inflorescentiam usque vaginati. *Folia* pollicem unum longa, 3½–4 lineas lata, basi rotundata vel subcordata, oblongo-lanceolata, obtusa cum mucrone obsoleto, striata, glauca, rigidula, in ambitu paginæ superioris tuberculis exasperata, in sicco nostro exemplo apice sæpe fissa.

Racemuli in apice culmi vaginato 4–5, ½–¾ poll. longi, graciles, patuli, scabriusculi. *Spiculæ* 3–4, alternæ, cum caudis 7–8 lineas longæ, oblongæ, compressæ, altero margine rectiusculo. *Glumæ* cum pedicello, 1–1½ lineas longo, basi confluentes; inferior major, in caudam rigidam rectam, ipsa glumali parte longiorem, extenuata, alte et curvatim carinata, 5-nervis, nervis in carinas elevatis et setoso-hirsutis; superior gluma 3 lineas longa, lanceolata, acuta, 3-nervis, 3-carinata, carinis simili modo hirsutis. *Valvula* florem a latere, glumæ superiori opposito, cingens, altitudine fere ovarii, tenerrima, apice truncata et emarginato-angulata, enervis (?). *Filamenta* pistillum æquantia, capillaria; *antheræ* pro filamentorum proceritate breves. *Stigmata* valida, valde plumosa, ramulis iterum plumulosis, superiora versus confluentibus. *Caryopsis* 2 lin. longa, distincte pedicellata, fere teres et subcylindrica, mucrone a styli basi residuo bidentato coronata, leviter substriata, fusca, latero latere linea depressiuscula pallida inscripta.*

(To be continued.)

Description of several New or Rare Plants which have lately flowered in Gardens in the neighbourhood of Edinburgh, but chiefly in the Royal Botanic Garden. By Dr Graham, Professor of Botany in the University of Edinburgh.

10th Sept. 1833.

Fritillaria minor.

F. *minor;* caule inferne nudo, subunifloro; foliis sparsis, linearibus, canaliculatis; flore subtesselato, petalis exterioribus oblongis, interioribus latioribus obovatis.—*Ledebour.*

Fritillaria minor, *Ledeb.* Ic. Pl. Fl. Ross. Alt. 2. 12. t. 130.—*Ibid.* Fl. Altaica, 2. 34.

Fritillaria meleagroides, *Patrin,* in Schult. Syst. Veget. 7. 395.

Description.—*Bulb* subrotund, white, about the size of a small hazel nut, with many slender roots from its base. *Stem* (in my native specimens from 7 inches to 1 foot high, in the cultivated specimen 1 foot 10 inches) erect, simple, single-flowered in my native specimens, and almost always so in such, according to Ledebour, in the cultivated 3-flowered, pruinoso-glaucous, brown and speckled towards its base, obscurely three-sided, naked for a considerable way above the base. *Leaves* scattered, smaller upwards (in native specimens 4–5, the lower 3 inches long, in the cultivated 7, the lower 6 inches long), lanceolato-linear, channelled along the upper surface, blunt, suberect, pruinoso-glaucous, half stem-clasping. *Flowers* (13 lines long, 10½ lines broad) generally solitary in the wild plant, 1–3 in the cultivated, springing from a common point at the top of the stem between two subopposite leaves, and provided with

* E Panicearum tribu novum genus prodiit, *Coridochloa* ampellatum, cujus typus est *Panicum cimicinum* Retz. Proximum hoc est genus *Anthenanthiæ* P. de B., sed distinctum spicula biflora et flosculo fertili setigera. Neutro flosculo valvula superior deest, vel potius transitu in lodiculas *ex transverso oppositas* lanceolato-acuminatas complicato-carinatas. De quo alio tempore seorsim acturus sum.

peduncles (above 2 inches long), nodding, dark blood-red, obscurely tesselated, pale, more yellow and more distinctly variegated within, nectaria linear; outer petals oblong slightly spreading at the apices, inner broader obovate connivent at the apex. *Stamens* subequal, about half the length of the corolla; filaments subulate, slightly dilated at the base, and very sparingly glanduloso-pubescent; anthers oblong, yellow; pollen granules small, oblong, yellow. *Pistil* rather longer than the stamens; stigma tripartite, erecto-patent, green; style triangular, cleft to about its middle, the stigmatic surface extending along the inside of the segments; germen of uniform diameter from end to end, distinctly grooved along the angles, and more obscurely along the sides; ovules very numerous, 2-rowed in each cell.

This plant was obtained by David Falconar, Esq. from Mr Goldie, who brought it from Russia. It flowered in the garden at Carlowrie, in the beginning of May, the same season in which it was found by Ledebour to flower in its native stations in Altai. It varies a little in the wild state. I have native specimens both from Dr Fischer of St Petersburg and from Ledebour. The former are smaller, but the flower is larger, and the leaves, which are longer and narrower, are collected nearer to the flower. Even in a wild state, it appears from Ledebour that occasionally, though rarely, there are more flowers than one on the stem, and the two lowest leaves are sometimes subopposite. I cannot but think that this plant scarcely differs more from *F. meleagris* than some of the acknowledged varieties of this species. The great length of the pendulous part of the stem or peduncle, which Ledebour considers characteristic, and which is figured in his beautiful illustrations of the Flora Altaica, is not possessed by my native specimens, nor by Mr Falconar's plant, and the flower in the figure is much less lurid, and longer in proportion to its breadth, than in any of these.

Leontice altaica.

L. *altaica;* folio caulino solitario, petioli a basi tripartiti ramulis segmenta 5 oblonga integra subpetiolulata palmatim disposita gerentibus —*Ledebour.*

Leontice altaica, *Pall.* Act. Petrop. 1779, p. 257. t. viii. f. 1, 2, 3.—*Willd.* Spec. Pl. 2. 149.—*Pers.* Synops. 1. 386.—*De Cand.* Syst. Nat. ii. 26.—*Ibid.* Prodr. 1. 110.—*Spreng.* Syst. Veget. 2. 121.—*Schult.* Syst. Veget. 2. 22.—*Ledebour*, Fl. Altaica, 2. 52.—Bot. Mag. 3245.

Description.—*Root* tuberous. *Stem* erect, succulent, green, purple at the base. *Leaf* solitary, petioled, petiole 3-partite, segments spreading, each bearing upon its summit five elliptical, glaucous, unequal leafets, on partial petioles, particularly the largest, and those adjoining it. *Raceme* terminal, deflected, about 12-flowered; *bracteæ* large, obovate, the lowest rotundato-reniform, pedicels spreading, single-flowered, twice the length of the bracteæ, farther elongated and cernuous when bearing the fruit. *Flowers* yellow. *Calyx* of six spreading elliptical leafets. *Petals* 6, yellow, opposite to the leafets of the calyx, erect, semicylindrical, truncated, bi-aristate at the apex, about half the length of the calyx. *Stamens* 6, yellow, opposite to the petals, and longer than them; anthers bilocular, opening by the sides folding upwards to the apex, where they adhere to the connective. *Stigma* small, simple. *Style* short, angular. *Germen* inflated, membranous, unilocular. *Ovules* four, obovate, green, erect from the base of the germen, and afterwards exposed by the rupture of its apex.

This very pretty plant was received by Mr Falconar from Mr Goldie, and flowered very freely in a cold frame at Carlowrie in April. It is a native of the Altai Mountains, towards the western part of which, it appears from Ledebour, it is most abundant, flowering early in spring, while, in the eastern part, it was not observed. According to Ledebour, it does not differ from *Leontice Odessana.*

In a most valuable collection of Ledebour's plants which I possess through the inexhaustible kindness of my friend Mr Hunneman, I have a specimen illustrating the singular appearance occasioned by the protrusion of the unripe seeds through the ruptured membranous capsule.

While this sheet was in the press, the excellent figure by Mr James Macnab of the specimen described, with dissections by Dr Hooker, appeared in the Botanical Magazine.

Libertia crassa.

L. *crassa;* caule subcompresso, flexuoso, pruinoso; floribus capitatis, capitulis multifloris, terminalibus lateralibusque, inferioribus pedunculatis, superioribus sessilibus; perianthii segmentis exterioribus ovato-ellipticis subherbaceis subcarinatis, interioribus subemarginatis cordatis; staminibus monadelphis; foliis margine exteriore minutissime serrulatis.

Description.—*Root* throwing up many crowns and flowering-stems. *Leaves* (6–14 inches long, half an inch broad at the base) sword-shaped, strongly nerved, the inner edge towards the base sheathing membranous and glabrous, above this slightly scabrous, the outer edge very minutely serrulate, the serratures being only visible under a pretty high magnifying power. *Stem* (1 foot 9 inches high) suberect, flexuose, stout, subcompressed, pruinose, each angle bearing a sheathing leaf-like spathe, which contains a single many-flowered capitulum, peduncled at the lower part of the stem, sessile above, external spathes gradually diminishing upwards, till they pass into the form of the internal, which are numerous, membranous, withering. *Flowers* on short pedicels. *Perianth* rotate, the three external segments subherbaceous, sessile, ovato-elliptical, blunt, the three internal (9 lines long, 7½ broad) twice the length of the external, and more than three times their breadth, pure white, cordate at the base, clawed, blunt or emarginate at the apex, with a conspicuous diaphanous middle rib, and faint diverging lateral veins. *Stamens* monadelphous; filaments white, diverging a little, shorter than the inner, longer than the outer segments of the perianth; anthers large, incumbent, yellow, cleft at the lower end, lobes parallel, bursting along their sides; pollen granules very minute, oblong, yellow. *Stigmata* minute, terminal. *Style* trifid for about two-thirds of its length, the lower part round, and insheathed by the cohering portion of the filaments, segments diverging between the stamens, angular, and each larger than the united portion. *Germen* green, glabrous, 3 sided, equal in length to the pedicel, and shorter than the outer segments of the perianth.

This was received, like the other species of the genus here described, at the Comely Bank Nursery from Mr Low of Clapton, and was, like it, imported from near Cape Horn by Mr Anderson. It is a much stronger plant than any of the other species with which I am acquainted, and flowered very abundantly in the open air. The flowers are larger, but in the present state of the plants, at least, this is less elegant than the next species. Bermudiana Narcisso-Leucoii flore of Feuillée, vol. ii. p. 9. t. iv. belongs to this genus, and is this, if either of the species now described; But I think it is different from both.

Libertia formosa.

L. *formosa;* caule folioso; foliis radicalibus caule brevioribus, margine lævibus; laciniis perianthii exterioribus ovatis, apice subherbaceis, carinatis, interioribus unguiculatis, cordatis, retusis, filamentis basi cohærentibus, fructibus flore minoribus.

Description.—*Root-leaves* (6 inches to 1 foot long, 2 to 4½ lines broad) equitant, every where glabrous, membranous at the edges of the sheath, linear-swordshaped, acute, nerved, the central nerve thicker and stronger than the rest; *stem-leaves* few (about 3) sheathing, smaller upwards (the uppermost 1½ inch long) in form and structure like the root-leaves, *Stem* (1 foot 4 inches high) simple, very slightly compressed, glabrous, light green, jointed at the origin of the leaves. *Flowers* capitate, pedicels light green, round, glabrous, outer spathe bivalvular, longer than the pedicels, membranous, repeated on the inner flowers, which expand in succession. *Perianth* superior, 6-partite, glabrous, rotate, tube none, outer segments small, narrow ovate and colourless at the base, concave, keeled and subherbaceous at the apex; inner segments (7 lines long, 6 lines broad) about twice the length of the outer, unguiculate, cordate, entire, very slightly crisped, retuse at the apex, somewhat fleshy or like white wax, with a distinct somewhat diaphanous middle rib, and very faint diverging lateral nerves. *Stamens* three, inserted into the base of the corolla, opposite to the outer segments, about as long as the inner; filaments like these segments pure white, erect, cohering for about a quarter of their length, above which they diverge a little; anthers yellow, incumbent, oblong, cleft at both ends, but especially at the lower, opening along the sides. *Stigmata* minute, terminal, capitate, colourless. *Style* white, single, shorter than the stamens, cleft into three to the point where the filaments cohere, segments diverging between the filaments, each thicker than the cohering part included within the sheath of the filaments. *Germen* inferior, oblong, triquetrous, green, glabrous, 3-locular. *Ovules* numerous, oblong, mutually impressed, fixed into a central placenta.

This species flowered beautifully in Mr Cunningham's nursery at Comely Bank, Edinburgh, in May, having been received from Mr Low at Clapton, who raised it from seeds imported from near the southern extremity of the continent of America by Mr Anderson. Its root forms a number of crowns, by which it no doubt may be propagated, and it probably will ripen seeds in the greenhouse.

This genus was separated from *Sisyrinchium* by Mr Brown, and the name of *Renealmia*, for a time suppressed by Smith, given to it; but as the genus *Renealmia* has been restored upon good grounds by Roscoe, it becomes necessary to adopt from Sprengel the appellation of *Libertia* for the genus of Brown, which is a most natural one.

Oxylobium ellipticum.

O. *ellipticum;* foliis ovali-oblongis, mucronatis, subverticillatis; bracteis infra apicem pedicelli caducis; capitulis terminalibus, racemosis, (leguminibus calyce duplo longioribus.—*Br.*)

Oxylobium ellipticum, *Br.* in Hort. Kew. 3. 10.—*De Cand.* Prodr. 2. 104.—*Spreng.* Syst. Veget. 2. 349.

Gompholobium ellipticum, *Labillard.* Nov. Holl. 1. 106. t. 135.

Callistachys elliptica, *Vent.* Malmais. 115.

Description.—*Shrub* erect; bark, on the stem brown, greenish and somewhat silky on the twigs. *Leaves* (1 inch long, 4½ lines broad) elliptical, mucronate, coriaceous, shortly petioled, dark green, reticulate, and glabrous above, somewhat silky below, reflected in the edges, subverticillate, four in each whorl. *Flowers* yellow, in terminal capitate spikes. *Bracteæ* single below the origin of each pedicel, and opposite a little above its middle, linear-subulate, caducous, silky. *Pedicels* spreading wide, silky. *Calyx* equal in length to the pedicel, bilabiate, upper lip of two approximated acute segments, lower of three spreading acute segments. *Petals* 5, nearly of equal length; standard concave, semicircular, crenate, slightly marked with orange in the throat, claw short; alæ elliptical, truncated at the base, claw very slender; keel of 2 petals, united in the middle, subinflated, each petal shaped like one of the alæ, but with rather a longer claw, and with a pouch projecting outwards and backwards near its base. *Stamens* hypogynous, included, free, filaments slightly compressed, anthers inserted by their backs, pollen yellow. *Style* ascending, exserted. *Stigma* small, blunt. *Germen* pedicelled, shorter than the stamens, silky. *Ovules* about 8.

Seeds of this plant were received at the Botanic Garden, Edinburgh, from Van Diemen's Land, through William Henderson, Esq. in February 1829, marked Prussian Shrub. The plant has been treated in the greenhouse in the usual way of New Holland shrubs, and in April last, when about three feet high, it flowered for the first time, every subdivision of its numerous branches bearing upon its apex a crowded bunch of flowers.

It appears from the Hortus Kewensis that the species was introduced from Van Diemen's Land by Mr Brown in 1805, but it seems to have been afterwards lost. The profusion of flowers with which it is covered, and the continued succession of these during a long while, renders it a very desirable species for cultivation.

Primula amœna.

P. *amœna;* foliis spathulato-oblongis, rugosis, crenato-denticulatis, hirsutiusculis, subtus incano-lanatis; umbellis multifloris, tomentoso-villosis, involucris subulatis; calycibus ovato-oblongis, angulatis; corollæ limbo plano glabro, tubo calyce vix longiore, collo hemisphærico.

Primula amœna, *M. Bieberst.* Fl. Taurico-Caucas. 1. 138.—*Lehman.* Mon. Prim. p. 39. t. 3.—*Roem. et Schult.* Syst. Veget. 4. 137.—*Spreng.* Syst. Veget. 1. 574.

Description.—*Leaves* (3½ inches long, 1¼ broad) spathulato-oblong, much attenuated towards the base, but scarcely petioled, crenate and denticulate, slightly hirsute and bright green above, densely covered with white wool below, neatly and regularly rugose; middle rib and veins very prominent behind, primary veins nearly at right angles to the middle rib and secondary veins, which latter are nearly equidistant, reticulated at the edge of the leaf. *Scape* (with the flowers 7 inches high) lateral, erect, tomentoso-villous; umbel many-flowered, involucre awl-shaped, pedicels erect, unequal (from half an inch to an inch long) pubescent. *Calyx* (4½ lines long) glanduloso-pubescent, pentagonal, ovato-oblong, 5-toothed, angles prominent and green, interstices membranous, diaphanous and purplish. *Corolla* very handsome, purplish-lilac in bud or recently expanded, more blue after a few days; tube scarcely longer than the calyx, purple, glabrous, wrinkled; faux hemispherical, slightly glanduloso-pubescent, and purple on the outside, yellow within; limb spreading, nearly flat, segments elliptical, emarginate. *Anthers* nearly sessile in the throat, yellow. *Pollen* yellow. *Germen* globular, glabrous, lobed. *Style* (in the specimen described, but, as in allied species, its length probably varies) twice the length of the germen. *Stigma* large, hemispherical.

This most desirable addition to the cultivated species of a universally admired genus, was obtained by Mr Neill from Mr Goldie, who brought it from St Petersburgh. It flowered beautifully in the cold-frame at Canonmills in April last, producing an umbel of eighteen perfect flowers. In its native station, the Caucasian Alps, it is described by Marschall Bieberstein, its discoverer, as having an umbel of from three to ten flowers; and a variety is noticed by him, in which the scape is awanting, the pedicels being all radical and single-flowered,—another analogy, if any were wanting, to confirm the opinion that there is no specific distinction between *Primula vulgaris* and *P. elatior,* our common Primrose and Oxlip.

Syringa Josikæa.

S. *Josikæa;* foliis elliptico-lanceolatis, acutis, ciliatis, rugosis, utrinque glabris, supra luridis, subtus albidis.

Syringa Josikæa, *Jacquin,* in Bot. Zeitung, 1831.

Description.—*Shrub* erect; branches spreading, very slightly warted, twigs purple. *Leaves* (3 inches long, 1¼ inch broad) elliptico-lanceolate, attenuated at both extremities, shining and lurid above, white and veined below, wrinkled, glabrous on both sides, ciliated, ciliæ short. *Panicle* terminal, erect. *Calyx*, like the pedicels, peduncles, rachis, petiole, middle rib of the leaf, and the branches, pretty closely covered with short glandular pubescence, 4-toothed, teeth blunt, and much shorter than the tube. *Corolla* (half an inch long) clavato-funnelshaped, deep lilac, glabrous, wrinkled; tube slightly compressed; limb erect, 4-parted, segments involute in their edges. *Stamens* adhering to about the middle of the tube; anthers incumbent, oblong, yellow. *Pistil* much shorter than the tube; stigmata large, cohering; style filiform, glabrous; germen green, glabrous, bilocular; ovules four.

This plant was received at the Botanic Garden from Mr Booth of Hamburgh in the end of October 1832, and flowered in the open border in the end of May and beginning of June. It seems therefore to flower later, and to remain longer in blossom than any of the species previously in cultivation, but does not equal any of them in beauty. As the name under which we received it was not legible, and as I had not seen it any where described, I proposed that it should receive the name of *S. Jacquinii*, from the botanist who first noticed it; but I have since received the above quotation from Dr Hooker.

CHEMICAL ANALYSES OF STRATIFIED ROCKS ALTERED BY PLUTONEAN AGENCY; AND ANALYSIS OF LARGO LAW BASALTIC ROCK AND WOLLASTONITE FROM CORSTORPHINE HILL.

I.

THE interesting displays of *changed stratified rocks* observed at the line of junction of stratified and unstratified formations, pointed out long ago by Hutton, abound all around Edinburgh. An examination of these *changed neptunian masses*, shews that, in some instances, they have been simply hardened, in others softened, to such a degree as to allow a movement of the particles, and consequently a new arrangement of these on cooling, thus giving to the altered rock a series of external characters different from that possessed by the unchanged rock. As the external characters of minerals are intimately connected with their chemical composition, it seemed probable that these softened rocks had, in all probability, acquired a new chemical composition; a conjecture illustrated by the following analyses.

Lochend.—At Lochend, near to Edinburgh, there is a fine display of the changes produced on some of the rocks of the coal formation by the greenstone of this district. The greenstone crag which rises immediately from the side of the Loch, rests upon, and is partially covered by slate-clay and sandstone of the coal formation, and in the body of the greenstone itself there are numerous fragments of those rocks, especially of the slate-clay. The slate-clay, upon which the greenstone rests, and the fragments of that rock contained in the greenstone, is so much changed as to resemble some varieties of compact felspar. I gave Mr Walker a specimen of slate-clay, taken from a bed at a distance from the greenstone, and another from the upper part of a bed of the same rock, in immediate contact with the greenstone, with the view of being analyzed. The following results were obtained:

1. *Unaltered* slate-clay from Lochend. Heated *per se* before the blowpipe, it fuses with difficulty; with ammoniacal phosphate of soda, it forms a white enamel; with phosphate of soda, an enamel yellowish-green when hot, and yellowish when cold; with borax it forms a greenish glass. Its constituents are: Silica, 58.22; Alumina, 17.50; Protoxide of Iron, 10.53; Lime, trace; Magnesia, 4.62; Soda, 2.02; Water, 6.70; = 99.59.

2. *Altered* slate-clay from Lochend. This specimen, which very much resembled some varieties of compact felspar, afforded the following constituent parts: Silica, 53.25; Alumina, 17.56; Oxide of Iron, 8.64; Lime, 6.62; Magnesia, 2.70; Soda, 7.85; Water, 2.23; = 98.85. This analysis shews that the altered slate has received a notable quantity of lime and alkali, thus giving it a composition different from that of the unaltered variety.

Understanding, from the communication of a chemist, that common alluvial clays contain alkali, I directed my young friend's attention to this point, and he ascertained, as stated above, that the unaltered slate-clay also contains alkali. The importance of this fact as connected with soils is too evident to require any particular consideration.

Altered or Changed Slate-Clay from a mass imbedded in the Greenstone of Salisbury Craigs.

Specific Gravity 2.52. *Chemical Characters:* Effervesces, and does not gelatinise with acids. Before the blowpipe, heated *per se*, it melts into a transparent greenish glass; with salt of phosphorus into a transparent and colourless glass. *Constituent Parts:* Silica, 66.100; Alumina, 19.5; Oxide of Iron, trace;

Lime, 6.4; Soda, 4.45; Water and Carbonic Acid, 3.3; = 99.65. The above analysis by Mr J. Drysdale, affords another interesting example of the chemical change induced in neptunian rocks by plutonean agency.

II.

1. *Analysis of the Basaltic Rock of Largo Law in Fifeshire.*

The beautiful hill named Largo Law, which rises 938 feet above the level of the sea, is composed of a greyish-black compact basaltic rock, belonging to the greenstone or dolerite series. It rises through the surrounding rocks of the coal-formation, in which it has occasioned changes of position, structure, and probably also in composition. The rock, although generally massive, in some parts of the hill appears disposed in elegant columns. As it had not been analyzed, I put a specimen of it into the hands of Mr J. Drysdale, who returned the following account of his examination of it:

Specific gravity 2.971. *Chemical Characters:* It neither effervesces nor gelatinizes with acids. Before the blowpipe *per se*, it melts easily into a black mass; with the salt of phosphorus into a transparent and colourless glass; with borax ditto, &c. *Constituent Parts:* Silica, 45.2; Alumina, 14.4; Protoxide of Iron, 14.0; Lime, 12.7; Magnesia, 6.55; Soda, 5.22; Water, 2.4; = 100.47.

2. *Analysis of the Zeolite named Wollastonite, by Thomson.*

Fine specimens of this mineral were found in the greenstone cliffs of Corstorphine Hill, by one of our best geological observers, General Lord Greenock. The following is Mr Walker's analysis of the Wollastonite from this new locality: It phosphoresces when heated, giving out a feeble white light. It does not effervesce nor afford a perfect jelly with acids. Heated *per se* before the blowpipe, it fuses with effervescence into a very hard white enamel. Its *constituents* are: Silica, 54.00; Lime, 30.79; Soda, 5.55; Water, 5.43; Magnesia, 2.59; Alumina and Oxide of Iron, 1.18; = 99.54.

CELESTIAL PHENOMENA FROM OCTOBER 1. 1833 TO JANUARY 1. 1834, CALCULATED FOR THE MERIDIAN OF EDINBURGH, MEAN TIME. *By Mr* GEORGE INNES, *Astronomical Calculator, 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.*

OCTOBER.

D.	H.	′	″	
1.	2	17	32	☌ ☽ 1 ξ Ceti.
3.	4	24	21	Im. I. sat. ♃
3.	17	43	–	☌ ♀ ρ ♌
3.	17	44	37	☌ ☽ 1 δ ♉
3.	18	16	41	☌ ☽ 2 δ ♉
3.	18	54	7	☌ ☽ 3 δ ♉
3.	20	17	28	☌ ☽ ε ♉
4.	11	39	42	☌ ☽ ι ♉
4.	20	7	–	Sup. ☌ ☉ ☿
4.	22	20	20	☌ ☽ ο ♉
4.	22	52	56	Im. I. sat. ♃
5.	2	39	20	☌ ☽ ζ ♉
5.	13	46	29	☌ ☽ H ♊
5.	18	17	35	☌ ☽ η ♊
5.	21	37	57	☌ ☽ μ ♊
6.	4	11	34	Im. III. sat. ♃
6.	15	45	36	☾ Last Quarter.
6.	20	57	11	☌ ☽ δ ♊
7.	3	25	44	Im. II. sat. ♃
8.	6	18	52	☌ ☽ γ ♋
9.	16	29	24	☌ ☽ η ♌
10.	17	16	34	☌ ☽ ♀
11.	9	58	59	☌ ☽ ν ♍
12.	0	47	27	Im. I. sat. ♃
12.	2	36	16	☌ ☽ ♄
13.	6	41	0	● New Moon.
13.	13	45	–	☿ near ♂
13.	14	7	27	☌ ☽ ♂
13.	14	8	23	☌ ☽ ☿
13.	19	16	9	Im. I. sat. ♃
14.	6	38	–	☌ ♀ σ ♌
15.	13	38	46	☌ ☽ γ ♎
15.	17	19	7	☌ ☽ η ♎
15.	21	28	39	☌ ☽ ϑ ♎
16.	10	23	27	☌ ☽ ψ Oph.
17.	10	41	14	☌ ☽ ρ Oph.
17.	19	11	2	Im. II. sat. ♃
17.	20	18	42	☌ ☽ D Oph.
19.	2	42	9	Im. I. sat. ♃
19.	2	57	32	☌ ☽ 1 ν ♐
19.	3	22	16	☌ ☽ 2 ν ♐
19.	7	37	43	☌ ☽ ο ♐
20.	11	37	30	☽ First Quarter.
20.	20	17	–	☌ ♀ β ♍
20.	21	10	52	Im. I. sat. ♃
21.	14	52	4	☌ ☽ η ♑
22.	5	43	0	☌ ☽ ♅
22.	8	26	34	☌ ☽ γ ♑
22.	10	55	18	☌ ☽ δ ♑
23.	15	6	44	☉ enters ♏
24.	4	10	16	☍ ☉ ♃
24.	10	43	10	☌ ☽ 2 ψ ♒
24.	11	46	45	☌ ☽ 3 ψ ♒
25.	0	19	6	Em. II. sat. ♃
25.	10	56	58	☌ ☽ τ ♓
25.	12	46	59	☌ ☽ ε ♓
27.	16	22	6	☌ ☽ ν ♓
28.	1	13	46	Em. I. sat. ♃
28.	3	23	43	☌ ☽ ♃
28.	8	46	28	☌ ☽ 1 ξ Ceti.
28.	15	20	0	○ Full Moon.
29.	18	10	7	☌ ♀ ♄
29.	19	42	39	Em. I. sat. ♃
31.	0	37	54	☌ ☽ 3 δ ♉
31.	2	0	19	☌ ☽ ε ♉
31.	17	13	15	☌ ☽ 1 ξ Ceti.

NOVEMBER.

D.	H.	′	″	
1.	2	55	19	Em. II. sat. ♃
1.	3	38	57	☌ ☽ ο ♉
1.	8	6	30	☌ ☽ ζ ♉
1.	18	57	50	☌ ☉ ♂
1.	19	2	1	☌ ☽ H ♊
1.	23	41	45	☌ ☽ η ♊
2.	3	22	2	☌ ☽ μ ♊
3.	2	27	35	☌ ☽ δ ♊
3.	22	32	21	Em. III. sat. ♃
4.	3	8	49	Em. I. sat. ♃
4.	12	20	14	☌ ☽ γ ♋
5.	0	21	24	☾ Last Quarter.
5.	21	37	32	Em. I. sat. ♃
5.	23	27	35	☌ ☽ η ♌
7.	9	4	–	☌ ♀ ϑ ♍
7.	18	23	56	☌ ☽ ν ♍
8.	1	4	11	☌ ☽ π ♍
8.	16	46	43	☌ ☽ ♄
10.	12	36	12	☌ ☽ ♀
11.	2	33	43	Em. III. sat. ♃
11.	9	49	6	☌ ☽ ♂
11.	17	26	0	● New Moon.
11.	18	49	33	Em. II. sat. ♃
12.	20	37	31	☌ ☽ ψ Oph.
12.	23	32	47	Em. I. sat. ♃
13.	7	0	43	☌ ☽ ☿
13.	20	34	39	☌ ☽ ρ Oph.
14.	6	1	22	☌ ☽ D Oph.
14.	12	50	29	☌ ☽ b ♐
14.	18	1	40	Em. I. sat. ♃
15.	12	1	8	☌ ☽ 1 ν ♐
15.	12	25	11	☌ ☽ 2 ν ♐
17.	22	47	44	☌ ☽ η ♑
18.	13	46	7	☌ ☽ ♅
18.	16	10	23	☌ ☽ γ ♑
18.	19	37	16	☌ ☽ δ ♑
18.	21	25	44	Em. II. sat. ♃
19.	7	37	0	☽ First Quarter.
20.	1	28	10	Em. I. sat. ♃
20.	3	52	–	☿ greatest E. [elong.
20.	18	47	50	☌ ☽ 2 ψ ♒
20.	19	21	26	☌ ☽ 3 ψ ♒
21.	18	36	52	☌ ☽ τ ♓
21.	19	57	4	Em. I. sat. ♃
21.	20	27	22	☌ ☽ s ♓
21.	23	47	–	☌ ♀ λ ♍
22.	11	37	17	☉ enters ♐
23.	5	24	–	☌ ♄ γ ♍
24.	0	15	11	☌ ☽ ν ♓
24.	3	23	30	☌ ☽ ♃
24.	16	39	17	☌ ☽ 1 ξ Ceti.
25.	7	37	–	☌ ♂ κ ♎
26.	0	1	52	Em. II. sat. ♃
27.	6	54	30	○ Full Moon.
27.	7	53	37	☌ ☽ 3 δ ♉
27.	9	14	47	☌ ☽ ε ♉
28.	0	10	49	☌ ☽ ι ♉
28.	10	33	45	☌ ☽ ο ♉
28.	14	45	58	☌ ☽ ζ ♉
28.	21	52	38	Em. I. sat. ♃
29.	1	36	42	☌ ☽ H ♊
29.	4	28	–	☌ ♂ λ ♎
29.	6	1	31	☌ ☽ η ♊
29.	9	17	41	☌ ☽ μ ♊
30.	8	5	43	☌ ☽ δ ♊

DECEMBER.

D.	H.	′	″	
1.	17	41	15	☌ ☽ γ ♋
3.	2	37	59	Em. II. sat. ♃
3.	4	46	24	☌ ☽ η ♌
4.	9	8	24	☾ Last Quarter.
4.	14	26	18	☌ ☽ ι ♌
5.	0	6	34	☌ ☽ 1 ξ ♍
5.	0	23	2	☌ ☽ ν ♍
5.	7	13	14	☌ ☽ π ♍
5.	23	48	19	Em. I. sat. ♃
6.	3	40	14	☌ ☽ ♄
7.	0	17	–	☌ ♀ 4 ζ ♎
7.	18	17	43	Em. I. sat. ♃
8.	15	45	31	☌ ☽ 2 ξ ♎
9.	6	20	–	Inf. ☌ ☉ ☿
9.	8	52	10	☌ ☽ γ ♎
9.	12	37	26	☌ ☽ η ♎
9.	13	21	38	☌ ☽ ♀
9.	16	28	58	Im. III. sat. ♃

DECEMBER—*continued.*

D.	H. ′ ″		D.	H. ′ ″	
9.	16 50 38	☌ ☽ ϑ ♎	21.	22 8 55	Em. I. sat. ♃
10.	7 14 8	☌ ☽ ♂	22.	0 22 1	☉ enters ♑
10.	23 5 48	☽ very near ☿	22.	1 33 31	☌ ☽ 1 ξ Ceti.
11.	7 52 54	● New Moon.	23.	16 37 56	Em. I. sat. ♃
12.	21 22 6	☌ ☽ 1 ν ♐	24.	17 5 44	☌ ☽ 3 δ ♉
12.	21 39 5	☌ ☽ 2 ν ♐	24.	18 26 24	☌ ☽ ε ♉
13.	1 44 6	Em. I. sat. ♃	25.	9 16 2	☌ ☽ ι ♉
13.	18 32 4	Em. II. sat. ♃	25.	19 31 28	☌ ☽ ο ♉
14.	20 13 2	Em. I. sat. ♃	25.	23 40 16	☌ ☽ ζ ♉
15.	7 25 40	☌ ☽ η ♑	26.	10 20 16	☌ ☽ H ♊
15.	20 15 –	☌ ♀ ♂	26.	14 39 52	☌ ☽ η ♊
15.	23 39 56	☌ ☽ ♅	26.	17 52 8	☌ ☽ μ ♊
16.	0 36 7	☌ ☽ γ ♑	26.	21 9 18	○ Full Moon.
18.	2 55 43	☌ ☽ 2 ψ ♒	27.	15 18 34	☌ ♀ ♂
18.	3 29 20	☌ ☽ 3 ψ ♒	27.	16 17 43	☌ ☽ δ ♊
19.	2 53 52	☌ ☽ τ ♓	27.	21 25 30	Im. II. sat. ♃
19.	4 38 43	☌ ☽ s ♓	27.	23 44 4	Em. II. sat. ♃
19.	6 15 36	☽ First Quarter.	29.	0 4 51	Em. I. sat. ♃
19.	23 39 –	☌ ☿ ♀	29.	0 46 50	☌ ☽ γ ♋
20.	18 49 16	Im. II. sat. ♃	29.	1 36 –	☿ greatest W.
20.	21 8 5	Em. II. sat. ♃	30.	10 55 27	☌ ☽ η ♌ [elong.
21.	8 58 5	☌ ☽ ν ♓	31.	19 57 21	☌ ☽ ι ♌
21.	11 16 42	☌ ☽ ♃			

The Moon will be Totally Eclipsed, December 26, *Visible* to all Europe.—The following are the times for the Edinburgh Observatory:

	D.	H. ′ ″
The Eclipse begins, ...	Dec. 26.	19 30 5,6
Beginning of Total Darkness, ...		20 30 31,7
Middle, ...		21 19 42,2
End of Total Darkness, ...		22 8 52,7
End of the Eclipse, ...		23 9 18,8

Times of the Planets passing the Meridian, and their Declinations.

OCTOBER.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	11 43	0 3 S.	9 34	12 5 N.	12 27	6 36 S.	1 29	11 13 N.	11 31	1 7 N.	20 45	15 52 S.
5	11 50	3 55	9 36	10 34	12 20	7 38	1 13	11 4	11 17	0 55	20 29	15 53
10	12 3	7 39	9 39	8 32	12 13	8 56	0 50	10 51	11 0	0 41	20 9	15 54
15	12 15	11 9	9 43	5 55	12 7	10 14	0 27	10 37	10 42	0 27	19 49	15 56
20	12 24	14 24	9 46	4 8	12 0	11 28	0 5	10 24	10 25	0 13	19 29	15 56
25	12 34	17 21	9 48	1 49 N.	11 53	12 41	23 38	10 9	10 8	0 0	19 9	15 57

NOVEMBER.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	12 48	20 50 S.	9 53	1 29 S.	11 45	14 19 S.	23 8	9 50 N.	9 43	0 18 S.	18 42	15 56 S.
5	12 6	22 37	9 55	3 22	11 39	15 13	22 50	9 40	9 29	0 28	18 26	15 56
10	13 5	24 3	9 58	5 41	11 33	16 17	22 28	9 28	9 11	0 39	18 7	15 55
15	13 14	25 6	10 2	8 3	11 28	17 20	22 6	9 16	8 53	0 52	17 48	15 54
20	13 18	25 34	10 6	10 18	11 22	18 18	21 44	9 7	8 36	1 0	17 28	15 52
25	13 16	25 23	10 10	12 27	11 16	19 14	21 22	8 58	8 17	1 11	17 8	15 50

DECEMBER.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	12 56	24 13 S.	10 15	14 53 S.	11 11	20 16 S.	20 57	8 50 N.	7 57	1 21 S.	16 45	15 4 S.
5	12 27	22 49	10 19	16 22	11 7	20 54	20 41	8 46	7 41	1 28	16 30	15 44
10	11 46	21 41	10 25	18 25	11 2	21 35	20 21	8 43	7 23	1 36	16 11	15 41
15	11 3	19 13	10 31	19 37	10 59	22 13	20 0	8 42	7 4	1 42	15 53	15 37
20	10 36	18 58	10 37	20 55	10 54	22 46	19 40	8 42	6 45	1 48	15 33	15 33
25	10 26	19 49	10 42	22 7	10 50	23 12	19 20	8 44	6 28	1 52	15 14	15 29

PROCEEDINGS OF THE SOCIETY FOR THE ENCOURAGEMENT OF THE USEFUL ARTS IN SCOTLAND.

The following articles and communications were laid before the Society during the months of February and March 1833 :—

April 3.—1. Communication on a System of Typography for the Blind. By Mungo Ponton, Esq. W. S. 30 Melville Street.

Printed Specimens, &c. were exhibited.

2. Description of a Calculating Machine, for proposing and answering Arithmetical Questions ; calculating Interest at any rate per cent. for any amount, and for any number of days :—chiefly intended for the use of Teachers of Arithmetic, Banking Houses, &c. Invented by Mr James Macfarlane, teacher of the Mercantile Academy, 48 George Square, Glasgow.

The machine was exhibited by Mr Macfarlane.

Mr George Angus, architect, 1 St Colme Street, Edinburgh, was admitted an Ordinary Member.

Donation.—The Code of Agriculture, including Observations on Gardens, Orchards, Woods, and Plantations ; with an account of all the recent Improvements in the management of Arable and Grass Lands. By the Right Hon. Sir John Sinclair, Bart. Founder of the Board of Agriculture. From the Author.

April 10.—1. An Alphabet and mode of Printing for the use of the Blind ; with specimens in metal. By Mr John Henderson, Mayfield Loan, Edinburgh.

2. Specimens of an Alphabet and of Printing for the Blind ; with relative letter. By Mr John Richardson, teacher, 11 Lothian Street, Edinburgh.

3. Model of a Chimney Top for Curing Smoke. By Mr Martin Gavin, slater, 2 Nottingham Terrace, Edinburgh.

4. Model and Description of a Fire-Escape. By Mr Alexander M'Coll, Cupar Fife.

5. Observations relative to Machines for " Treading and Consolidating the Soil ;" and for " Breaking Sea shells into dust for Manure." By the Right Hon. Sir John Sinclair, Bart.

6. Additional Specimens of Lithographic Views, chiefly Scottish, intended for immediate publication. By Mr Samuel Leith, lithographer, Banff.

7. Observations on the Improvements which may be effected by means of Competition among working Tradesmen. By William Grierson, Esq. of Garroch.

April 17.—1. Model and description of a Chimney Top for Curing Smoke. By Messrs Thomas Brown, 4 Shakspeare Square, and John Adam, 11 Market Street, Edinburgh.

2. Mode and Description of a machine to enable Blind persons to write with ease and accuracy. By Mr John Henderson, Mayfield Loan, Edinburgh.

3. Description of a Portable Steam Kitchen, manufactured by Mr Alexander Aitken, tinsmith and ironmonger, 30 George Street, Edinburgh.

The Steam Kitchen was exhibited of two sizes.

4. An Alphabet for the use of the Blind. By the Rev. Edward Craig, Minister of St James's Episcopal Chapel, Edinburgh.

5. Additional paper on an Alphabet and method of Printing for the use of the Blind, with specimens. By Mr Alexander Hay, teacher, 10 Catherine Street, Edinburgh.

April 24.—1. Description and Drawing of a new and powerful Break Harrow. By Mr Thomas Johnston, 137 George Street, Glasgow.

2. Specimens of Lithography from Chalk Drawings. By Mr David Allan, lithographer, Trongate Glasgow.

3. Description, with specimens, of an Alphabet and Method of Printing, for the use of the Blind. By Mr James Gall, printer, Niddry Street, Edinburgh.

Three Copies of the Gospel by St John, in the binding of which, different degrees of pressure have been used, and several other specimens, were exhibited.

4. Description with printed specimens, of an Alphabet and method of Printing, for the use of the Blind. By Edmund Fry, M. D. late letter founder, Dalby Terrace, City Road, London.

5. Specimen and Description of a Relief and Incuse Alphabet for the use of the Blind. By Mr Richard Eaton, London Wall Street Coventry.

May 15.—1. Specimens of Lithography, by William Johnston and Son, letterpress and lithographic printers, Greenock.

2. Remarks on Dressed Leather made from the Skins of Rats. By Mr James Dowie, boot and shoemaker in ordinary to his Majesty for Scotland, Frederick Street, Edinburgh. Specimens exhibited.

3. Additional communication on the subject of Arithmetical Notation for the Blind. By Mungo Ponton, Esq. W. S. Edinburgh.

4. Description of an Alphabet and Mode of Printing for the Blind, with Specimens. By Mr Daniel Macpherson, wood-engraver, 93. Leith Wynd, Edinburgh, with additional remarks thereon.

5. An Alphabet and Mode of Printing for the use of the Blind. With a supplementary paper, extending the plan of Wire and Counters to an abbreviated System for the Reading, Correspondence, Arithmetic, and Music of the Blind; and with Drawings and Descriptions of various Alphabets for the Blind. By Mr John Lothian, 37. George Square, Edinburgh.

6. The following Candidates were balloted for as Ordinary Members, and duly admitted, viz.

Alexander Hamilton, Esq. W. S. F. A. S., 6. Stafford Street, Edinburgh.
Mungo Ponton, Esq. W. S., 30. Melville Street, Edinburgh.

7. The Council reported regarding the Donation of L. 400, offered to the Society, at Whitsunday 1833, for the encouragement of the Useful Arts in Scotland, by Sir David Brewster and Dr James Keith, the surviving Trustees of the Fund left by the late Alexan-

der Keith, Esq. of Dunottar, for the promotion of Science and the Arts in Scotland; and the acceptance of the same by the Council in name of the Society.

May 29.—A new system of Tangible Signs, comprising the Roman, Greek, and Hebrew alphabets; with numerical figures, algebraic symbols, musical notation, and a variety of other characters, for the use of the blind. By Mr Robert Milne, professor of music, 7. Nicolson Square, Edinburgh. Printed specimens exhibited.

2. An Alphabet and Description of Double Frame and Type for Printing in Relief, for the use of the Blind. By Mr John Johnston, 15. Cavendish Street, Glasgow. No printed specimens sent.

3. Description of a new and economical Pump for Draining Deep Mines. By Mr John Milne, teacher of drawing, &c. Edinburgh, Cur. Soc. Arts. A model and drawings exhibited.

SCIENTIFIC INTELLIGENCE.

METEOROLOGY.

1. *Absolute Weight of the Atmosphere during Cholera greater than at other times.*—At a meeting of the British Association, Dr Prout exhibited a table containing the results of eighty-seven experiments on the absolute weight of the atmosphere between the 16th December 1831, and the 24th March 1832. The experiments were usually made about noon, and as nearly as possible under similar circumstances. The following is a summary of the results: The mean of all the experiments (with one exception, to be presently noticed,) is, that 100 cubic inches of dry atmospheric air, free from carbonic acid, at the temperature of 32°, barometer 30 inches, in the latitude of London, weigh 32.7958 grs., the extreme differences between the highest and the lowest observations being .0507 grs. The mean of the first forty-four experiments, between the 16th of December and the 8th of February inclusive, is 32.7900 grs.; the mean of the last forty-four, between the 10th of February and the 24th of March inclusive, 32.8018 grs; the difference between the two series being .0118 grs. The exception alluded to above occurred on the 9th of February, on which day the weight of the air was 32.8218 grs.; and it is remarkable, that after this period, during the whole time that the experiments were continued, the air almost uniformly possessed a weight above the usual standard; so that, as above stated, the mean of the forty-two observations after this crisis exceeds the mean of the forty-four preceding it by no less

than .0118 grs. The apparatus employed, and the care taken, were the same throughout; and there can be no doubt, that the difference, whatever it depended on, really existed, and did not arise from error of experiment. How the circumstance is to be explained, it is difficult to form a conjecture; but perhaps it might be worth while to observe, *that almost precisely at the period above mentioned, the wind veered round to the north and east, where it continued for a considerable time, and that under these circumstances the epidemic cholera first made its appearance in London. It would seem, therefore, as if some heavy foreign body had been diffused through the lower regions of the atmosphere about this period, and which was, somehow or other, connected with the disease in question.* The action of this body is quite unknown; but it could have scarcely possessed acid or alkaline properties, as, in the former instance, it would have been separated by lime-water, and in the latter by sulphuric acid. We may probably consider it as a variety of *malaria;* and, what renders the conjecture more likely are its effects upon the animal economy, which are somewhat analogous to those known to be produced by certain varieties of this poison. Thus, during the present spring and summer, the saliva and the exhalations from the skin, in almost every individual on whom the experiment was made, have been found to be unusually acid; the state of the urine also, and other secretions, has been most remarkable, and that in so great a number of individuals as to prove the existence of some widely acting cause, such as has not occurred in our time, or at least since the author of the present communication has turned his attention to the subject. Should the above conjectures prove to be well founded, they lead us to hope that the cause of the present formidable epidemic will not be permanent, but will pass gradually away; though, from the deep-seated and malignant influence which it has exerted in organic action, it is probable that several years will elapse before its effects will be entirely obliterated.

2. *Weight of the Atmosphere at New and Full Moon.*—The weight of the air, says Dr Prout, is observed to be very unsteady, and usually heavier about the new and full moon. Whether this arises from aërial tides has not been satisfactorily determined. It may, however, be proper to observe, that many of the minute differences in the weights of the air at different

times are more apparent than real, and depend upon the sluggishness of the mercurial barometer, which prevents it from being an exact measure of the movements of the lighter and more mobile fluids.

GEOLOGY.

3. *Fossil-Tooth in Sandstone of the Coal Formation.*—General Lord Greenock, some months ago, brought me a specimen of red sandstone, which he refers to the coal-formation, from the vicinity of Paxton, in Berwickshire, in which there is imbedded a well preserved tooth. On examining the portion of the tooth uncovered, I considered it as probably that of a *fish*,—other naturalists here thought it might belong to a saurian animal. Wishing for further examination, I sent the specimen to London. There, a celebrated anatomist said, " This portion of tusk approaches nearer to that of a *wolf* than any other with which I have been able to compare it. It is not, however, yet completely developed, though I have exposed a greater part of its surface than when it was put into my hands." Another acute and experienced observer, on examining the specimen at the College of Surgeons in London, was somewhat puzzled, but having got it into his own keeping, he returned it with a groove, cut so as completely to shew the *fang*, as also specimens of *similar teeth* from the *Lophius piscatorius*, or sea-devil. In our next number we hope to give a more complete account of this interesting relic.

4. *Living Trilobite discovered.*—Every one familiar with the history of the trilobites, is aware that a good deal of controversy has existed among naturalists, respecting the precise link, in the grand chain of organized beings, these singular fossil animals should occupy, and also whether or not they have been annihilated by some ancient revolution of our planet. All these matters, says one of Professor Silliman's correspondents, are now put to rest by the late discovery of some living trilobites in the southern seas, near the Falkland Islands, by Dr James Eights. We have had the pleasure of seeing the specimens of Dr Eights, of what appear to be trilobites. If this opinion is correct, the trilobites must be regarded as being of almost all geological ages.

5. *Faraday on Carbonate of Lime.*—At a meeting of the Royal Society of London, 3d May 1833, Mr Faraday read a

notice on the combination of carbonic acid with lime. After some details on the importance of carbonate of lime, the variety of forms under which it occurs, the different applications for economic purposes, for marl, manure, smelting in metalling operations, &c. he called the attention of the members to the fact, that carbonate of lime, when heated without the presence of any other gas but carbonic acid, did not lose its carbonic acid, whatever may be the intensity of the heat employed, and under the common atmospheric pressure. An analogous fact is the occurrence in lime-kilns of masses of limestone that have been softened and crystallized without the loss of their carbonic acid. Probably pressure has little to do with the retention of the carbonic acid during the fusion of carbonate of lime. The absence of moisture, as well as the presence of carbonic acid, may contribute powerfully to the retention of the carbonic acid.

6. *Prevost on the Geological transition from Chalk to Tertiary Deposits.*—In travelling from Syracuse to Cape Passaro, Prevost observed an apparent passage from the tertiary to the secondary formations in the neighbourhood of Noto, by means of thick beds of white friable limestone, almost without fossils, which on the one hand was connected with the tertiary deposits by its mineralogical characters and superposition, and on the other passed in an equally gradual manner to calcareous beds, which the greater number of geologists refer to the chalk formation.

7. *Antediluvian Ambergris.*—In the clay ironstone of our coal-formation, near to Bathgate, Burntisland, &c. we have been long familiar with a pale yellowish-white and wine-yellow, translucent, soft, inflammable mineral, to which no particular name had been given. It is now said to have the chemical characters of ambergris.

8. *Belemnites in Talc-slate, &c.*—Studer stated at the meeting of naturalists at Clermont, that he had found belemnites amongst garnets in talc-slate on the south side of St Gothard. The same naturalist also announced his having discovered at the Lake of Lugano that the black augitic porphyry was *older* than the red quartziferous one, the latter forming *dikes* in the former, but not the reverse, as he and Von Buch thought in 1827.

9. *Geological Map of Spain.*—Boubè, Elie Beaumont, and

Duffrenoy are among the Pyrenees. Le Roy is still in southern Spain, where he has discovered many interesting facts. Schulz, inspector of mines in Spain, who is at present busy exploring Gallicia and Vallejo, has it in charge from the Spanish government to make a geological map of the whole of Spain. If we add to the list of active geologists who have visited that country, the names of Silvertop, Hausmann, Lyell, Cook, &c. we may be allowed to hope, that, ere many years have elapsed, we shall have a map expressive of the general geognostical features of Spain. Pitta de Castro, who returns with the young Queen Donna Maria to Portugal, will describe the geognosy of his native country.

10. *Geology of Greece.*—Boblaye and Virlet are publishing rapidly their interesting observations on Greece and Asia Minor. Von Buch is now in Greece, but it is to be regretted that that great observer had not had an opportunity of reading before his departure the fine observations made by these French naturalists.

NEW PUBLICATIONS.

1. *The Principles of Geology.* By Charles Lyell, Esq. F. R. S., &c. &c. 8vo. Vol. iii. Pp. 530, with numerous Illustrative Plates. John Murray, 1833.

This, in our opinion, is the most interesting volume of Mr Lyell's geological work. It is almost entirely occupied with details and views illustrative of the geognosy and geology of the Tertiary Formations.

2. *The Geology of the South-East of England.* By Gideon Mantell, Esq. F. R. S. &c. &c. 8vo. Pp. 420, with Maps and Plates. Longman & Co. 1833.

This valuable work, already, we doubt not, in the library of all our geologists, treats of the Physical Geography, and next of the geological structure of Sussex, in the following order, viz. 1. Diluvium; 2. Tertiary Formation; 3. Chalk Formation; 4. Organic Remains of Upper and Lower Chalk; 5. Chalk Marl, Firestone, Galt or Folkstone Marl, Blue Chalk Marl, Shanklin or Lower Green Sand; 6. The Wealden Formation; 7. Organic Remains in the Wealden Formation; 8. Observations on the Fossil Remains of Saurian Animals; 9. Results of the Geological Investigation of the South-East of England.

3. *Barometric Tables for the use of Engineers, Geologists, and Scientific Travellers.* By WILLIAM GALBRAITH, A.M., &c. Edin. Stirling & Kenney, and A. Adie, Optician. 1833.

Mr Galbraith, already so well known as a cultivator of mathematical and physical science, has done an acceptable service to geologists, and others, by the publication of these useful tables. They were computed by the author with the greatest care, and the results examined by means of differences, before putting to press. In reading the proofs, the same care was bestowed. They were then cast, and proofs from the stereotype plates were next read, with the same precautions as before; and, in the whole, two errors only were discovered and corrected. Table I. contains numbers in English feet, corresponding to the height of the barometer in inches, tenths, and hundredths, with proportional parts to thousands, from 1 to 9. Table II. contains the corrections for the expansions of mercury. depending on the difference of the temperatures of the mercury in the barometer tubes, indicated by the attached thermometers. Table III. contains the corrections depending on the mean temperature of the air and the approximate height. Table IV. embraces the corrections for the latitude λ, and the corrected height H′. Table V. will be found useful for converting French metres into English feet, when a comparison is made with heights previously determined, either trigonometrically or barometrically.

4. *Naturalist's Library.* Vol. I. *Humming Birds,* with 34 Coloured Plates, and Portrait of Linnæus. Vol. II. *Monkeys,* 28 Coloured Plates, with good Portrait of Buffon. Descriptions by Sir W. JARDINE, F. R. S., M. W. S., &c. &c.; the Engravings and Drawings by W. H. LIZARS. Edin. 1833.

That the taste for popular natural history is on the increase, is shewn by the numerous light and gay works on this subject, daily issuing from the press. Enterprising publishers and artists, aware of the general desire among all classes of readers for this kind of information, have at times given to their readers correct information, illustrated by judiciously selected and well executed engravings. The most beautiful of these cheap books on natural history we have met with, is the Naturalist's Library, of which already a good many thousand copies of each volume have been sold.

5. *On Fossil Fishes, comprising* 500 *extinct species ; an Exposition of the Laws of the Succession, and of the Organic Development of Fishes, throughout all the revolutions of the terrestrial globe ; a new Classification of those Animals, expressing their relations to the series of formations ; and, lastly, the general geological considerations deduced from the study of these organic remains.* By Dr Louis Agassiz. In 5 vols.; the text in 4to, and 250 plates in folio, on fine paper.

It is now, says Professor Agassiz, nearly three years since I announced this publication in the prospectus of my "*Fresh-water Fishes of Europe.*" Circumstances over which I had no control, have, till now, prevented the publication of these two works, which ought to have appeared together, for their mutual completion, and for exhibiting my idea of the science of Ichthyology. A more favourable position now enables me to undertake this enterprise, and I commence with printing my *Fossil Fishes.* The mere study of species, and their individual organization, has been almost the exclusive aim of naturalists. When they have pushed their investigations farther, the objects of their research has been limited to the philosophic principles of their classification and organization. I have also constantly kept in view these two points in my researches on fossil fishes. In establishing successively 500 extinct species, the remains of which are scattered through all the collections of Europe, I have made many new observations on their structure, as compared with that of existing fishes, and other vertebrate animals. But this study has led me farther. I have deduced the law of succession and organic development throughout every geological epoch. In the contemplation of this class, during its successive metamorphoses from formation to formation, science may trace, in this one grand division of the animal kingdom, the progress of organization through a complete series of the different ages of the earth. After such multiplied comparisons, it will not excite surprise that I announce changes in the classification of fishes, which will often indicate, at the same time, affinities hitherto unknown; but the most interesting circumstance is, that the new classification which I am about to promulgate, will completely express the natural affinities of fishes with each other, and their succession in the series of geological deposits. The general geological principles deduced from the study of these fossil remains, will indicate the connexion which exists between the organic development of the earth, and that of different classes of animals. These ideas will be illustrated by an organic delineation of each of the grand geological epochs.

The "Researches on Fossil Fishes" will be printed in 12 numbers, each consisting of from ten to fifteen sheets of text in quarto, and of 20 folio plates, at the price of 24 francs of France, or 11 florins of Germany.

The first will appear on 1st September 1833, with 20 sheets of text, and 20 plates: it will comprehend the family of the *Lepidotides*, and, besides the figures of all the fossil remains which characterise the species, the skeletons of the living species with which it is necessary to compare them, restored figures will be given of one species of each genus.—The succeeding numbers will appear, without intermission, every four months.

6. *The Internal Structure of Fossil Vegetables found in the Carboniferous and Oolitic Deposits of Great Britain.* By H. T. M. Witham, Esq. F. R. S. & M. W. S. 4to. 84 pp. 16 Coloured Plates, containing 150 Figs. Black, Edin. and Longman, Lond.

In this richly ornamented and interesting volume, besides a reprint of former papers, there are many additional details illustrative of the structure of fossil trees, in different secondary formations, and also of the formations themselves. An attempt is made by Mr Witham to classify minutely some of the petrifactions, which we consider premature, because such determinations cannot be of much value until we are better acquainted with the structure of the recent woods than is the case at present. We therefore recommend to our author, and others engaged in this inquiry, a close study of the structure of the *recent woods*, before instituting any more minute comparisons with the fossil ones.

7. *Boyle's Work on the Botany and Natural History of the Himalaya Mountains.*

The intelligent author of this projected work is a surgeon in the India Company's service, who has enjoyed a lucrative appointment as one of their botanists. The work will be principally devoted to the natural history of plants; for, as we have already often remarked in this Journal, the India Company have hitherto bestowed their munificent patronage almost entirely on botanists. "Although," says a valued correspondent, "this work will be chiefly botanical, the reader will not find there, as he too often finds in works of this nature, a mere farrago of Latin definitions to satisfy his curiosity. Mr Boyle has collected all the information he could obtain in the East regarding the virtues and properties of the several plants: he has cultivated them in the Botanic Garden at Saharumpore, of which he was the superintendant, and administered them to the sick; he has studied them in connection with climate, soil, and situation. The animals will be described, and their natural history fully considered, and the minerals also will be noticed." This work, from what we have heard of Mr Boyle's talents and acquirements, promises to be of a very superior cast.

8. *Cyclopædia of Anatomy and Physiology; being a series of Dissertations on all the Topics connected with Human, Comparative, and Morbid Anatomy and Physiology.* Edited by Professor Grant of the London University, and Mr Todd, Lecturer on Anatomy and Physiology in London.

The name of Professor Grant alone is a sufficient guarantee to the public that the editors will fulfil to the letter all the conditions, and these are very important ones, of the prospectus now in circulation. The object of Dr Grant and Mr Todd, and those embarked in this undertaking, is to put within the reach of every practitioner and student of medicine the marrow of an anatomico-physiological library; to enable them to command all that is known of the pathology or comparative anatomy of any disputed or doubtful point; to make them acquainted with the anatomical peculiarities of species in zoology, which it would occupy hours in a well stocked library to ascertain;—in short, to afford an amount of information upon these subjects which no other printed work can supply. The work will appear in parts, and the first part will be published early in 1834.

9. *Bridgewater Treatises.*

A second edition of Sir Charles Bell's beautiful and interesting treatise is about to appear. Dr Roget's treatise on Physiology, in three volumes, now in the press, will take the lead, in Britain, in this department of science. Buckland has been engraving, but has not yet begun to print; he will be the last, but certainly not the least important, of the Bridgewaters. Dr Prout's anxiously expected treatise now passing through the press, will, we doubt not, fully sustain the high expectations formed of it. Dr Chalmers's eloquent volumes, and also the admirable treatise of Professor Whewell, are reprinting.

10. *French Works on Natural History.*

Brongniart is about to publish a new edition of his Mineralogy, in which he will make use of Gustavus Rose's late work. We are glad to learn that there is some probability of Ferrusac's valuable Bulletin being recommenced. A useful weekly journal is now publishing in Paris, entitled, "L'Institut, Journal des Academies, et Sociétés scientifiques de la France, et de l'Etranger," in quarto sheets. It gives an account of the proceedings of all learned societies, with some scientific news. Boué is engaged with a work on the general Bibliography of all the sciences more or less connected with geology, viz. astronomy, physics, chemistry, mineralogy, geology, geognosy, paleontology, natural history, physical geography, geodosy, &c. All the works, academical memoirs, periodicals in all languages, &c. will be methodically and chronologically arranged, and illustrated by notes and critical remarks. The second volume of Daubuison's Geology is about to appear.

11. *Cheap Publications on the Continent.*

At Paris there is at present an extraordinary demand for cheap publications; the weekly two sols papers are increasing in number. We have now, says a correspondent, "the Magazin pittoresque, the Lanterne magique, Panorama, Mosaique, France pittoresque, all published in quarto, with fine wood-cuts, at the weekly rate of two sols each, and many others are in preparation. A cheap dictionary of natural history is about to be started, under the guidance, not of quack naturalists, but of men of high reputation in the scientific world. The *shares* of some of these publications have risen from the original value of 300 francs to that of 5000 francs;—so much for speculation in this kind of stock. The desire for reading, I find, after having travelled over the most of Europe, to be marvellously on the increase. Truly scientific periodicals at the rate of six francs per annum, is a wonderful feature of our times."

List of Scottish Patents will be given in next Number.

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