THE QUARTERLY

JOURNAL OF SCIENCE.

EDITED BY

JAMES SAMUELSON

AND

WILLIAM CROOKES, F.R.S.

VOLUME V.

With Illustrations on Copper, Wood, and Stone.

LONDON:

JOHN CHURCHILL AND SONS, NEW BURLINGTON STREET.

Paris: VICTOR MASSON ET FILS. | **Leipzig:** ALFONS DÜRR.

MDCCCLXVIII.

LONDON: PRINTED BY W. CLOWES AND SONS, STAMFORD STREET,
AND CHARING CROSS.

AN ESTANCIA ON THE RIVER PLATE

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JANUARY, 1868.

I. ON AN EXTRANEOUS MEAT SUPPLY.

By James Samuelson, Editor.

There is no subject which has engaged the attention of the British public during the last few years, of such paramount importance as the great "meat question." That staple food of our countrymen of all ranks has been gradually becoming more costly and difficult of acquirement; the highest class of agriculturists, the lettered men of the farm, although they have lost no opportunity to improve our breeds of domestic cattle, have observed with anxiety the constantly increasing demand and the disproportionate supply of live-stock; whilst our labouring classes, the muscle and sinew of the nation, have found the description of food which is, to them, indispensable for the performance of their daily toil receding month by month from their reach. And in this, as in all similar emergencies, it is becoming the fashion to look to "Science" for aid, and to censure her should the relief not be immediate and effective. Our coal supply threatens to fail us—"Science" must enable us to penetrate more deeply into the bowels of the earth; and whilst she teaches us to economize and husband our present supply, must provide us with a larger store in the future. She, too, must bring distant lands nearer, enabling us to draw upon their mineral wealth. Already we are told that an exorbitant price in the London market would attract a supply of coal from Westphalia. Civil war sweeps over the great cotton-growing districts of the West, and, in consequence, famine makes rapid inroads into our manufacturing centres. The products of other lands in the far East are considered unfit for our purposes; but soon the staple is improved abroad, new machinery is fitted up at home, and the bitter cup is averted by "Science."

Nor must it be supposed, because one section of the scientific community is directing its attention to abstract questions with respect to food, as, for example, the relative heat-giving and work-sustaining properties of nitrogenous and non-nitrogenous substances, that therefore scientific men are regardless of the more practical aspect of that matter.

As we have already said, agriculturists are improving the breed of our cattle and seeking to bring a better supply to the meat market; manufacturers are multiplying our stores of artificial fodder, so that a good or bad season for pasture is of less moment than formerly, and each succeeding year brings us stores of fresh materials for this purpose from some new quarter of the globe; whilst chemists and meat curers are engaged in the keenest competition to preserve beef and other kinds of flesh abroad and at home; so that all the resources of art and science are being brought to bear in the effort to counteract the result of cattle plagues, the rapacity of butchers, and a rapidly increasing population.

But there is, at present, one grave obstacle in the way of obtaining effectual relief from a short supply of meat, which extends to hardly any similar substance, and that is the difficulty of importing it from abroad in its fresh condition. Cotton shipped from distant parts arrives here unimpaired in quality and undepreciated in value; so too coffee, tea, wheat, and hundreds of other necessaries and luxuries of life; but with the exception of smoked or salted flesh imported from a distance, and the limited supply of lean cattle brought from nearer countries, and rendered still more limited by cattle plague regulations, we have so far been unable to avail ourselves to any large extent of the live-stock of other parts of the globe. Something has, however, been accomplished, and in what condition we should have been, were that not the case, it is impossible to surmise. From Holland, Belgium, and other European countries we have for a long time past obtained supplies of lean-stock which has been rapidly fed in England (chiefly upon food originally the produce of Russia, India, and Africa), and placed upon our markets. Hams, bacon, and pickled or salted beef have formed a considerable feature in our North American import trade, and recent advertisements have informed the public that South American press-packed beef, of the finest quality and free from bone, is retailed "at a handsome profit to the dealer at fourpence per pound;" of the last named, it is right to say, that it cannot be looked upon as a description of food which will long maintain its footing, and the enterprising men who have so far succeeded in preserving their meat, must improve its quality, or it will not find its way into competition with our best English beef: to this subject we shall refer fully hereafter. A not unimportant feature in our meat-supply, and one for which we are solely indebted to Science, is the manufacture of the so-called "*Extractum Carnis*" of Professor Liebig, a process, as our readers are doubtless well aware, by which the nutritive properties of meat are condensed into a portable form, and brought from other parts of the world, from whence it would be difficult at present to import live stock or fresh meat with any chance of its arriving here in a sound or healthy condition. From its concentrated form, and comparatively reasonable price, this extract of meat is now largely used in the preparation of soup, and the readers of such papers as the 'Pharmaceutical Journal' must see with surprise with what energy it is being pressed by the manufacturers upon the notice of the medical profession; it cannot fail to relieve in some degree the demand for fresh meat.

Still, there is a great outcry for an artificial, or rather for an extraneous supply of fresh meat, and when we come to look abroad, and consider the relative value of this commodity there and at home, we are not a little startled at the result of our inquiries. "First-rate meat is sold in the market at Buenos Ayres by the piece and not by weight, *a leg of mutton costing from* 10*d. to* 1*s.*, *and beef is comparatively cheaper*;"* the flocks of sheep about the River Plate are so numerous, that "the term of natural life of the animal renders it henceforth necessary that there should be annually slaughtered and, for want of a better means of utilizing them, 'boiled down' more or less 6,000,000 to 7,000,000 sheep, otherwise they would die natural deaths or from starvation, and their carcass-products, the main sources of a breeder's profit, be lost,"† and on an "Estancia" belonging to a well-known firm of breeders in Uruguay, which is now being converted into a joint stock company, with a view to the breeding and feeding of cattle and the preservation of meat for the English market, there are nearly 90,000 sheep, 5,600 head of cattle, and 1,200 horses, valued together at 59,227*l.*; in other words, the sheep are valued at about thirteen shillings each, and about 7,000 head of cattle and horses are thrown into the bargain gratis, whilst the "freehold" land is said to be "rich bottom land, with scarcely a stone to be found on it, irrigated by numerous rivulets, producing most luxuriant fodder for sheep and cattle," and it is set down in the valuation at eighteen and ninepence per acre.‡ In short, whilst in England the half-starved people are breaking into butchers' shops to enforce a reduction of meat upon tenpence a pound, the same staple may be bought within five weeks' steaming of us at a nominal price, and is annually *destroyed* in immense quantities to save the more valuable (because more easily preservable) fat and hides; and the land upon which the cattle is pastured may be bought under *a pound an acre!* We

* 'Report on the Methods Employed in the River Plate for curing Meat for European Markets,' by Francis Clare Ford, Esq., Brit. Chargé d'Affaires at Buenos Ayres. Presented to both Houses. 1866. London: Harrison & Sons.

† Letter of Mr. W. Latham to 'The Times,' dated Buenos Ayres, Sept. 25, 1867.

‡ 'Supply of Meat from South America,' by A. Prange, Esq. Mr. Prange wrote to the 'The Times,' Oct. 22, and his statement is confirmed by other writers in the same journal, that he can produce the best fed beef on his Estancia, Nueva Alemania, on the River Plate, at twopence per pound!

need not be surprised if here and there a practical man shakes his head sceptically, and asks, What is the use of Science if it allows such a state of things to exist?

As we have already said, the great difficulty to be overcome is the conveyance of the cattle to England or the preservation of the meat abroad, either in its raw state, or at least in such a condition as to render it fit to be brought into competition with English meat, and many persons are engaged both practically and experimentally in endeavouring to gain that end.

Mr. Ford, in his Report already referred to, notices three processes employed at Buenos Ayres for the preservation of meat, namely, Morgan's, Liebig's, and Sloper's; and Mr. Prange in his pamphlet mentions that of Messrs. Medlock and Bailey, of Wolverhampton.

"Mr. Morgan's process is based on forced infiltration," and he has adopted the circulatory system of the body as a means of introducing brine into the tissues. The operation is performed by allowing all the blood to escape through artificial incisions made in the heart of the animal after death, and by the subsequent injection into the heart, and through it into the whole circulating system, of a fluid consisting of water and salt ("one gallon of brine to the cwt."), and "a quarter to half-a-pound of nitre, carefully refined." The writer of the report considers this system of curing superior to that by means of salt outwardly applied, as he believes that the "natural juices and alimentary substances" are retained; and he says, "The meat has hitherto arrived in England sound and good, and I am enabled from personal experience to testify to the admirable quality of the samples I tasted which were inviting and palatable." It will occur to the reader, however, to inquire whether Mr. Ford tasted this "inviting and palatable" beef in Buenos Ayres before it was shipped (for his report comes from thence), or after it had passed through the ordeal of a long sea-voyage in the confined hold of a vessel; and if in Buenos Ayres, then, whence he derives the authority for his statement, that the meat "has hitherto arrived in England sound and good." We have often seen it exposed for sale, at a price below that of salted beef, and although it is sometimes purchased out of curiosity by the middle classes, we may confidently say that it does not compete with home-grown beef, and is of a very inferior quality.

Of Liebig's process, which Mr. Ford describes in detail, we have already spoken; and will now add a few particulars which may interest our readers. "The meat of the animal after being killed is allowed to cool for twenty-four hours; it is then placed in round iron rollers (armed inside with points) which, being revolved by steam, reduce the meat to a pulp. This pulp is thrown into a large vat with water, and allowed to steam for an hour, and is then passed into a reservoir (shaped like a trough with a sieve at the bottom), from whence the fluid of the meat oozes into another vat from whence the fat is drawn off.* The pure gravy is then put into open vats supplied with steam-pipes and with bellows on the surface, which produce a blast and carry off the steam, thus helping the evaporation and preventing condensation. Here it remains from six to eight hours, when it is passed into a filtering vat and drawn off in the form of extract of meat. When cool it partially hardens, and is ready for packing in tins and exportation." Mr. Ford tells us that eight small tins will hold the concentrated alimentary matter of an entire ox, at the price of 96*s.*, and will make over 1,000 basins of good, strong soup, costing, therefore, rather less than a penny a basin.

Mr. Ford speaks rather doubtfully of Mr. Sloper's process;—and, whilst he is very enthusiastic about Morgan's (to which reference has been made), he says concerning that of Mc Call and Sloper, "These gentlemen profess to be able to preserve meat in its fresh and raw state, which is to arrive in England or elsewhere in the exact condition as butcher's meat just killed, &c., &c." He observes, in another part of his report, that the price paid for Morgan's beef is barely remunerative, so the other gentlemen are probably adopting the wiser course of bringing their system to perfection (if this can be done) before applying it in a practical manner. It must be clearly understood that we do not wish to discourage the attempt to preserve meat chemically, but believing that as at present imported it gains little favour, and is calculated to raise a prejudice which it may be found very difficult to remove hereafter, we would recommend the greatest caution in the practical application of any new system. Messrs. Medlock and Bailey use Bisulphite of Lime, and Mr. McCall Bisulphite of Soda in the preservation of his meat; both these processes are patented, and we believe the system of injection is employed as described above.

By far the most valuable, as it is the simplest, system of preservation, however, is that of packing the meat in tin cases as practised in America, Australia, and at home, and to this we shall now direct the reader's attention. At Mr. McCall's Factory in Houndsditch this operation may be seen in perfection, and no secret is made of the process. On entering the factory, the visitor is struck with the long rows of legs of mutton and venison, and pieces of meat to be preserved; and is introduced into a large shed where a great many butchers are employed in cutting the bone and a portion of the fat from the meat, and reducing it to a suitable form for preserving in tins. The raw meat is then packed tightly in these tins (varying in weight from half-a-pound to six

* We are quoting Mr. Ford, and must not be held responsible for the verbiage of a State document.

pounds), and a little water being added the lids are closed, a small hole being left in each of them; and a considerable number are then placed in a bath in such a manner as to leave the upper part of the tins exposed. This bath contains Chloride of Calcium in solution raised to about boiling point, and whilst the contents of the tins are boiling, the water escapes as steam through the holes punctured in the lids. After a time the air is all expelled, the holes are soldered up, and the tins with their contents transferred to another bath, but raised to 260 degrees, and should any of them be imperfectly soldered they at once begin to leak. After boiling there for some time the meat is in a fit state for being kept any length of time, and it only remains to ascertain whether the air has been perfectly excluded. For this purpose the tins are placed in a dry chamber warmed up to about 90 degrees, and are left there for a time. The workman then gives each tin a light tap at the upper end, and if it emits a hollow sound, indicative of a space below, he is satisfied there is a vacuum and marks the tin as perfect; but should the sound be dull, as though the meat were in immediate contact with the lid, such a tin is not considered fit for retention and is set aside. Meat so preserved is already very largely employed for ships' use, and it is hardly necessary to say that as so simple an operation may be, and is, performed abroad where meat is cheap, as well as in England where it is dear, the development of this branch of industry will have a most important effect upon our meat-supply.

The great desideratum will be to provide a quality of meat suitable for preservation, and as that applies to all systems, whatever they may be, we shall now direct our attention to this phase of the subject. Of the remarkable facilities which exist on the River Plate for the breeding of sheep and cattle we have already spoken, and we would now, in passing, direct the reader's attention to the illustration accompanying this paper, which will convey some idea of the appearance of an *Estancia*, or cattle-breeding and sheep-shearing farm in Uruguay. In the foreground are the cottage with its *Corral*, or cattle-pen, its store and shearing house, and in the distance, the sheds, wharf, and vessels loading hides, tallow, and wool. These are the chief products of the live stock, besides the calcined bones, which the breeder aims to secure, the flesh being quite a secondary matter, and all authorities are at present agreed that the meat offered for sale on the River Plate is not suitable for preservation and exportation. The reasons are that the cattle is wild and unfit for slaughter, that no attempt on a large scale has been made to breed such as would produce good meat, and that if even the stock sent to Buenos Ayres be of a good description when it leaves the Estancia, it arrives there "miserably fatigued, the effect of which on the meat cannot but be disastrous, as after that its nutritive power is diminished and it cannot keep,"* and Mr. Latham considers that "it will take two or three pounds of Argentine meat *in its usual condition* to equal in nutritive value one pound of English-fed meat." It must therefore be obvious to every reflecting person, that if such meat be exported to England, and arrives here in the best condition, the price at which it is offered, say fourpence a pound, cannot afford a sufficient inducement to purchasers, who would find a better investment for their money in home-grown meat at sevenpence or eightpence per pound. There is, however, nothing impracticable in the way of feeding-up suitable animals, and the land and cattle owners do so for their own use on the farm. Mr. Prange writes to 'The Times': "I have every year reared a small number of oxen for household consumption, and I may safely say that their beef is as tender and juicy as the fine joints I dine off at this hotel."† "Beef," he further adds, "from the cattle as now reared can be bought in Uruguay at a half-penny per pound; and I shall make a fine business of it, if in a few years I can sell 6,000 oxen, fattened on my land, at 2*d.* per pound for the best beef."

Seldom have words of so encouraging a kind appeared in the leading journal, and we have no hesitation in saying that as such a result can be attained within four or five weeks' voyage of our shores, the time is not far distant when a large supply of wholesome meat will find its way into our markets. As long as there was no regular outlet for such beef—it being worth in Buenos Ayres less than a penny a pound, and employed only as "charqui," or jerked beef for export to Brazil and Havannah for the use of the slave population—it was not likely that the breeders would trouble themselves to improve its quality. Soon, however, it will come into competition with English preserved meat; and an Estancia has just been sold to a German Joint Stock Company established for the manufacture of the extract of meat, whilst another has for some time been worked by the "Antwerp Liebig's Meat Extract Company."

With respect to the improvement in the breed of Cattle, and the fattening of stock, there appears to be no difficulty whatever. Mr. Latham in his letter to 'The Times,' and in his excellent work on the River Plate, has discussed the subject fully and impartially,‡ and what he tells us agrees entirely with the statements of the owners of large Estancias. For many years past, English bred cattle has been imported for the purpose of crossing with and improving the native breeds, and on the better regulated Estancias good cross-bred

* Mr. G. Bell's letter to 'The Times,' October 28, 1867; and 'The States of the River Plate' (p. 140), by Wilfred Latham. Longmans. 2nd edition. 1868.

† Morley's.

‡ 'The States of the River Plate,' pp. 15, 19, 22, 23, 34, 44.

(short-horn cross) cows are kept. Oxen are also fed up (as stated by Mr. Prange as well as Mr. Latham) for the use of farmers, and the latter gentleman informs us that the produce of crosses of short-horned and Hereford bulls with selected native cows, when somewhat extra care is taken to secure the even growth, is, as he has seen and proved, highly satisfactory, especially in the third or more advanced crosses, and "on the same feed, they will make nearly double the beef and fat that can be attained from the native breed." As to sheep, Leicester, Lincoln, Southdown, and Shopshiredown varieties have been imported and successfully intercrossed with native breeds.

Then with regard to the feeding process. The natural resources of the country appear likely to suffice, without the necessity of importing artificial food. There is "succulent, as well as tall, sedgy, and hard grass,"* and the grasses are more tender and less coarse in the province of Buenos Ayres than in the other provinces. We are informed also by the owners of large Estancias that some of the pastures teem with rye-grass and clover. Moreover, we find that many flesh, as well as fat-forming grains, such as wheat, barley, and Indian corn, are largely grown, whilst the oleaginous seeds, such as linseed, &c., could easily be cultivated. Mr. Latham even speaks of a wild thistle growing in "camps," and covering immense tracts of land, on the oleaginous seeds of which the sheep feed and grow fat. All the requisites for artificial feeding are therefore accessible, and there is really no reason why the finest stock should not be raised there, as it is in England. Nevertheless this work should not be left to untutored hands, and we cordially endorse Mr. Latham's recommendation, that if the attempt be made to produce and fatten stock for exportation, alive or dead, "such an initiatory and experimental undertaking must necessarily be placed under the direction of men who have a good practical and theoretical knowledge of cattle feeding, and also of the country, its climates, products and agricultural capabilities, together with perseverance and zeal."† As to the difficulties of conveying the meat to England when a good quality is obtained, those will, we think, be found to diminish year by year. If it has been possible to transport selected stock in safety from England to the Plate for breeding purposes, it is obvious that there can be no serious obstacles to the importation from thence of live stock, more especially if large steamers are fitted up for the purpose. In fact the Liverpool steamers to the River Plate have already commenced to carry deck-loads of live sheep from thence to Rio. The next plan is that of preservation in closed packages as already described, in which case the meat should be lean, and *flesh-forming* food should, we think, be largely used in the feeding

* 'States of the River Plate,' p. 15. † Ibid., p. 46.

process. Of the chemical preservative operations we have already spoken at length. At present they do not inspire much confidence where the object is to preserve meat for long voyages, for if there be anywhere in the world a fastidious diner, it is the Englishman of every rank. What improvements in these systems may be introduced concurrently with the production of an improved quality of meat abroad we are unable to say, but we would recommend those who are practically engaged in the rearing of cattle and the preservation of beef to turn their attention to the smoke drying and curing processes already in use. In this case also the cattle must not be too fat, for the fat decomposes more readily than the flesh: and of the curing processes known to us, that which appears the most likely to be immediately successful and remunerative is the one by which "Hambro' smoked beef" is prepared. This kind of beef is becoming a great delicacy even in England; and as the breeders on the Plate have, from their associations and connections (many being Germans) peculiar facilities for perfecting the process there, where the raw meat has only a nominal value, we hope soon to see it sent over in large quantities, and of a quality equal to that now imported from Germany.

These are a few of the numerous devices by which it is sought to supply our home market with imported meat of a wholesome and nutritious description, and the reader will perceive that the resources of trade, navigation, art, and science are being brought to bear in the execution of this all-important object. There is no unmixed evil: indeed what we in our ignorance are apt to regard as an evil is often designed by Providence as the incentive to exertion and progress; had it not been for the alarm excited by the cattle plague, it is not improbable that the vast resources of the River Plate and of our own Australian Colonies, to the development of which the energies of the adventurous trader and agriculturist are now being directed, would have lain dormant for years to come, until perhaps, with an increased population, we should have found ourselves reduced to an extremity and exposed to fatal dangers which may now be happily averted.

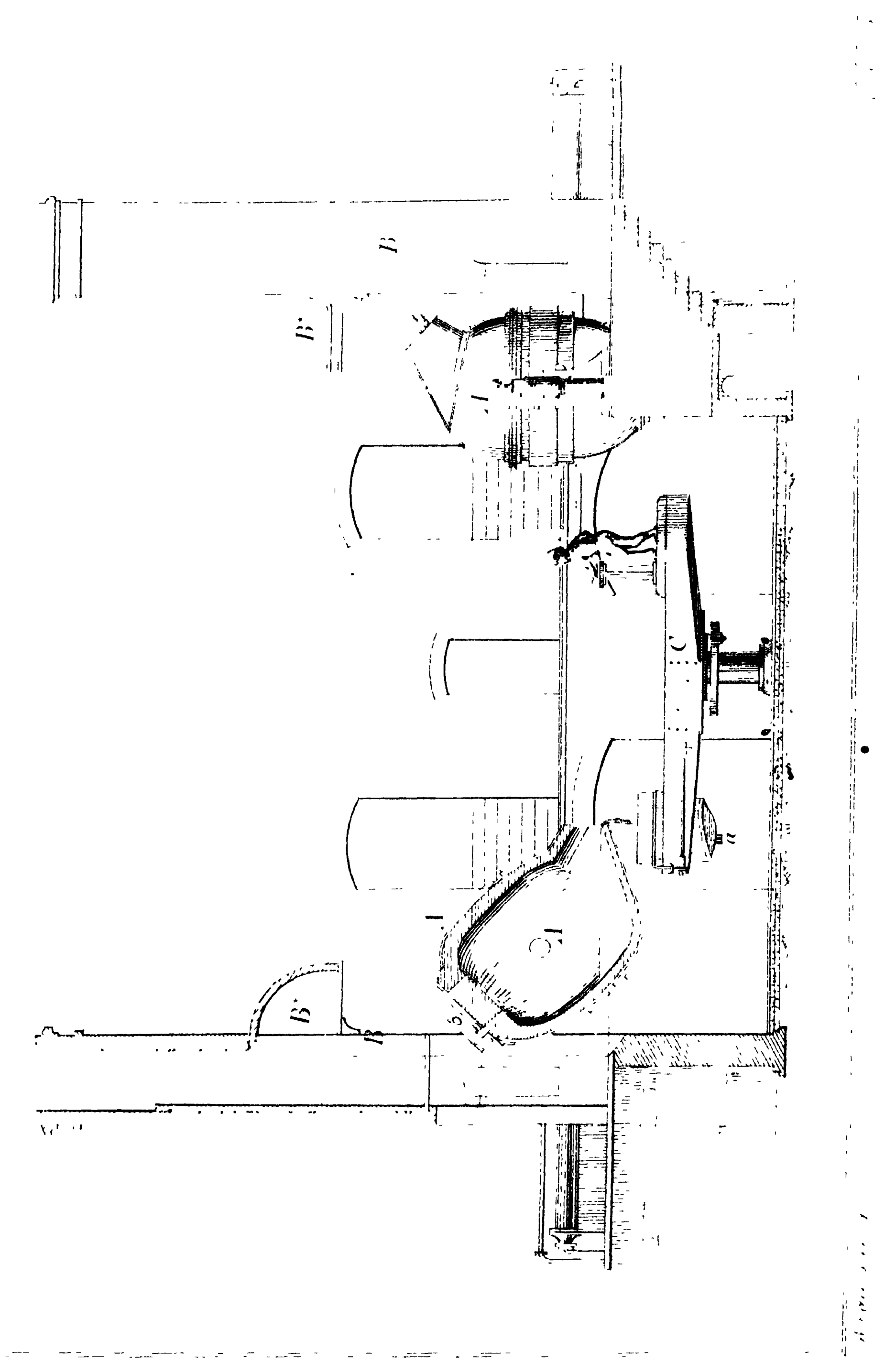
II. ON THE MECHANICAL PROPERTIES OF IRON AND STEEL.

By W. Fairbairn, F.R.S.

Henry Bessemer, like his prototype, Cort, has effected a revolution in the manufacture of iron and steel; and the present improvements exhibit a means of development by which the former will ultimately double its strength, and in the state of steel be substituted for purposes of construction. The result of this change, when applied to structural purposes, is considerable, as half the weight of steel is equal in strength, and consequently is cheaper than a given weight of iron. In almost every case where iron is at present used, steel would then be employed: as in the construction of bridges, ships, and other structures to which iron is now applied. It only requires certainty and uniformity of character in its manufacture, to ensure its superiority and extend its application. This has not as yet been accomplished; but the Bessemer process, by depriving the crude metal of its carbon in a separate vessel, certainly tends in that direction; for by this process increased facilities are not only afforded, and new combinations formed, but the introduction of measured quantities of the same metal, containing the requisite quantity of carbon, poured into the converting vessel, appears to be the only true principle on which steel in its varied conditions of ductility, tenacity, &c., can be produced. These quantities, when duly proportioned, indicate the quality of the steel to be obtained from this process, and, when cast into ingots are ready either for the forge or the rolling-mill. From this it will be seen that every description of homogeneous iron or steel may be produced, care being taken to ascertain the exact percentage of carbon requisite to be infused in order to combine with the mass of refined metal.

This process of conversion as adopted by Mr. Bessemer is entirely new, when compared with the old method employed in the converting furnace with the bars embedded in charcoal, which required at least a fortnight for the refined iron to absorb the necessary quantity of carbon to form steel. By the new system steel is produced in the Bessemer vessel in less than twenty minutes, whereby a great saving of time, fuel, and other expenses is effected. As this process is extremely interesting, it may be briefly described as follows:—

A quantity of pig-iron, containing an average quantity of carbon, say 5 per cent., is melted in one or more reverberatory furnaces, according to the size of the converting vessel to be used, which varies in capacity from five to ten or twelve tons. When the metal becomes fluid, it is run into the converting vessel, to which is



applied a strong blast of air, which combines with the carbon at an intense white heat. This is continued for about eight or ten minutes, until the whole of the carbon is consumed, when the blast is stopped. In this stage a quantity of metal, containing the requisite percentage of carbon necessary to form the exact quality of the steel required, is poured into the vessel, and this combining with the refined iron gives to the mass all the properties and characteristics of steel.

To show the facility with which the crude iron may be converted into refined iron or steel, the converting vessel may be placed if necessary so near to the blast furnace as to allow the iron to flow direct into it; or the metal in the shape of pig-iron may be melted in reverberatory furnaces, as is now generally the case, and thence run direct into the converting vessel. This vessel is of the shape shown in the Plate, supported on trunnions at A, which enable it to turn upon its centre and discharge its contents into a large ladle when the process is complete. The general apparatus will, however, be better understood by referring to the Plate, which is a view of the interior of the converting house. It will be seen that two vessels, A A, are employed; they are placed in such a position as to throw the sparks and slag away from each other, and into the lower part of the chimneys, B B, which have hoods at B* to conduct the flame into them. The casting pit is semicircular in front, and central to it is placed the casting crane C, which supports the ladle into which the steel flows, and from which it is delivered through a cone valve, *a*, at the bottom of the ladle. One of the vessels is shown in section in the act of pouring out the fluid steel into the ladle, while in the other the process of conversion is going on. When necessary both vessels may be worked at the same time, and their contents poured into one large ladle, so that an ingot of 20 tons may be made from what is usually styled a 10-ton apparatus. It will be observed that the hydraulic casting crane, C, is brought so far from the line formed by passing through the centres of the converting vessels as to allow one vessel to be moved round if necessary, while the ladle is in front of the other vessel. This position of the crane enables the casting pit to be made larger, and gives more space for the moulds.

In the act of pouring the steel from the converter into the casting ladle, the crane is steadily lowered and its bend moved round to accommodate the curved path in which the spout of the converting vessel moves. This lowering of the crane is effected by a boy on the valve stand, which is situated at a distance of about twenty feet from the casting pit, and in a line with the centre of the casting crane. On this stand the cocks for the moving of the vessel are placed; here also are the handles of two large balanced air-valves by which the blast is regulated.

To ascertain the comparative values of steel when subjected to transverse, compressive, and tensile strains, the following abstracts of results have been taken from "Fairbairn's Experimental Researches" on the mechanical properties of Steel in its present improved state of manufacture.

Abstract of Summary of Results from the Experiments on Transverse Strain.

Manufacturer.	Mean value, D, of the deflections for unity of Pressure and Section.	Modulus of elasticity, E, corresponding to 112 lbs. Pressure.	Work of deflection, U, for unity of Section.	Value of C, the unit of Working Strength.
				Tons,
Messrs. Brawn & Co.	·0012739	31,551,000	52·721	5·918
,, Cammell & Co.	·0013518	30,680,000	·5·9897	5·921
,, Naylor & Vickers....	·0013007	29,481,000	65·049	6·548
,, S. Osborn & Co.	·0014296	27,540,000	52·574	5·622
,, Bessemer & Co.	·0016384	28,673,000	49·489	5·659
,, Sanderson Brothers ..	·0013229	29,355,000	47·411	5·521
,, Turton & Sons	·0013120	30,750,000	52·680	5·886
The Titanic Steel Co.	·001235	33,088,000	63·542	6·435
Mean.	·0013615	30,141,000	55·420	5·939

In this short abstract we are unable to give the experiments in full or the General Summary of Results, our limited space admitting only the mean value of each sample of bars as received from the different works. These bars were of different qualities, and were tested separately in order to determine their tenacity, elasticity, ductility, &c., and the details of each are given separately in the general table of Results. From these tables we have merely taken the mean of the resistances to strain and the working values of the bars as determined from the experiments and the samples, taken collectively, from each marker. In the general report, the strength and other properties of the different specimens are given separately, and for these details we must refer the reader to the 'Transactions of the British Association' for 1867.

It will be observed that the above and the following tables of Results are taken from the General Summary, where the deflections, elongations, and compressions are carefully recorded; and from these are deduced the different powers of resistance and working value, as exhibited in the columns of each table. The difference in this case is, that the mean results are taken from the whole number of specimens received from each maker, and not from the separate bars experimented upon, as given in the Tables.

The first column gives the names of the makers, or the works from which the steel was obtained; the remaining columns give respectively the deflections for unity of pressure and section, the modulus of elasticity corresponding to 112 lbs. pressure, the work of deflection and the unit of working strength, which is the mean value or working tenacity of each set of bars, as deduced from the experiments in their collective form.

Abstract of Summary of Results from the Experiments on Tension.

Manufacturer.	Weight laid on in lbs. producing rupture.	Breaking Strain per square inch of Section.	Corresponding elongation per unit of length.	Value of U, or work producing rupture.
		Tons.		
Messrs. Brown & Co.	33,603	40·35	·0781	2005
" Cammell & Co.	33,718	45·14	·0591	2714
" Naylor & Vickers	39,448	48·25	·0372	1826
" S. Osborn & Co.	44,129	46·07	·0340	1842
" Bessemer & Co.	38,189	40·15	·0753	3212
" Sanderson, Brothers	39 592	42·65	·0229	1253
" T. Turton & Sons	39,925	41·61	·0165	807
Mean	38,372	43·46	·0461	1951

From the above it will be seen that the mean of all the specimens of steel experimented upon is greatly in excess of iron, which, taken at a breaking strain of 20 tons per square inch of section, gives a ratio of 43·46 : 20, or as 2·17 to 1, being more than double that of iron in its resistance to tension. These and previous experiments clearly show the advantages which this material has over iron in its malleable state, and the important benefits which it is likely to confer when rightly applied in constructive art.

Abstract of Summary of Results from the Experiments on Compression.

Manufacturer.	Greatest weight laid on per square inch.	Corresponding compression per unit of length.	Value of U, or work expended in crushing the bar.
	Tons.		
Messrs. Brown & Co.	100·7	·347	39,101
" Cammell & Co.	100·7	·339	38,231
" Naylor & Vickers	100·7	·287	32,300
" Osborn & Co.	100·7	·267	30,014
" Bessemer & Co.	100·7	·379	42,720
" Sanderson, Brothers	100·7	·328	36,906
" T. Turton & Sons	100 7	·260	29,256
Mean	100·7	·315	35,504

This table shows the resisting powers of steel to a force tending to crush it; the middle column exhibits the amount of compression produced by 100·7 tons, the mean of which is ·315.

These experiments also indicate the superior resisting powers of steel, which in every case is greatly superior to iron in all the varied forms of resistances to strain to which it may be subjected.

We have given this short abstract from a long series of recent experiments in anticipation of steel superseding iron in almost every case where strength is required. That the time is not far distant when this will be accomplished, we have every reason to believe, and assuming that the change will be of great national benefit, we shall hail with the liveliest satisfaction the disappearance of iron and the substitution of steel as a superior material for general purposes of construction.

III. ON EXPERIMENTS FOR ASCERTAINING THE TEMPERATURE OF THE EARTH'S CRUST.

By Edward Hull, F.R.S.

The question of the rate of increase of temperature of the Earth's crust from the surface downwards is one which engaged the attention of members of the British Association at the recent meeting in Dundee, and to the investigation of which, by actual experiment, the Association is likely to devote some portion of its funds. In anticipation of such operations, we venture to offer a few observations both as regards what has been done and what may be done and the mode of doing it, even at the risk of suggesting matters which have already occurred to the minds of those who are to carry out the experiments entrusted to them. It is desirable that whatever money and labour are to be devoted to this purpose should not be uselessly expended in the repetition of observations which have already been made with a degree of accuracy as great, perhaps, as the case admits of, but that they should be used in perfectly new and untried grounds, or, in other words, for the testing of hitherto unexplored depths. Before entering, however, upon this branch of our subject, we shall prepare the way by bringing to the reader's notice examples of what has already been done by previous investigators.

Although the opinions of philosophers regarding the condition of the internal nucleus of the globe are widely different, all are probably agreed as regards an actual increase of temperature from the surface downwards to an unknown depth; and that this is the fact the evidence both of a theoretical and experimental character is probably conclusive. It is no argument against this view that we find strata, in their natural or unaltered state, which on stratigraphical grounds we believe to have been at one time buried beneath newer strata to a depth of several thousand feet; for assuming the increase of heat to be at an average rate of 1° Fahr. for every 60 feet, the boiling point of water would not be reached under 12,720 feet; and while on the one hand it is doubtful whether metamorphism would take place in ordinary strata at this temperature, it is seldom we meet with rocks which we are certain had originally been buried at much greater depths.

Whether this increase of temperature is continuous for any considerable distance in reference to the semi-diameter of the earth, or whether it increases or diminishes according to definite laws, are questions which are probably beyond solution by actual experiment, for, in the words of Humboldt, the question of the internal central heat, as a mathematical problem, "yields rather negative than positive results." The experimental evidences, however, as far as they come within the range of investigation, all point to one conclusion. They are also of several kinds, derived from observations of the temperature of the water springing from different depths through artesian borings—those obtained from testing the temperature of the water issuing from coal-seams and fissures in mines, and those obtained from observations made during the sinking of mining shafts both through wet and dry strata. It is on the experimental evidences we propose here to dwell, and taking some examples from authorities within our reach, to present the reader with a succinct account of what has already been achieved, and afterwards to offer some suggestions as to the best manner, in our opinion, for pursuing further investigations.

One of the most remarkable and carefully-observed cases of artesian borings is that of the Puits de Grenelle, near Paris. The sinking of this bore-hole was watched by Arago till 1840, down to a depth of 1,657 feet, when the borer had left the Chalk formation, and was beginning to penetrate the Gault. The series of observations were completed by Walferdin in 1847. The surface of the basin of the well at Grenelle lies at an elevation of 119 feet above the sea, and the borings extend to a depth of 1794·6 feet from the surface. The water which rises from the Lower Greensand formation is of a temperature of 81·95° Fahr., and the increase is at the rate of 1° Fahr. for every 59 feet.*

The next boring we shall describe is that of Neu Saltzwerk, in Westphalia, and situated 231 feet above the level of the sea at Amsterdam. It penetrated to an absolute depth of 2,281 feet from the surface. The salt-spring lies, therefore, at a depth of 2,052 feet below the level of the sea, a relative depth which is, perhaps, the greatest that has yet been reached. The temperature of the brine is 91·04° Fahr., and as the mean annual temperature of the air at these works is about 49·3°, we may assume there is an increase of 1° Fahr. for every 54·68 feet.† This boring is 487 feet deeper

* 'Cosmos.' Trans of Otté and Dallas, v l. v., p. 35–6. † Ibid., p. 36–7.

than that of Grenelle, and the temperature of the water is 9·09° Fahr. higher.

An artesian boring in the vicinity of Geneva to a depth of 724 feet, and at an elevation of 1,600 feet above the sea-level, showed the increase to heat at the rate of 1° Fahr. for every 55 feet; while another at Mendorff, in Luxemburg, which penetrated to a depth of 2,394 feet, gave a result of 1° Fahr. for every 57 feet. This boring is particularly interesting and valuable, not only for its depth, but from the fact of its passing through several formations, including the Lias, Keuper, Muschelkalk, Gies bigarré, and entering slaty rocks.*

Some years since, Mr. R. Were Fox undertook a series of experiments on the temperature of the Cornish mines, which are reported in the 'Transactions of the British Association.'† These experiments appeared to show that the increase of temperature was in a decreasing ratio to the depth; but it is to be recollected that in the case of mines, the temperature is affected by several sources of error, such as the spontaneous combustion of pyrites. The results, however, are not without value, and are as follows:—

At a depth of	*354 feet*	*the temperature was*	*60° Fahr.*
,,	792 ,,	,,	70° ,,
,,	1,434 ,,	,,	80° ,,

Assuming the invariable temperature, presently to be explained more fully, to be 50° Fahr., the rate of increase would be arrived at as follows:—

10° at 354 feet, less 50‡ = 304 feet,	or 1° in 30·4 feet.
of 10° at 438 ,,	or 1° in 43·8 ,,
and of 10° at 684 ,,	or 1° in 64·2 ,,

The observations taken in the Tresavean mine in 1837, which were the deepest of the series, gave the following results:—

At 1,572 feet from the surface the temperature was	82·5° Fahr.
At 1,740 ,, ,, ,,	85 3° ,,
At the above depth in another lode ,,	86·3° ,,
,, in a third lode ,,	92·1° ,,
Giving the mean temperature for a depth of 1,740 feet	87·9° ,,

Mr. R. Hunt, F.R.S., who has made some observations in reference to the question of increase of temperature in mines, states that he has found the temperature as high as 100° at a depth of 1,920 feet (320 fathoms) in the Tresavean mine.

Several carefully executed experiments carried on in coal mines have been recorded; and amongst the earliest on which much reliance is to be placed, are those of Professor J. Phillips, F.R.S., at

* 'Cosmos.' Trans. of Otté and Dallas, vol. v., p. 3–56. † Vol. ix.

‡ 50 feet from the surface is here assumed as the depth of no variation of temperature all the year round.

Monkwearmouth Colliery, near Sunderland, at a depth of 1,590 feet, from water issuing from a coal-seam at a depth of 1,499 feet below the sea-level, and which gave a resulting increase of temperature of 1° for every 60 feet.*

During the sinking of Rose Bridge Colliery, near Wigan, to the celebrated Cannel-seam, between the years 1854–61, careful observations of the increase of temperature were made by the manager, Mr. Bryham, and communicated to the author; the following are the results:—

At a depth of	483	feet the temperature was found to be		64·5°	Fahr.
"	564	"	"	66°	"
"	1,650	"	"	78°	"
"	1,800†	"	"	80°	"

Taking the invariable temperture at 50°, and at a depth of 50 feet, the resulting rate of increase is 1° Fahr. for every 58·3 feet.

But of all the observations as yet made, perhaps the most elaborate are those which were undertaken by Mr. W. Fairbairn, F.R.S., during the sinking of the Astley Pit of the Dukenfield Colliery in Cheshire.‡ These observations were carried on over a period of ten years (between 1848–59), and reach downwards to a total depth of 2,151 feet from the surface. Great care was taken to remove the thermometer from the disturbing influences either of the air in the shaft, or of water in the strata. The instrument was as often as possible inserted in a dry borehole in advance of the sinkings, and left in its bed from two hours to two days, according to circumstances. Fifty-two observations are recorded, and range from an invariable temperature of 51° Fahr. at a depth of 16½ feet from the surface to 75·5° at the bottom of the pit, and 75·0° at 22 yards lower in the roof of the "Black coal," taken seven months afterwards. This last observation does not in all probability give the original temperature of the stratum, which we may well suppose was somewhat lowered, owing to contact with the air. Rejecting for the above reason the last observation, we find that there has been an increase of 24·5° in 2,040 feet; so that the average rate for the whole depth is 1° for every 83·2 feet.

This series of observations is the most valuable of any that have been made in this country, both as regards the unsurpassed depth to which they extended, and the care that was taken to ensure accuracy. On the whole (with occasional minor variations) they show a remarkable uniformity in the rate of increase, and induce confidence

* 'Philosophical Magazine,' vol. v.

† Another observation was made nine months afterwards, when it was found the temperature had cooled down 8°, or from 80° to 72°, owing to contact with the down-current of air.

‡ See account of these observations by Mr. W. Hopkins, F.R.S., in the 'Philosophical Transactions,' vol. cxlvii.

in the results. From the following analysis, it will be observed that at the lowest depths the rate of increase was nearly as great as at any portion of the descent:—

The first observations gave 51° as the invariable temperature at a depth of 16½ feet, as already stated.
Between 693 feet and 710 feet the temperature was nearly uniform at 58°.
Between 710 and 927 feet the rate of increase was 1° for 62·4 feet.
Between 927 and 1,257 feet the rate was 1° for 60 feet.
Between 1,257 and 1,839 feet the rate was 1° for 86·91 feet.
Between 1,839 and 2,055 feet the rate was 1° for 65·6 feet.

And the mean of the whole series of observations gives 1° for every 83·2 feet, which is under the average of the observations.

The increase of temperature appears to be independent of altitude, of the place, or of the density of the air, as proved by the observations of Humboldt.* Thus, in a silver mine in the Andes of Peru, at an elevation of 11,875 English feet above the sea, the temperature was found to be 25·4° Fahr. higher than the external air. In another mine at the same elevation, the difference between the temperature of the internal and external air was found to be 15·8° Fahr., and the water streaming down the rock showed 52·3° Fahr. These observations were repeated in other localities with similar results.

The concurrent testimony, therefore, of all the observations which have been made, is in favour of an increase of temperature, though at rates varying considerably from one another, and this has been established as holding good down to a depth of about 2,400 feet from the surface. What seems to us now to be required, and for several reasons, is a series of experiments made at even greater depths.

First.—With so many recorded observations, all approximately concurring towards one conclusion, any sinkings or borings to a depth of less than 2,000 feet would, in all probability, only afford another series of similar results, and would be so much money uselessly expended; and secondly, it seems probable that at greater depths several sources of error would be avoided. Of all these sources of error—the percolation of water through the strata—is probably the most formidable; now it has generally been found that the quantity of water in coal-mines derived by percolation from the surface, decreases in proportion to the depth, and that at depths greater than 500 or 600 yards the mines are dry. It is somewhat difficult to account for this where there are thick beds of porous sandstone, but it is to be recollected that a rock which is full of joints and fissures at the surface, is often found extremely solid at a considerable depth, and the friction, or resistance to percolation,

* 'Cosmos,' Sabine's Trans., vol. iv.

of the particles of which it is composed, offers an accumulative obstacle to the passage of water downwards, more than balancing the hydrostatic pressure, and amounting at length to an absolute stoppage. This is a conclusion which wells in the New Red Sandstone—itself a very porous rock—seem to offer, for after a certain depth has been reached, the increase of supply appears to take place in a diminishing ratio to the depth,* and we may suppose a zero point would ultimately be reached.

As far, then, as our experience goes, it is very probable that at depths greater than 2,000 feet, no water would be found in ordinary coal-measure strata, and thus by sinking in this formation a principal source of error would be avoided. Other sources of error (such as those arising from differences in density, and conducting power in the several varieties of strata) being of less moment, would disappear, or become inappreciable, on taking the mean temperature of very deep borings.

After much consideration, the plan which we venture to recommend, in case of experiments being undertaken by the British Association, or any other scientific society, would be, not to commence at the surface, but at the bottom of a coal-mine, of not less depth than 600 yards.

There are several collieries, particularly in Lancashire and Cheshire, sufficiently deep for the purpose. It would be an easy matter to excavate a chamber in the coal and its roof, where the borings might be carried on. The chamber ought to be a short distance from the bottom of one of the shafts, and out of the way of mining operations. As the process of boring progressed, observations should be taken at every 10 yards, and at every change of strata from sandstone to shale, or coal. The boring might be carried down at least to a total depth of 1,000 yards from the surface, and having been completed under proper supervision, could not fail to give results of value to science. It is also probable that a proprietor of some colliery of the required depth would willingly afford the facilities for carrying on the experiment for the sake of the information he would derive regarding the minerals underlying the coal-seam then being worked.

Before closing these observations, some further explanation is required regarding the depth of invariable temperature, or, in the words of Humboldt, the depth of "the invariable stratum." The surface of the earth undergoes a change of temperature according to the season of the year. In summer the rays of the sun and the warmth of the atmosphere affect the surface and penetrate gradually downwards with decreasing intensity, while in winter the cooling

* As may be gathered from the account of the sinkings at the Green Lane Well of the Liverpool Corporation Waterworks. See 'Quarterly Journal of Science,' vol. ii., p. 421.

influences prevail from the surface downwards, and the result is, the formation of an envelope or stratum of invariable temperature at a short and variable distance from the surface all over the globe. The temperature of the invariable stratum approximates to that of the mean annual temperature of the place, and, according to Humboldt, its depth is regulated by the latitude (increasing from the Equator towards the Poles), by the conducting power of the rock or soil, and by the amount of difference between the temperatures of the hottest and coldest seasons. At Greenwich, the mean temperature is 49·5°, and that of the invariable stratum about 50·5° at a depth of about 50 feet from the surface.

It will be evident, on reflection, that the stratum of invariable temperature is the standard of departure for all measurements at greater depths, and this point would require a separate series of experiments for its determination at the locality selected for the deep borings; but for ordinary purposes it is probable 50° Fahr., at a depth of 50 feet, may be taken as the temperature and depth of the invariable stratum over the greater part of Central England.* In the latitude of Paris (48° 50′) the depth and temperature of the *Caves de l'Observatoire* (86 feet and 53·30 Fahr.) are generally regarded as those of the invariable stratum.

It is scarcely necessary to point out the questions on which an accurate series of observations extending to great depths might throw light. As one illustration, we may select the subject of metamorphism of rocks, which is full of difficulties requiring solution, such as that presented by the rocks of the highlands of Scotland, where we find the metamorphosed Lower Silurian rocks reposing on unchanged Cambrian sandstones. Again, the change of bituminous coal into anthracite is only as yet partially explained in such instances as those of South Wales and the coal-field of the Don, where the same beds occur in both forms at opposite sides of the field. The nature and the fluidity of the interior of the earth itself is also at this moment (and probably ever will be) a matter of controversy among physical philosophers,† and one of those questions on which possibly some light might be thrown by the proposed experiments, though considering the small fraction of the earth's radius which comes within reach of man's feeble operations, one cannot be very sanguine on this head. It is to be remembered, however, that in prosecuting physical researches, it is not necessary to have a definite end in view, except that of adding to our knowledge. No new and well-certified observation will be allowed to lie for ever useless.

* See Professor Forbes' "Experiments on the Temperature of the Earth at different Depths."—'Trans. Royal Society of Edinburgh,' vol. xvi., 1849.

† I refer more particularly to the views stated by Dr. Sterry Hunt in his lecture before the Royal Institution, London; and the reply thereto by Mr. D. Forbes.—See 'Geological Magazine,' vol. iv., pp. 357 and 413.

IV. THE PAST AND PRESENT OF CHEMISTRY.

By Dr. Herrmann Kopp,
Professor of Chemistry in the University of Heidelberg.

Chemistry is generally regarded as one of the youngest of the sciences, and as exhibiting most unmistakably several characteristics of youth. Some think that, whilst she has made rapid progress of late, her development has achieved, in some aspects at least, but little of a solid and lasting character. Others allege, as a characteristic of her youth, that she often presumptuously gives her opinion and advice. She brings her judgment, supported by knowledge only just acquired, to bear upon older sciences, whilst she claims to be heard in the discussion of subjects with which her elder sisters have earnestly occupied themselves for centuries. In fact the venerable science of medicine, with her continually changing aspect, the somewhat younger natural philosophy with her glorious modern developments,—these and many other sciences long held in respect, may assert that they were already well grown when chemistry was still in her babyhood, talking nonsense, and manifesting the most perverse tendencies,—that they can remember the time when they took the infant under their fostering care, and led her by the hand.

Chemistry cannot deny this. She even gratefully acknowledges it, notwithstanding that, under their care, she was at times somewhat grossly maltreated. She cannot avoid the confession that, in her present aspects and pursuits, she is still very young; on the other hand, however, she may fairly plead that she does not quite date from yesterday. She can prove by documents, which, though not altogether indisputable, have yet considerable claims to authenticity, that she was at least in existence 1,500 years ago. It must be admitted that this is a respectable age, although insignificant as compared with that of some other sciences whose birthdays are lost in the gray mists of antiquity.

How can this ripe age of chemistry be reconciled with the youthfulness to which she generally confesses, and on account of which she has not unfrequently to submit to many reproaches? The mystery is explained when we take into consideration that the science which was known as chemistry to the ancients occupied itself with the solution of problems of an entirely different nature from those which engage the attention of chemists at the present day. For a long period chemistry, with childish illusion, pursued a phantom, and attempted the solution of an insoluble problem. Comparatively recent is her occupation with the task which we now consider to be her legitimate employment, and which as regards her way of dealing with it, we now look upon as the correct method of investigation. Chemistry had a long childhood, and the more mature phases of her life are compressed into a comparatively short and recent period. Chemistry in childhood and chemistry in youth are almost as two distinct individuals. Let us endeavour to compare the characteristics of this childhood and this youth—the problems of the one and the pursuits of the other—the past and present of chemistry.

If we search for a connecting link between early and modern chemistry, we find it in a problem, the solution of which has occupied the minds of chemists in all ages. This problem, always more or less prominently kept in view, is the composition of the different substances found in nature or produced by art—the different heterogeneous materials which can be extracted from, or made to combine and form, a homogeneous substance.

The ancients made hardly any attempt to ascertain the chemical composition of substances. First, among the Greeks, and later among the Romans, we find sagacious observations on the diversities of bodies, but it was rather the physical than the chemical differences concerning which scientific observations were made. According to the doctrines of Aristotle, which, promulgated 2,200 years ago, so long maintained their authority, the fundamental properties of everything corporeal and palpable were considered to be dryness or moisture (that is, solidity or liquidity), and warmth or coldness. These are obviously physical conditions and different degrees of a physical property, and on the occurrence and the proportion of certain of these fundamental properties, other qualities, such as density or lightness, hardness or softness, were thought to depend. The assumption of the four elements, Earth, Water, Air, and Fire, offers to the mind a representation of the simultaneous occurrence of these fundamental properties. To Earth, as the representative of all solids, were ascribed dryness and cold; to liquid Water, moisture and cold; to Air or vapour, moisture and heat; to Fire, heat and dryness. The four elements of Aristotle represented fundamental conditions of matter, and the properties of bodies were regarded as depending on the proportion in which they contained the elements—the producers of those qualities. The whole conception was formed from a physical point of view rather than from one having even the faintest approximation to that of chemistry. The elements of Aristotle, as such, were not regarded as contained in different substances—as combining to form them, or as separable from them by analysis. The assumption of their existence did not therefore involve even the merest rudiments of a chemical idea. They were not regarded as different kinds of matter, but as different fundamental conditions which, when added to indifferent matter, endowed it with various properties.

This view, that the difference of bodies depended essentially upon their physical properties, was the natural consequence of the slight knowledge of chemical qualities which the ancients possessed. The idea of chemical composition had not yet been conceived except, perhaps, in its very crudest form, as suggested by the composition of metallic alloys artificially prepared. But the well-known metals were scarcely distinguished from each other; thus lead and tin were regarded by the Romans as differently coloured varieties of the same metal—as dark and light lead. Of the most important chemical problems, such as those relating to combustion, to the changes effected in metals by the action of fire, or the caustic qualities of quicklime, we find scarcely a single one proposed, still less any attempts made at their solution. In regard to their knowledge of chemistry the ancients may be compared to ignorant or half-educated tribes of the present age; knowledge of important chemical phenomena they did not lack, but they made no attempt whatever to discover the causes of these phenomena.

This almost total ignorance on the part of the ancients, especially the Greeks, of any of the aspects of chemistry, is due entirely to their method of scientific investigation. Chemistry is essentially an experimental science, but experimental methods were little known either to the Greeks or Romans. The favourite mode of investigation with the most highly-cultivated people of antiquity, consisted in attempts to attain, by a pure effort of the intellect, to the conception of an universal principle by means of which all phenomena might be predicted and explained. Such a method of research could not even enable them to approach the domain of a science like chemistry. A few centuries later, however, we find the art of experimenting more advanced, and a real, if somewhat vague attempt being made to obtain a knowledge of the chemical composition of at least one class of bodies. It is true that this knowledge was sought after, not for its own sake, but as an aid to the solution of the problem of the transmutation of the common into the nobler metals. Alchemy existed in the fourth century of our era, and for more than a thousand years presented almost the only, and certainly the most important field for the development of chemistry.

Our knowledge of the spread of alchemy, and of the resulting progress of chemistry, is very defective for the period between the fourth and the thirteenth centuries, and we know nothing whatever of the origin of alchemy, nor where it was first attempted. All that can with certainty be said is, that alchemy is undoubtedly older than the most ancient testimony that has reached us concerning it (from the fourth century), for this testimony does not speak of it as a new pursuit but as one which had long been carried on. The confident assertions regarding the practicability of alchemy do not now concern us, but it is important to a clear comprehension of the present state of chemistry that we should know what were the grounds of the belief that one metal could be transformed into another.

The foundation of this belief was a theory of the cause of difference in matter, which finds its best expression in the doctrine of Aristotle already alluded to, that matter itself is everywhere one and the same thing, and that its varieties are produced solely by a variation of its qualities. Changes in the properties of substances, and especially of metals, were recognized at an early period. Thus it was known that, by the action of certain substances, copper could be made as yellow as gold, and, by that of others, as white as silver, the transformation being effected throughout the entire mass. We now know that when red copper is turned into yellow copper (brass) or into white copper (German silver), a change takes place in the composition as well as in the colour; but at the period when alchemy flourished, such a change was not thought of any more than we now consider it as taking place when soft steel is transformed into hard steel—a transformation with which the ancients were also acquainted. The hardness, colour, ductility, fusibility, and some other properties of certain metals could be altered, and hence it was thought that it must be possible so to change all the properties of one metal into those of another, that the one metal would really be transformed into the other. Until the fifteenth century, and even somewhat later, the idea underlying the pursuits of alchemy, was the existence of an universal matter which, endowed with various properties, forms all known substances, and consequently all the metals; in short, that a change in appearance constitutes a veritable transformation of a metal. If a fragment of iron be dropped into a solution of blue vitriol, the iron gradually disappears and in its place we find copper. We now know that the iron is dissolved and the copper contained in the vitriol precipitated; we do not regard the visibly iron-coloured metal, which is dropped into the solution, as including the same matter as the visibly copper-coloured metal which is afterwards found in its place, but in the alchemical stage of the science a totally different view prevailed, and the mythological nomenclature then used, such as Mars for iron, and Venus for copper, clearly expresses the then prevailing theory. The same material which in Mars's coat of mail appeared as iron, reappeared in the garb of Venus (as copper) after being acted upon by the vitriol.

In the sixteenth century chemistry emerged from its previous degraded condition, and passed into the hands of men who were not trammelled by the doctrines of Aristotle. The physicians who were the followers of Paracelsus paid but little respect to ancient authorities, and relied entirely upon their own observations and investigations. Three properties of matter especially excited their attention, *viz.*:—first, that of enduring the action of fire without alteration; secondly, that of being volatilized by heat, in an unchanged condition; and thirdly, that of burning or undergoing change by fire. They assumed that an ideal something, which they called *salt*, was the cause of the property of resisting the action of fire; that another ideal, something which they termed *mercury*, was the cause of the property of volatility; and that a third substance, also ideal, and named *sulphur*, was the cause of combustibility. And as one at least of these properties occurs in every substance, their supposed causes came to be regarded as the constituent elements of all matter. If a substance were found to be combustible, it contained this ideal sulphur; if it volatilized without change, the ideal mercury was present, whilst if it left an unchanged residue, ideal salt was amongst its constituents.

These so-called elements—sulphur, mercury, and salt—the original notion of which may be traced farther back than the sixteenth century, played a most important part in the medical science of that and the seventeenth century. Physicians then believed that the health of the human body, as well as of its separate organs, depended on the combination in certain proportions of the before-mentioned elements, that disease was the result of a disturbance of these proportions, and that restoration to health was effected by their re-establishment. These applications, however, do not now immediately concern us, but they are important as indicating the gradual development of the theory that different substances differ, that is, exhibit different qualities, because they are composed of different ingredients, or of the same ingredients, in different proportions; nevertheless the conception of this idea was still so crude that totally dissimilar substances, such as the incombustible portions of the most widely different bodies were all known as the salt constituent, the universally-accepted elements were purely fictitious, and that hardly any attempt was made to extract them from the substances in which they were supposed to exist.

But whilst chemists were thus busying themselves with these imaginary elements, they were also making gradual progress in the sounder recognition of the composition of a great number of substances. They discovered, for instance, that copper is present in substances which, to the eye, reveal no appearance of metallic copper, as in blue vitriol, and that vermillion contains mercury and sulphur—not the imaginary elements known by these names—but real mercury and real sulphur. Such knowledge as this steadily increased and became more prominent. Towards the end of the seventeenth century it had in fact made such progress, that the recognition of the substances which a body may be proved to contain, was considered as the only problem which chemistry should strive to solve, whilst investigations, involving the assumption of elements, the existence of which cannot be demonstrated, and which, when more closely examined, prove to be imaginary, was regarded as a mischievous fallacy. It was Robert Boyle, who, about the year 1660, first expressed himself decidedly on this subject, and so laboured for the recognition of this truth, that we must regard it as having been established by him. From that time forth those substances only were regarded as the constituents of bodies, which could be extracted from them by analysis, or which had been added to them by synthesis, and those substances only were considered to be elements which defied all known means of analysis. Further, these chemical elements were regarded as fundamentally different kinds of matter of the simplest constitution then known.

What a contrast is exhibited between the ancient idea of the cause of difference in various forms of matter and that which obtained from the time of Boyle! If we consider these two opposite conceptions historically, and the transition from one to the other, they appear like two totally dissimilar pictures; but, like dissolving views, changing, the one into the other by slow degrees. In the first place we have the Aristotelian idea, according to which, matter itself devoid of properties, becomes endowed with characteristic qualities by the addition of properties, and forms, when invested with these properties, the various substances known in nature; then this idea passes gradually into that of the alchemists, but becomes confused in the transition, inasmuch as the differences of physical conditions and properties are no longer regarded as the only causes of variety in substances; the difference in chemical properties receives more attention, the existence of elements, the producers of such properties is assumed; and thus the path is prepared which leads to the idea of chemical composition. Then we see the Aristotelian theory gradually becoming indistinct, whilst the idea of the importance of the chemical deportment and composition of bodies assumes prominence, and at last we see clearly that the differences between the substances which nature presents to us in such overpowering numbers, or which we have ourselves formed artificially, depend upon differences in their chemical composition. The idea of *chemical composition*, which makes its first appearance indistinctly in the history of the chemistry of the middle ages, now forms the foundation of the science. In modern times a clear comprehension of it is the essential condition of all progress.

Turning to modern chemistry: we now recognize sixty-three different simple forms of matter which we term elements, and which, when combined, form all known compound substances. The dissimilarity of these elements and the difference in the modes and proportions according to which they are capable of combining, are now believed to be the causes of dissimilarity in those substances which are regarded as chemically different. Such dissimilar compounds are regarded as being composed either of different materials, or of the same materials in different proportions. Tin, silver, mercury, and sulphur are regarded as fundamentally dissimilar substances; but in wood, in alcohol, in acetic acid, and in many other bodies, the same substances, *viz.* carbon, hydrogen, and oxygen, are contained in different proportions.

Until about the year 1830 it was believed that the chemical differences of bodies depended solely upon the causes just enumerated. It was supposed that the same element could only present itself in one form, endowed with one invariable set of properties, and that from the combination of the same elements in the same proportions, only one and the same substance could possibly result. But at this period facts became known which rendered this opinion untenable. At first these facts were few, and were regarded as exceptions to an essentially valid law, but their number rapidly increased, so that what had previously been considered as an invariable law was now shown to have owed its invariability to limited knowledge, and it became obviously insufficient to explain the chemical differences of bodies. Vinegar and sugar are, even from a purely chemical point of view, widely different substances, but they are composed of precisely the same elements, *viz.* carbon, hydrogen, and oxygen, combined in exactly the same proportions. An extinguished spirit-lamp, the wick of which is still red, emits an intolerably pungent smell; the very volatile liquid which is here produced and which emits this suffocating odour, has the somewhat uncouth name, aldehyde. Acetic ether, which has a delicious and refreshing smell, possesses entirely different chemical properties. Again, butyric acid, which is contained in rancid butter, and which has a most disgusting odour, is a body differing widely from aldehyde and acetic ether. Nevertheless, these three substances, which differ so markedly, both as regards chemical and physical properties, consist of the very same elements, *viz.* carbon, hydrogen, and oxygen united in precisely the same proportions.

In the case also of some elementary bodies such a variation of properties has been observed, that it would be almost impossible *à priori* to imagine that it is one and the same substance which appears in such various forms. The elementary body, phosphorus, which has been known for nearly 200 years as a soft, yellow substance, fusing easily, exceedingly inflammable, and undergoing rapid change when exposed to the air, appears also in the form of a red, brittle material, capable of enduring a high degree of heat without inflaming or undergoing any alteration, even when simultaneously exposed to the air. Again, the element oxygen, contained in large quantities in the air, which has no smell, acts upon certain substances only at a high temperature, and may remain for a long time in contact with moist silver without producing any change in the metal; this very element, when in the condition in which it is called ozone, possesses properties as utterly different as we should expect to find only in a totally distinct substance. It is now a powerfully pungent gas, violently attacking at the common temperature the very same substances upon which ordinary oxygen has no action, and causing moist silver rapidly to become black with rust; in both these cases we perceive the existence of what appear to be different substances of undoubtedly similar composition.

Do not such facts appear to contradict the thesis advanced above as the acquisition of modern chemistry? They certainly do contradict the earlier and narrower conception of it; but they only serve to confirm the wider and more modern view, and to maintain it as the fundamental doctrine of chemistry. A few words of explanation will serve to render this clear. Science can no longer dispense with the hypothesis, that bodies consist of very small ultimate particles, which cannot be further divided without the production of something totally different from the matter subjected to this division. These homogeneous particles, of which a substance is built up, are called the physical atoms or *molecules* of that substance. A piece of copper is composed of copper molecules, the smallest perceptible quantity of oxygen or alcohol, of oxygen or alcohol molecules. A distinction is made between the molecules of bodies, *i.e.* the smallest particles which can be conceived as capable of independent existence, and *atoms*, *i.e.* the smallest particles which can enter into a chemical compound or contribute to the formation of a molecule. The molecules are composed of atoms. The molecules of compound bodies are composed of dissimilar atoms, atoms of different elements, whilst we assume that the molecules of undecomposable bodies—of elements—are built up entirely of the same kind of atoms. We have no knowledge of the absolute number of atoms which unite to form the molecules of different substances, whether a copper molecule, for instance, consists of 2 or 10 or 100 atoms of copper. But we do know or at least we can form very probable conjectures concerning the proportion in which the atoms unite to form a molecule; for instance, in what proportion the carbon, hydrogen, and oxygen atoms are combined in a molecule of alcohol, or what is the proportion between the number of oxygen atoms contained on the one hand in a molecule of alcohol, and on the other in a molecule of common oxygen.

It will now be apparent how the different conditions of the same elementary substance may depend upon differences in its composition. The same elementary atoms may obviously, by combining in different numbers to form molecules, give rise to dissimilar molecules. We know with almost absolute certainty that a greater number of oxygen atoms is contained in a molecule of ozone than in a molecule of ordinary oxygen. We can assume with great probability that the number of oxygen atoms in a molecule of ozone stands to the number in a molecule of ordinary oxygen in the proportion of three to two. Thus, ozone and ordinary oxygen consist of molecules, the composition of which differs, not in respect of the quality but of the number of atoms which they contain. Imagine the oxygen atoms as so many soldiers belonging to one army, although this comparison be a rough one, it is not so inappropriate as might be imagined; for in fact, in chemical action, these atoms do fight against the alliance between other kinds of atoms, and must vanquish their opposition before they can take up and maintain new positions. A certain weight of oxygen consists of an unspecified number of these atoms or soldiers; but in equal weights of ordinary and of ozonized oxygen, the same number is arranged in a different manner. A given weight of common oxygen contains a certain number of these atoms or warriors, which are marshalled in a certain number of battalions or molecules; an equal weight of ozone contains the same number of exactly similar atoms or warriors, which are, however, placed in a smaller number of molecules or battalions. A molecule of ozone is numerically a stronger battalion than a molecule of oxygen. By the help of this crude simile, it is easy to understand how the same element can pass from one of these conditions into the other, and how, according to the different marshalling of the said atoms, the same element may have different chemical effects upon other bodies—may attack the molecules or battalions of which they consist in a different manner.

The explanation just offered of the possibility of similar atoms being arranged in different kinds of molecules, is manifestly applicable also to dissimilar atoms. Imagine different kinds of elementary atoms—carbon, hydrogen, oxygen atoms for instance, to be represented by different kinds of soldiers, as infantry, cavalry, riflemen. Equal weights of acetic acid and sugar contain the same quantities of carbon, hydrogen, and oxygen, *i.e.* the same number of atoms of the three elements, or of warriors of the three different arms. But the arrangement of these warriors in military order—in battalions or regiments—is dissimilar in the two bodies. A molecule of sugar contains a greater number (at least thrice, perhaps six times as great) of atoms of carbon, hydrogen, and oxygen as a molecule of acetic acid. Although the composition of acetic acid is identical with that of sugar, both as regards quantity and quality of the contained elements, yet the molecules of the two substances are of dissimilar formation, *i.e.* they contain the same elementary atoms in different numbers though in the same proportions, and we know with still greater certainty that in aldehyde, only half as many atoms of carbon, hydrogen, and oxygen are united to form a molecule, as in acetic ether or butyric acid, which in all other respects have exactly the same composition, containing the same elements in the same proportions.

But what is the cause of the difference between the two last-named substances—butyric acid and acetic ether, the molecules of which consist of equal numbers of the same kinds of atoms? Obviously the atoms contained in a molecule may differ, not only in number and quality, but also in the mode in which they are grouped together. To employ the simile once more, the battalions are divided into companies, and it is evident that this mode of division may differ, whilst the number and kind of elementary atoms remain the same. Two battalions containing equal numbers of warriors of three kinds and in like proportions may have very different internal formations. The soldiers of each class may, for instance, be massed in separate companies, or they may be mingled indiscriminately throughout the whole battalion; again, the number of companies and the mode in which the different classes of warriors are arranged may differ widely in the two battalions. These differences of internal arrangement may greatly affect their respective aggressive movements and powers of resistance, and when the battalion is vanquished and dispersed, its previous formation will affect the combinations which may be formed from its fragments.

Thus, even in modern chemistry, the fundamental idea that the varieties of matter depend upon differences of chemical composition, is still maintained, although not precisely in the same sense in which it was understood forty years ago; its scope is wider, and it has received new developments in special directions. Pure chemistry—as distinguished from its technical applications—is at present occupied with the working out of this idea in the most varied directions. The different bodies found in nature are being interrogated with the view of ascertaining if any description of atom can be found which has not hitherto been met with, and to render the list of elementary substances more complete, new and more searching methods of investigation are being devised, in order to discover any kind of matter which has hitherto remained hidden or unnoticed. Many laws relating to the method of arrangement of the elementary atoms in molecules have been already discovered, and the existence of others foreshadowed. Certain peculiarities of the different kinds of elementary atoms are becoming more and more apparent—for instance, that some will enter in couples only into the composition of a molecule, and that elementary atoms present different numbers of sides, so to speak, for the attachment of other atoms. How the elementary atoms are grouped into the proximate constituents of various complex substances, and how certain chemical properties, such as those of acids, depend upon a special arrangement of atoms; these are examples of the problems which are now being assiduously investigated. Also the dependence of many of the physical properties of substances on their chemical composition, in the widest sense of the term, has been proved, and has been the subject of continual investigation, resulting in ever-extending knowledge. The

FIG 1

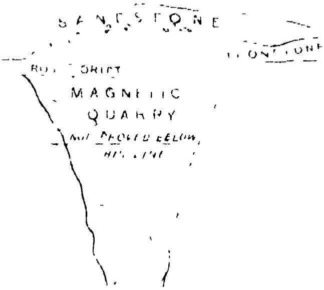


FIG 2

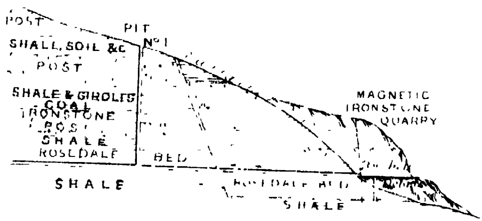


FIG 4

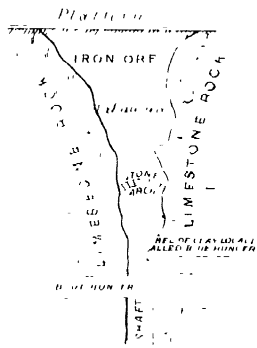


FIG 3

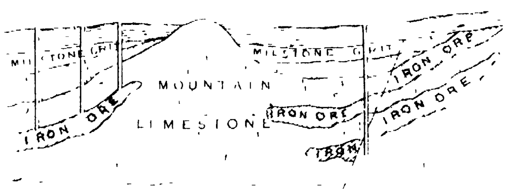


FIG 5

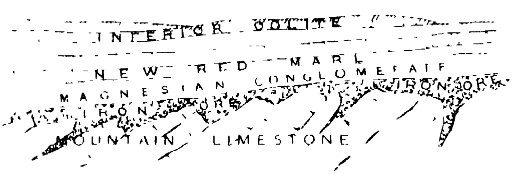


FIG 6

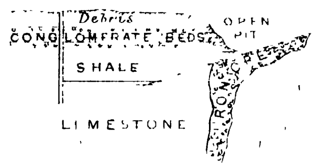


FIG 7

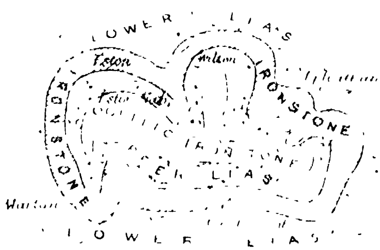
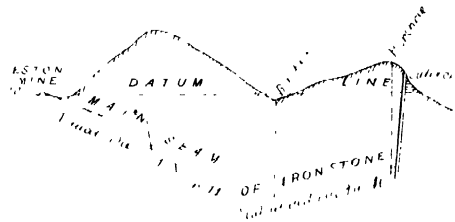


FIG 8



limits of this article prohibit the further pursuit of the ideas which guide modern chemists in their investigations, but we have followed these latest developments sufficiently to show that, notwithstanding their widely-different aspects, one and the same leading idea underlies the chemistry both of the past and of the present.

V. THE IRON ORES OF GREAT BRITAIN.

By Robert Hunt, F.R.S., Keeper of Mining Records.

In the year 1866 more than ten million tons of Iron ores were submitted to the action of fire in 613 blast furnaces, and from them we obtained about four millions and a half tons of Pig Iron. The great importance of these minerals, regarding them merely as sources from which we draw the material for the manufacture of our almost infinite variety of machines and tools, our rails, our armour-plates, and nearly every description of implement and cutting instrument, necessarily renders any examination of the phenomena connected with their occurrence in Nature of considerable interest. We find Iron disseminated through every rock, and in various conditions of aggregation in almost every geological formation, playing often a very important part in giving character to the mass. Indeed, the fact that this metal is found in each of the three Kingdoms of Nature indicates some especial function, which is not yet clearly appreciated, of equal importance in the organic and the inorganic worlds. It is, however, only with the occurrence of Iron in rock-masses that this paper will deal. It is intended especially to examine the peculiar conditions under which some of the varieties of Iron ores occur, and to discuss the circumstances which probably attended the formation of many of our ferruginous deposits, whether occuring as nodular concretions, intercalated with our coal-beds, as crystalline mineral forming lodes in the older rocks, or as sedimentary beds, spread over wide areas of very different geological ages.

The following list gives the varieties of commercial Iron ores produced and used in this country, showing the average percentage yield of Iron of each variety, and the proportions in which they are employed in the Iron manufactures of these Islands:—

	Per cent. of Iron.	Proportions in which used.
Red Hæmatite	65·13	15 per cent.
Magnetic Oxide	56·10	2 „
Brown Hæmatite	41·40	13 „
Ditto Ditto (*Oolitic*) ..	35·60	26 „
Spathose Ores	40·95	2 „
Black Band	37· 8 }	42 „
Argillaceous Ores	30·68 }	
Mean average of all, if used in equal quantities ..	47·30	100 „

In attempting any classification of Iron ores which shall be regulated by the conditions under which they are found, we are at once met with the difficulty of finding many similar varieties of ores occurring in lodes or veins, and also amongst those which are evidently sedimentary deposits. It will not, therefore, be attempted. There can be no doubt that the most ancient of the Iron formations are those Oxides of Iron which occur as lodes or veins in the slate and granite rocks. Of this kind we have some examples in Cornwall, Devonshire, Wales, and Scotland. Generally speaking, however, these veins are not sufficiently extensive to be worked. The Iron Mine at Restormel, near Lostwithiel, in Cornwall, which has been wrought for many years, and which still produces considerable quantities of ore, and those near St. Austell, in the same county, are amongst the most remarkable. At Hennock, on Dartmoor, there occurs an immense vein of Micaceous Iron ore, but this of late years has not been employed. All these are evidently the result of the aggregation of ferruginous particles, often under the influence of crystallogenic force, mechanically separated from water holding iron in solution, which has flowed through the rock fissures probably within a limited period after the formation of those fissures. The Iron lodes differ in no respect from those of the other metals, except in the nature of their contents, and they have been formed under analogous conditions, all of them indicating the influences of an elevated temperature, of an electrical disposing power, and those mechanical agencies which are still obscure, but which are being gradually developed under the general appellation of Osmose forces.

Magnetic Iron Ores.—Magnetic Oxide of Iron or Magnetite is a compound ore of the Sesquioxide of Iron and the Protoxide of Iron. Amongst other adventitious matters, this ore usually contains manganese and sometimes tin. In Western England several lodes of magnetite are known, one near Penryn and another not far from St. Austell, in Cornwall, has been worked, but not extensively. Near the Haytor rocks, on Dartmoor, a much more extensive deposit of this ore is found; but it is difficult in this case to determine satisfactorily, whether this is a set of veins or of beds interstratified with slate and sheeted masses of greenstone porphyry. At Brent, which is only a few miles distant from the Dartmoor deposit, we find magnetic ore covering, like a shell, an immense boss of trappean rock. In nearly all cases, magnetite is associated with, or is found in proximity to, some igneous rock, and to the action of this on either Oxide or Carbonate of Iron is no doubt due the magnetic character which distinguishes this ore. If the Spathic Carbonate is exposed to a regulated heat, it is converted into a Magnetic Oxide of Iron, and manufactories have been established for its production, to be used as a paint for work which is much exposed to the action of the weather.

A curious mass of Magnetic Iron ore occurred at Rosedale, in Yorkshire. The first discovery of this deposit of Iron-stone was at a quarry on the south-west side of the valley of Rosedale, about a mile south from Rosedale Abbey. When this quarry was opened out, it was found apparently to consist of a confused mass of iron-stone boulders, of an ellipsoidal structure, often three or four feet in diameter. The interior of these boulders was generally blue, and comprised a solid dark oolitic iron ore, with, in many cases, sandy and solid crusts around it; and in receding from the centre the iron ore became paler, alternating with dark-brown purplish layers. Those variations did not occur where the iron-stone was covered by other strata, and the magnetic property proved to be most decided where the mass was the thickest. These circumstances appear to indicate that this mass was at one time in the state of a Carbonate of the Protoxide of Iron, not very unlike that which occurs in the Cleveland Hills, but that it had been exposed to influences—not necessarily calorific—by which the chemical change into Magnetite had been effected. This ore especially resembles the hydrated Magnetic Oxide of Iron, which can be obtained as a precipitate from an aqueous solution. Figures 1 and 2 in the Plate will explain more fully than any words the peculiar conditions of this remarkable and valuable Iron ore formation. The first section is by the late Mr. Nicholas Wood, the second by Mr. Bewick. It should be noted that the latter observer, writing of this deposit, says, "The Iron ore of Rosedale, instead of being a large mineral field, as was first asserted, and still believed to be so by many, is nothing more than a volcanic dyke; and the iron-stone opened out in this locality is not, as it is reputed to be, the main seam now being worked in Cleveland and Grosmont." The Magnetic Oxide of Iron has been discovered in Banffshire, Aberdeenshire, the Shetland Islands, and the Hebrides. It occurs also in Antrim, in Wicklow, and especially in the Mourne Mountains.

Red Hæmatite.—The deposits of this valuable ore—an anhydrous Sesquioxide of Iron,—which are found in Furness near Ulverstone, and near Whitehaven, are deserving of the closest attention. At Whitehaven, this ore is found in the carboniferous limestone and millstone grit (locally called "Whirlstone") near the outcrop or surface edges of the slaty rocks upon which these formations rest. Fig. 3 shows the mode of occurrence. At Todholes, where this ore was worked as a quarry, the bed had a thickness of twenty feet, and at the Park Mines a thickness of seventy feet of solid Hæmatite occurred.

The Ulverstone ore differs in physical condition from those of Whitehaven. Much of it is equally compact with the Cumberland ore, and this is known as "blast" ore; but the major portion occurs as a less coherent aggregate of exceedingly fine filmy scales of micaceous iron. In the Whitehaven district the ore is found filling cavernous spaces, which had evidently been formed in the limestone previously to the deposit of the Iron; these caverns being probably due to the action of water charged with carbonic acid, which readily dissolved a certain proportion of the limestone. In the Low Furness district, at Rickett Hills, and Mousell, the Hæmatite is found in lake-like deposits, which have been well described as "dish-shaped." These dishes of ore run from fifty to sixty yards in width, and are usually from eighteen to twenty feet deep. At Roanhead the ore is found in two basins, which are slightly connected with each other, but they have nothing of the character of a mineral lode. These basins are covered generally with sea-sand, which is often overlaid with a tenaceous clay. Nothing like a mineral lode occurs either at Whitehaven or at Ulverstone. At Stainton, a chasm worked open to day was long looked upon as a vein of ore, but the full exploration of it proved the contrary. Fig. 4 is a section of this chasm, which was worked altogether to the depth of sixty yards. The stone arch shown was built to support the walls of the fissure, it being thought that the ore would be found to a considerable depth below. Within a short distance a bed of clay, locally called "blue hunger," came in, below which there was not a trace of Iron ore.

Brown Hæmatite.—The Forest of Dean may be regarded as the chief locality for this variety of Iron ore, about 150,000 tons being raised annually. The Forest of Dean ores are commercially classified into *Brush Ore,* containing 90 per cent. of Sesquioxide of Iron; *Smith Mine* giving 89 per cent., and *Clod* or *Grey Vein* about 50 per cent. These iron ores occur under much the same circumstances as the Red Hæmatites of Whitehaven. The ironstone formation is immediately overlaid by the "Whitehead Limestone," a regularly stratified rock, the beds of which are often highly crystalline. This limestone is locally called "crease," and is traversed by innumerable small joints, which appear to have arisen from a shrinking, probably during the consolidation of the mass. The worked-out spaces in the "Mine Measures," that is,—the ironstone beds which have an average thickness of twenty-five yards,—are so extensive that they have been compared to the crypt of a cathedral. These prove the deposit to have taken place in caverns which had been previously formed by the removal of the limestone. There are many curious phenomena connected with the Iron ore formations of the Forest of Dean, which demand a careful examination. It is not, however, possible in this place to give the required consideration to those, since the space which can be allowed to this article is fully occupied, with the general review of our iron-stone deposits, and remarks on the conditions under which they appear to have been formed.

Some valuable deposits have been recently worked in Glamorganshire. The Iron ore deposits at Llantrissant, which have only of late years attracted marked attention, appear to have been worked at least two centuries since. The name of the principal mine is Mwyndy, and this is derived from the estate in which the mineral is found. The word signifies Ore, therefore Mwyndy House is "Ore House," and around it in all directions we now find Iron slag and remains of the charcoal with which it was once smelted. This Iron ore, which is now worked by two companies only, "*The Mwyndy Iron Ore Company*," and "*The Bute Hæmatite Company*," partakes in its general character of the ordinary conditions of the Brown Hæmatites. Its situation is similar to that of the Whitehaven Red Hæmatite, and it does not appear in this respect to differ from the ferruginous deposits of the Forest of Dean. It occurs at, or rather immediately beyond, the southern outcrop of the Coal Measures of South Wales. Between the coal seams immediately south of the village of Llantrissant and these Iron ore deposits, the Permian rocks occur, these being represented more especially by large masses of Conglomerate. It will be seen by the section given (Fig. 5), that we have conglomerate and shale rocks resting on the limestone formation, which here forms the boundary of the South Wales coal basin. Under the conglomerate and coal measure shale, in which some thin bands of coal occur, the Iron ore is deposited on the upturned edges of the limestone, and in the fissures formed in that rock. It has been thought hitherto that the ore would be found only at the line of inclination of the limestone, but a recent discovery has shown that it suddenly descends into the limestone itself. This vertical mass of ore (Fig. 6) may be found to terminate abruptly, as shown in the Ulverstone section, or it may lead to a limestone cavern which has been filled in with this peroxide of iron. In the immediate neighbourhood of this deposit a small band of argillaceous nodular iron has been discovered.

At Frampton Cotterel, in the Bristol Coal-field we find the Brown Hæmatite occurring in the Pennant Grit, or sandstone bed of the coal-measures. This iron ore deposit has been formed in a great fault, evidently under similar conditions to those which have regulated the deposits already named, in the limestone.

Numerous deposits of Brown Iron ore exist in Cornwall and Devonshire. Near St. Austell in the former county, and near Brixham and Newton Abbot in the latter, these ores are worked with success. The Brown Hæmatites of North Wales and other districts have not as yet attracted much attention. A very remarkable calciferous Brown Hæmatite occurs at Froghall, near Cheadle, in North Staffordshire, which is largely used in the iron works of South Staffordshire. This ore, which occurs in the lower coal measures, may probably be regarded as an altered highly ferruginous limestone.

The Brown Hæmatites of the Oolites must be considered as Hydrous Sesquioxides of Iron; they are in nearly all respects peculiarly distinguished from those ores of which notice has been already taken. The Northamptonshire and Lincolnshire Iron ore deposits especially represent this class; they are continued, with various shades of difference, through the adjoining counties.

The first impression on examining the various beds of Iron ore, which we can now trace from near the Humber to within a few miles of Oxford, will be, that they are the result of deposit from water, as peroxide of Iron, in the same way as we see ferruginous springs depositing—as the water is exposed to the air—the Iron which they hold in solution. This hypothesis supposes those beds to be of recent formation. After, however, a careful examination of all the evidences afforded by the fossil remains which exist in those beds, and in other beds above and below the ferruginous ores, no other conclusion can be arrived at, than that they are of very different ages, the result of a recurrence of the same conditions, but all of a marine origin.

Spathose Iron Ores, Sparry Carbonate of Iron.—These ores of Iron have been long selected for the production of the celebrated "steel irons" of Siegen, Styria, and Carinthia, consequently of late years they have been sought after in this country.

Mr. Charles Attwood, to whom we are especially indebted for a knowledge of the Spathose Iron ores of Weardale, notices the same conditions as those found in other districts. They have certainly been all at first deposited as carbonates more or less pure, and have passed into the state of oxides and hydrates, by the joint effects of atmospheric and of aqueous action. Examples of every stage of the transition present themselves in all directions, and there are also met with, from time to time, abundant proofs that whilst the carbonates deposited are more or less rapidly passing into the hydrated condition, a fresh deposit of carbonates is continually going on in the cavernous interstices, and on the roofs and sides of ancient workings. Upon one occasion Mr. Attwood found protruding for six inches from a block of pure and large grained Sparry carbonate of iron, *a rod of malleable iron*, of about a quarter of an inch in diameter, of which the other end was firmly embedded to about the same depth in the block, which had just before been broken from a mass of it, incrusting the walls and roof of an ancient drift, but which block must have been formed within one or two centuries. Mr. W. W. Smyth remarks, "When we look to the successive introduction of the various minerals which have filled these interesting veins, it is evident that the carbonate of Iron has been one of the latest comers. Many of the specimens exhibit it, investing, as a crystalline incrustation, the previously formed crystals of fluor spar and galena; and the striking manner in which it is found to coat only those surfaces which face in a peculiar direction, is well worthy of attention in the study of these obscure phenomena." Besides the Spathose ores of Weardale, we have the same ores occurring in great abundance on Exmoor, and they are worked extensively on the Brendon Hills, near Watchet, over a length of nine miles, to Eisen Hill. At Perranzabulæ, on the north coast of Cornwall, a still more remarkable deposit of these ores exists, but at the present time they are but slightly worked. In the northern corner of Perran Bay a lode appears in the cliff, with a width of nearly 100 feet, and it has been traced for some miles inland and worked at several points. Beyond this brief notice, space cannot be given to the further consideration of these most interesting Iron ores.

The Argillaceous Iron Ores of the Lias.—The Cleveland Iron ore is the finest example we have of this class of ore. The immense extent of this deposit, the value of the Iron works which have arisen amidst the Cleveland Hills, places this district amongst the first of our Iron-producing districts.

This remarkable deposit may be traced by its outcrop for miles along the escarpments of the Cleveland Hills. Above the flat land which extends from Redcar to Middlesborough there crops out a solid stratum, often fifteen feet in thickness, of this Iron-stone. It is a deposit of a green or grey colour, having generally an oolitic structure, and containing numerous well-known fossils of the Marlstone, especially *Belemnites* and *Pecten Æquivalis.* The plan and section, Figs. 7 and 8, will show the mode of occurrence of this ore. This vast ferruginous deposit is composed, to a great extent, of Carbonate of Protoxide of Iron. We know that such a deposit could not be formed, unless it was precipitated from water charged with Carbonic acid in excess. We have no evidence that such conditions ever prevailed, to the required extent, over this district, when those Iron-stone beds were being formed. Mr. Sorby has drawn attention to the fact that if the Iron-stone be examined it will be seen that it contains, more or less, entire portions of shells. All the indications appear to show that the Cleveland Iron ore was deposited probably as a limestone, containing a large amount of the oxides of Iron and organic matter. By their mutual reaction these would give rise to the bicarbonate of Iron, which in solution, percolating through the limestone, would remove a large part of the carbonate of lime and leave in its place carbonate of Iron.

It is our object in writing this paper, to draw more especial attention than has hitherto been done to the Hæmatites, and the Argillaceous Carbonates of the coal-measures, as related to each other, in their mode of formation.

It will be evident to everyone who carefully studies the conditions of the clay band Iron-stones spread out in beds amongst the seams of coal and coally shale, that they have been associated in some way with the formation of the coal itself. As the coal deposits have been produced by a series of chemical changes in vegetable matter, spread over an immensity of time, so have the Iron-ore deposits, as we find them, been the result of sundry changes carried out upon the older rocks, those especially which belong to the Devonian or Old Red Sandstone period. The enormous deposits of Sandstones and Shales formed in our coal basins prove the gigantic nature of the denudations which have taken place, and which have produced the sedimentary beds, as they are placed before us, striking records of the world's mutations. From all that remains of those older rocks we know how highly ferruginous they were. The waters of the coal period swept around Old Red Sandstone rocks, and the plants from which our fossil fuel is derived grew upon the soil produced by the disintegration of these formations.

Let us study for awhile the phenomena which, in all probability, took place. As we now find at the mouths of great rivers,—especially within the tropics,—vast masses of vegetable matter, undergoing a series of changes, in the process of decay, so must we suppose the condition of a swamp, of an estuary, a lake, or inland sea, to have been, when the vegetable matter of an ancient world was *rotting*, in its progress towards coal. The result of the change was the formation of immense quantities of carbonic acid, and this would be largely retained by the water holding vegetable extractive in solution. This water would rapidly dissolve any limestone with which it came in contact, and would change the peroxide of Iron in the rocks into a protoxide; which would be eventually dissolved, either as a carbonate of the protoxide of Iron, or in water holding an excess of carbonic acid, as a protoxide merely. Experiment shows this satisfactorily. Place recently precipitated peroxide of Iron in a shallow vessel with a large quantity of dead leaves and water; expose this to the ordinary atmospheric changes; it will be found eventually, that the peroxide will be changed into a protoxide and dissolved. Under some conditions,—especially if the arrangement is made part of a voltaic circuit,—crystals of carbonate of Iron will be the result; and under others an accretion of amorphous carbonate will form around small fragments of vegetable matter, producing indeed, in miniature, the clay-band Iron-stones of the coal measures.

Now, if the water flows away from the influence of this mass of vegetable matter in its state of change, and if it be exposed in a thin sheet, to the action of the atmosphere, the Iron in solution will be rapidly oxidized and it will fall to the bottom of the vessel as peroxide of Iron.

These results appear to teach us that the present conditions of our coal measure Ironstone formations were the direct result of the process of coal formation, the water in which the coal was formed removing from the surrounding rocks, by virtue of the dissolving power of carbonic acid, the Iron which they contained; this, if retained within the coal basin, gradually produced the argillaceous carbonates of Iron as we find them, but if the ferruginous waters passed away from the influence of the dissolved vegetable matter, then oxidation ensued, and hence the deposits of Hæmatite in ponds and fissures as we see them near Ulverstone. The same carbonized water had previously been active in dissolving the limestones formed around the coal basins, and into the cavernous spaces thus formed,—and these are common in all our carboniferous limestone districts—the peroxide of Iron was deposited, as at Whitehaven, in the Forest of Dean, and in Glamorganshire.

Further study is required before it can be certainly determined whether or not the chemical changes indicated, are those only which have been active in producing our Iron ores as we now find them. It is, however, believed that the hypothesis put forward will serve to explain most of the conditions which are presented to the careful observer. They are, at least, honest attempts to read the phenomena which are presented to us in the varied conditions under which we find the most useful of the metals, IRON, occurring in the inorganic world.

VI. ON MEDICAL SCIENCE: ITS RECENT PROGRESS AND PRESENT CONDITION.

The season which has passed away, although not especially fertile in the fruits of the earth, has not been deficient in those of the mind. The intellectual harvest, gathered at the autumnal meetings of learned and scientific societies, at statistical congresses, and other assemblages of men earnestly engaged in the pursuit of common objects, has been plentiful and of perhaps more than average quality. We have already registered many of these products, but is one class of them, which, from its purely technical nature and the unfitness of many of its details for public discussion, is rarely noticed, except in Journals strictly professional; and yet it relates to matters in which we are all deeply interested. If there is any subject which "comes home to our business and bosoms," it is that of Medicine. Next in importance to the supply of our daily wants of food and clothing, is the care of our health, and the improvement of the means of its conservation is a topic to which none of us can be indifferent; an occasional survey, therefore, of the condition of Medical Science, free from objectionable details, may fitly find a place in a Journal designed for general circulation.*

We have before us the papers read at the Dublin meeting of the British Medical Association, the communications to various provincial meetings of the same body, contributions to the Journals, and last, but by no means least in value, the addresses delivered at the opening of the winter session at the different medical schools, metropolitan and provincial. The conclusion to be drawn from these various sources of information as to the recent progress and present condition of Medical Science is a most encouraging one. In no former period of equal length have such advances been made as in the last half-century in the detection of diseased action or morbid change, and if equal progress has not been made in the Art of Medicine, in the application of Science to the prevention of death or the relief of suffering, still even in that respect the advances have been immense. The practitioner now undertakes with confidence the treatment of diseases which his predecessors regarded as incurable, and the modes of treatment have, in many instances, been simplified and made less painful.

A recapitulation of some of the additions thus made to the means of combating disease ought to be specially interesting to the readers of a Journal like ours, for it has been strictly and exclusively by the means of research furnished by experimental science, that our knowledge of disease has been extended, and if wise empiricism, or happy imagining (the inspiration of genius), has, rather than scientific research, furnished the improved methods of treatment, Science has provided the means of utilizing the thoughts thus suggested.

But leaving those generalizations, let us proceed to a few details, and first of the improved methods of research. Of these the foremost has been the extension of the power of vision by the microscope. The additions to our stores of knowledge, both of healthy structure and of morbid changes, thus acquired, would fill volumes; and we have not space for the enumeration of even a few of them.

Next, in point of value, should be placed the discovery which to some extent does for the sense of hearing what the microscope

* We think it right to say that, in making such a survey, we take as our guide and as a sketch-map of the country over which we intend to travel, an address recently delivered before the North Wales branch of the British Medical Association, by its president, Mr. Thomas Eyton Jones, of Wrexham. In choosing such a guide, we are not alone influenced by the intrinsic merits of the address, as a lucid and comprehensive abstract of the recent progress of medicine, but we have pleasure in showing that not only in our great cities, the centres of mental activity, is medical science studied with earnestness, but that the men living in remote provincial towns, and practising among widely scattered populations, are able to keep pace with, and to rival their more favourably situated brethren.

does for the sight. We know not who first applied his ear to the walls of the chest, to endeavour to learn, from the sounds thence emitted, the variations in the action and conditions of the organs therein contained; but he who first thought of interposing between the ear and the naked body a tube of some unyielding material, and thus made mediate auscultation an universally applicable mode of research, deserved to be ranked among the greatest benefactors to mankind. And an equal rank should be given to the inventor of percussion as a mode of examination, the man who first showed that by close attention to the varied quality of the sounds produced by a smart blow on the walls of the chest, most precious knowledge might be obtained of the condition of the contained viscera.

The sense of touch also has not been without its cultivators. The *tactus eruditus* has long been one of the most highly valued accomplishments of the surgeon, but improved methods of palpation have made it almost equally useful to the physician; and most valuable additions have recently been made to the information which the touch gives as to the pulse. The knowledge gained by gentle pressure with the tips of the fingers on a superficial artery, of the frequency, force, and other qualities of the action of the organs of the circulation, is necessarily uncertain, because it is subjective knowledge, and because therefore the accuracy of the observations must depend on the carefulness and experience of the observer, and the delicacy of his sense of touch. A beautifully imagined instrument now registers for us the pulsations, and describes on paper the height, form, and other qualities of each arterial wave. We must also regard as helps to the sense of touch the improved modes of applying the thermometer to the surface and the cavities of the body. Most precious knowledge is thus acquired as to the progress of febrile and inflammatory diseases, and our powers both of prognosis and of diagnosis have been immensely increased.

To all these modes of rendering medicine more and more one of the exact sciences, must be added the improved modes of research furnished by chemistry. Our knowledge of the composition of organic bodies, and of the chemical changes constituting assimilation and degeneration, and of the processes of growth, secretion, and excretion, has only within the last quarter of a century acquired anything like the character of certainty. The physiological chemist has not only entered so far into the *arcana* of Nature as to be able to ascertain, to a great extent, how she does her work, but has even succeeded in imitating her operations. Not content with analysis, he has with considerable success attempted synthesis also. "Already he has been able to produce a large number of organic compounds from carbonic acid, water, and ammonia, and even from the pure elements themselves. In fact, of the three great classes of alimentary substances, the production of the oleaginous is quite within his reach; that of the saccharine is almost within it; but the albuminous is still beyond."*

The application of such researches as these to the Science of Medicine is too obvious to need pointing out. They furnish the only safe basis on which the knowledge of diseased actions and of morbid poisons can be founded. To the latter class of bodies, owing to the unusual prevalence of infectious diseases, special attention has recently been paid, and we seem to be on the eve of brilliant discoveries in reference to some of them. The question is still unsolved whether the poison, or *contagium*, of the so-called Zymoses, consists of living germs, *i.e.* entire, although undeveloped, organisms, or of living portions of organic matters, *i.e.* germinal particles or cells, or of dead matter, peculiarly compounded, and undergoing some special process of decomposition.

For a further extension of our power of research into the chemical constitution of organic bodies, we are indebted to a new application of the Science of Optics. Spectrum analysis now not only tells us of what elements the planets and the photosphere of the sun are composed, but whether certain red spots which may be the subject of medico-legal inquiry, are or are not stains of blood. For this great discovery we have to thank Mr. Sorby, of Sheffield. Dr. Bird Herapath, of Bristol, was the first to employ it in the inquiry into a case of alleged murder. It is impossible in imagination to limit the extent to which micro-spectroscopy may aid us in the analysis of organic bodies.

One of the latest applications of physical science to the purposes of medicine is a further extension of the powers of sight. Endoscopy, in its various forms, by most ingenious combinations of lenses, mirrors, tubes, and, in some instances, increased means of illumination, enables us now to explore all the canals opening on the surface of the body, and even to inspect some of its cavities. The revelations thus made are wonderful, and have far exceeded the expectations of those who first suggested such means of research. It might have been expected that, looking through the window of the Cornea, we might ascertain the exact condition of the internal structures of the eyeball. But who would have imagined that from the morbid changes observed in them we might be able to pronounce with certainty on the existence and nature of disease existing, not only in the brain, but in so remote an organ as the kidney? An amusing instance of the enthusiasm with which this line of inquiry is now pursued was given at the international medical congress which recently sat in Paris. A zealous worker in the field of endoscopy foretold the time when, by means of the lime-light, the whole body

* Dr. Letheby's Introductory Lecture at the London Hospital.—*British Medical Journal*, Oct. 5, 1867.

would be rendered diaphanous, and morbid changes be detected in its innermost recesses.

But our space will not permit us to linger in this tempting field, and we pass on to notice a very few of the latest improvements in the Art of Medicine. If asked to indicate the one quality which characterizes the present race of practitioners as compared with the majority of their predecessors, we should say that it is conscientiousness, shown by increased reverence for the human body, and a greater wish to diminish pain or to avoid its infliction. Surgery has become eminently conservative. The man is not now most admired by his brethren who performs in the most dashing style the capital operations of surgery. It is almost universally felt that such operations, being more or less serious mutilations, are, in the same ratio, confessions of the imperfection of the art. He is not now liable to be sneered at, as he was within our recollection, who professes greater pride in the preservation of a finger than in the amputation of an entire limb. Modern surgery thinks it no condescension to labour in the removal, not of disabling deformities only, but of disfigurements and blemishes, and by various plastic operations to endeavour to restore to "the human form divine" its pristine beauty, lost by accident or disease. Many of these triumphs of conservative surgery would, because of their tedious and therefore additionally painful nature, have been impracticable but for the grandest discovery ever made in relation to the art of medicine, that, *viz.* of a safe and easy method of producing temporary unconsciousness of pain. If there be one invention of human genius worthy to be called an anticipation of the millennium, it is that of anæsthetics. To say nothing of the preservation of life, the amount of agony from which mankind has thus been saved is incalculable.

This topic, the avoidance of suffering in surgical operations, is one of such surpassing interest to humanity that we are tempted to enlarge upon it a little. Nearly a quarter of a century has elapsed since the introduction into practice of the use of anæsthetics, and of the present generation few are conscious, from their own experience or observation, of the magnitude of the boon; and this may be said even of the large majority of surgeons now in practice. We will, therefore, extract from a work not likely to be read except by professional persons, and written by one who has done more than any other man living to bring about this blessed change, Sir James Simpson, a description by a master in the art of composition, the late Professor George Wilson, of Edinburgh, of the horrors of a surgical operation under the old mode of treatment.

"Several years ago," Professor Wilson writes in a letter to Sir James Simpson, "I was required to prepare, on very short warning, for the loss of a limb by amputation . . . . I at once agreed to submit to the operation, but asked a week to prepare for it;

not with the slightest expectation that the disease would take a favourable turn in the interval, or that the anticipated horrors of the operation would become less appalling by reflection upon them, but simply because it was so probable that the operation would be followed by a fatal issue, that I wished to prepare for death and what lies beyond it whilst my faculties were clear and my emotions comparatively undisturbed. . . .

"The week, so slow and yet so swift in its passage, at length came to an end, and the morning of the operation arrived. . .

"Before the days of anæsthetics, a patient preparing for an operation was like a condemned criminal preparing for execution. He counted the days till the appointed day came. He counted the hours of that day until the appointed hour came. He listened for the echo, in the street, of the surgeon's carriage. He watched for his pull at the door-bell; for his foot on the stairs; for his step in the room; for the production of his dreaded instruments; for his few grave words, and his last preparations before beginning; and then he surrendered his liberty, and, revolting at the necessity, submitted to be held or bound, and helplessly gave himself up to the cruel knife. The excitement, disquiet, and exhaustion thus occasioned could not but greatly aggravate the evil effects of the operation upon a frame predisposed to magnify, not to repel, its severity. To make a patient incognisant of the surgeon's proceedings, and unable to recall the details of an operation, is assuredly to save him from much present and much future self-torture, and to give him a much greater chance of recovery. . . .

"The operation was a more tedious one than some involving much greater mutilation. It necessitated cruel cutting through inflamed and morbidly sensitive parts, and could not be despatched by a few swift strokes of the knife. . . .

"Of the agony it occasioned I will say little. Suffering so great as I underwent cannot be expressed in words, and thus fortunately cannot be recalled. The particular pangs are now forgotten; but the black whirlwind of emotion, the horror of great darkness, and the sense of desertion by God and man, bordering closely upon despair, which swept through my mind and overwhelmed my heart, I can never forget, however gladly I would do so. . . .

"During the operation, in spite of the pain it occasioned, my senses were preternaturally acute. . . . I watched all that the surgeons did with a fascinated intensity. I still recall with unwelcome vividness the spreading out of the instruments; the twisting of the tourniquet; the first incision; the fingering of the sawed bone; the sponge pressed on the flap; the tying of the blood-vessels; the stitching of the skin; and the bloody dismembered limb lying on the floor.

"These are not pleasant remembrances. For a long time they haunted me, and even now they are easily resuscitated; and though they cannot bring back the suffering attending the events which gave them a place in my memory, they can occasion a suffering of their own, and be the cause of a disquiet which favours neither mental nor bodily health. From memories of this kind those subjects of operations who receive chloroform are of course free; and could I even *now*, by some Lethean draught, erase the remembrances I speak of, I would drink it; for they are easily brought back, and are never welcome."

"After perusing," continues Sir James Simpson, "such a touching and terrible account of what surgical patients were sometimes called upon to suffer, before the introduction of modern anæsthetics, it is delightful to reflect that all these forms of human agony are essentially ended and abrogated. We now know also and acknowledge that these tortures, so long endured as dire necessities, were of no advantage, but the very reverse, to the patient himself. . . . While anæsthetics save the patient from the agonies produced by the cutting of his living flesh, they at the same time preserve his strength and enhance his chances of recovery. But they are not a boon merely to the patient: they are a blessing also to the surgeon himself, as they enable him to accomplish his knife-work far more calmly and deliberately."*

There is one use of anæsthesia in which, although it applies only to one sex, we must all rejoice. The pain, often amounting to agony, which, in obeying the first command, "increase and multiply," by a mysterious arrangement of Providence, woman alone endures, may, by the use of chloroform or similar agents be, with perfect safety to mother and child, rendered comparatively insignificant. And by the avoidance of the nervous exhaustion caused by long-continued suffering, life is often saved which, under different circumstances, would have been sacrificed.

Great, however, as have been the blessings conferred by general anæsthetics, their use has its drawbacks. A few persons have succumbed to their depressing effects on the vital energies. The discovery, therefore, of some means which, without producing general unconsciousness, would render the part to be operated upon insensible, had become a desideratum. The want has been supplied in more than one way. The local application, as proposed by Dr. Arnott, of ice or of freezing mixtures, by which the part was temporarily frozen, was a great advance; but the perfection of local insensibility seems to be attained by Dr. Richardson's beautiful invention of ether-spray.

* Anæsthetics do more for the surgeon even than this: they save him from possible physical suffering The writer of this article, when many years since a dresser at a London hospital, had one of his fingers severely bitten by a poor little boy, who was undergoing a painful operation.

The same end—the prevention of suffering—has also been attained in another way, to which some allusion has already been made, *viz.* the simplification of the modes of dressing the wounds caused by surgical operations. The improvement in this respect has been gradual. The cumbrous dressings and often torturing applications of our remote forefathers, the boiling pitch into which the amputated limb was plunged, or the heated iron by which the surface of the recent wound was seared, had long been banished from use; but the dressings were still too complicated, and the mode of closing the larger blood-vessels by ligature inevitably prevented the early healing of the wound, by leaving between the two surfaces foreign bodies, the ligature threads and particles of dead and putrid matter, the extremities of the blood-vessels, detached by the pressure of the ligatures. The very recent discovery of acupressure—a discovery for which we are indebted to the illustrious discoverer of chloroform—has to a very great extent removed both these obstacles to the speedy healing of surgical wounds. By needles of suitable size and length passed either through the external skin over the vessels to be closed, and again brought out through the skin, or applied in other ways which need not here be described, pressure is made on the arteries; the lips of the wound are then brought together by metallic sutures, an immense recent improvement, and further closure is effected by a few strips of isinglass plaster; the limb is then placed in a suitable position, with due provision for its immobility, and, with the exception of the withdrawal of the needles after the lapse of a few hours, or at the most a day or two, and after a longer interval the removal of the wire-sutures, the treatment is complete. Nature does all the rest. There is, say those who have extensively tested this mode of dressing, no sloughing, no suppuration, no absorption of pus, and consequent surgical fever; there are no painful dressings repeated daily for, perhaps, weeks. To use the words of a speaker at the late annual meeting of the British Medical Association in Dublin, "If surgeons are strangely apathetic as to the desirability of attaining such results, patients are not equally so. I was lately told by a medical friend of the case of a gentleman who had a tumour, some time ago, removed in Edinburgh, and who, after being operated upon, was weeks in getting well. After returning home, he happened to get hold of a book on acupressure, by Dr. Pirrie, and after reading it, angrily argued with his ordinary attendant, my informant: Why was I tortured for six weeks to please old surgical prejudices, when I might have been cured in a day or two?"

The illustrations we have so far given of the recent improvements in the art of medicine have been drawn from one branch of it, that, *viz.* which deals with external diseases and injuries. But in the treatment of the ailments more especially coming under the care of the physician, results equally great in the aggregate, although, perhaps, not individually so splendid, have been produced. The most valuable, perhaps, of these has been increased confidence in the efficacy of drugs. The remark was long since made, by whom first we know not, that the mind of every practitioner who thinks for himself, and is not content to be guided merely by routine, passes through three stages. In the first stage he has unbounded confidence in medicines. In the second, disappointed by the non-realization of the brilliant dreams of his youth, he doubts their efficacy altogether. In the third stage, that of mental maturity, he believes that, judiciously administered in accordance with the teachings of enlightened empiricism, they can do a great deal. The professional mind, as a whole, has within the last half-century gone through a similar series of changes. But a few years since it appeared to be sinking into a hopeless condition of scepticism as to the utility of strictly medicinal treatment. A brighter age has happily succeeded. A discriminating confidence in the powers of remedies of proved efficacy has taken the place both of doubt and of blind faith in all drugs; and here again the duty of relieving pain, and of avoiding unnecessary suffering, has been recognized. It has come almost to be a fundamental principle that in nearly all diseases, acute or chronic, of which pain is a prominent symptom, to relieve the pain is to cure the disease, and that therefore, wherever narcotics do no harm in other ways, they ought to be administered. Modes of giving them otherwise than by the mouth have in consequence been devised, and one of those is so ingenious and so elegant, if the expression is admissible, as to be worthy of description. By means of a little syringe, having a nozzle drawn out into a minute pointed tube, perforated like the fang of a rattlesnake a little way below its extremity, a few drops of concentrated solution of morphia are injected under the skin, so as to come directly into contact with the extremities of the nerves of the painful or inflamed part. To quote a portion of one of the many recent professional utterances now lying before us, "We see neuralgia of long standing cured by one injection of morphia; we see the same treatment visibly restoring to health congested vessels of the conjunctiva; reducing unnatural heat, not of the whole body, but of a suffering portion of it; lessening the swelling of an inflamed joint; arresting vomiting, depending on a lacerated brain, or upon peritonitis, or suppressed menstruation." *

The hypo-dermic administration of medicine has not been limited to morphia. Other vegetable alkaloids have been given in the same way. The most promising results thus obtained have been when

* Mr. T. P. Teale, jun., Opening Address at the Leeds School of Medicine. —*British Medical Journal*, Oct. 5.

two powerful remedies, which in their operation on the brain and nervous system are antagonistic to each other, such as morphia and atropia, the active principle of belladonna, are injected simultaneously. The headache and phantasms of atropia have been found to be controlled by morphia, as well as the partial deafness and the visual defects of the former alkaloid. Conversely the drowsiness and stupor caused by morphia disappear under the use of atropia. In other respects the two remedies thus administered have been found to be mutually antidotal.*

Who knows how many lives of persons poisoned by opium, and too far narcotized to be capable of swallowing, may be saved by the subcutaneous administration of atropia?

To these triumphs in the cause of humanity something must still be added. It must often occur to the earnest-minded practitioner that in the exercise of his calling he is treading in the steps of his Divine Master, whose chief work on earth was to heal the mental and bodily diseases of those who came to Him.

But the physician now, if it may be said without irreverence, goes beyond his Master, although he is only following out the natural developments of his Master's teaching.

To use the words of an eloquent and popular writer:—"No man who loves his kind can in these days be content with waiting as a servant upon human misery, when it is possible in so many cases to anticipate and avert it. Prevention is better than cure, and it is now clear to all that a large part of human suffering is preventable by improved social arrangements. . . . When the sick man has been visited, and everything done which skill and assiduity can do to cure him, modern charity will go on to consider the causes of his malady, what noxious influence besetting his life, what contempt of the laws of health in his diet or habits, may have caused it, and then to inquire whether others incur the same dangers, and may be warned in time. . . . Christ commanded his first followers to heal the sick and give alms; but He commands the Christians of this age, if we may use the expression, to investigate the causes of all physical evil, to master the science of health, to consider the question of education with a view to health, the question of labour with a view to health, the question of trade with a view to health, and, while all these investigations are made, with free expense of energy and time and means, to work out the re-arrangement of human life in accordance with the results they give."†

In justice to the faculty of medicine be it said, that some of its members were among the first to recognize these great truths.

* 'Biennial Retrospect of Medicine and Surgery for 1865–6.'—*New Sydenham Society*, p. 460.

† 'Ecce Homo,' 4th edition, pp. 196, 202.

Happily they do not now stand alone. The exertions of a small band of zealous men, continued through many weary years, have at length succeeded in placing Preventive Medicine in something like its proper position in the estimation of the profession and of the general public. It is now seen to be as much the duty of our rulers to care for the Public Health, as to make provision for the peace and the material prosperity of the community.

Within the last few years several Acts of Parliament bearing upon Public Health, each on the whole an improvement on its predecessor, have been passed, and the last of them, the 'Sanitary Act of 1866,' requires only, to make it almost perfect, that some of its enactments, now permissive, should be made compulsory.

In other countries also the subject is attracting attention. We have lately seen an assemblage of diplomatists met, not to divide conquered provinces or to obviate threatened war, but to prevent, if possible, another invasion of Europe by the pestilence which had already three times ravaged many of its cities and towns.

These are encouraging facts, but to make our condition perfectly satisfactory much has yet to be done. We want a Government Department of Public Health, presided over by a single responsible head. We want travelling inspectors, constantly at work, to anticipate local outbreaks of preventable disease, and not to be sent down only when such outbreaks have occurred. We want medical officers of health in every registration district, and we want a higher status and more power for the medical officers in the three great public services, the Army and Navy and that of the Poor Law. Recent events have shown the miserable consequences of the disregard of the advice of military and naval surgeons, and the country would have been spared the shame and the sorrow of the recent revelations of the condition of the workhouse infirmaries, metropolitan and provincial, had the medical officers been placed in a more independent position, and had the Poor Law Board trusted rather to their reports than to those of inspectors too often incapable or careless. Thanks to the non-official inspections organized by the proprietors of the 'Lancet,' and more recently by the British Medical Association, a better state of things has already been inaugurated in the metropolis, and improvements will, it is to be hoped, follow in the provinces.

Before concluding, we wish to direct the attention of our medical readers especially to one mode of preventing disease, to which some of them, it is to be feared, are not yet sufficiently awake. Too many of the buildings designed for the reception and treatment of poor persons suffering from various ailments or accidents, by their very construction, generate maladies far more dangerous than those they are designed to cure. We believe that there is not a public hospital in the kingdom, built before the Crimean War, which is not unfit for its purpose—which does not kill many of those it ought to cure. Surgical fever, or Pyæmia, is the bane of general hospitals; puerperal fever, of obstetric institutions. Small are the chances, more especially at certain seasons of the year, of the man whose leg has been smashed by a railway accident or similar casualty, and who undergoes amputation in an old-fashioned hospital. Far better would it be for him to be treated in a hovel on a bleak hill-side, or under a tent. In like manner, the poor women who in their hour of sorrow have to depend on public charity, have far better chances if attended in their own comfortless homes, than in many a luxuriously furnished maternity hospital of the old construction. The conviction of these truths has recently led to the proposal to abolish hospitals altogether, and to substitute for them clusters of cottages which shall accommodate one, or at most two, patients in each room. Happily we need not make a change so sweeping and likely to be attended with so many inconveniences.

Hospitals built on the pavilion system, carried out in its integrity, may have as pure an atmosphere as a detached cottage, and the medical officers of the older hospitals, who do not with all possible urgency strive to impress upon those in authority the duty of rebuilding their hospitals on the improved plan, will assuredly incur a grave responsibility. The example has been set in the Herbert Hospital, in the new St. Thomas's, and in the new infirmaries at Leeds, and some other places, and it is to be hoped that it will be universally followed.

VII. FARADAY.

On the 25th day of August, 1867, a spirit passed away from amongst us, leaving a gap amidst the noble few, who have, by the powers of their intellectual industries, placed themselves in the position of being the rulers,—the instructors,— of mankind. All that remained of Faraday was laid in the earth at Highgate, on the 30th of the same month, without display, without parade, and the busy world, involved in the circles of its joys and cares, appeared to be little conscious of the extinction of a light, by the aid of which it had been advanced into some of the recesses of Nature, and gleaned a few of those truths which alone are capable of giving man power over matter.

With a strange inconsistency the world applauds with enthusiasm the doings of the warrior, the influences of whose labours are often the chaining of truth, the reinvigoration of vice, and the perpetuation of ignorance amongst men. The appreciation of his greatness is shown by recording in enduring bronze, above his ashes, the deeds by which he has been distinguished, the triumphs which he has won. Whereas the man who has devoted all the powers of his mind with unwearying industry to seeking out "the knowledge of causes, and secret motions of things, and the enlarging of the bounds of human empire;"* the man who really advances the human race by dispelling ignorance, by dethroning superstition, by throwing light into dark places, and by training all in the right use of that intellect with which they have been gifted, and by the strength of which alone they can fulfil the first command of the Creator and subdue the earth—he passes away in silence, and is consigned to "the lap of earth," with the mournful tribute of the tears of a few; but with slight indications of sorrow from the many. "The storied urn or animated bust," however, which rises in honour of him who has trodden "the paths of glory" are but short lived in comparison with the monument which is reared for him who has linked his name with the discovery of some Eternal Truth.

Mr. Davies Gilbert, to whom we are indebted for the discovery of the Carver's Son, at Penzance, who "was said to be fond of making chemical experiments," who raised himself to the temporal rank of Sir Humphry Davy, Bart., and to the intellectual position of the leader of Science, once said, paraphrasing a remark made respecting Bergman and Scheele, "The greatest discovery Davy ever made was the discovery of Faraday." This, be it remembered, was not spoken by Davies Gilbert in depreciation of the master, but it was a forcible way of putting his high appreciation of the merits of the man.

In recording our sense of the loss which the world has sustained, we have no intention of writing a memoir of Michael Faraday, even in brief: That he was born on the 20th September in 1791, the son of a blacksmith at Newington, in Surrey, and that he died,—having achieved for himself a world-wide reputation,—in the Royal Palace of Hampton Court in 1867, at the age of seventy-six, is the sum of our notice of the ordinary life of Faraday. But we have something more to say respecting the higher life, the intellectual labours of this great man. Faraday's childhood was one of promise, and all the learning which a common day-school could give him was turned to early account. At thirteen he became the apprentice of a bookbinder, and the books of Science which he bound, he so far made his own as to be enabled by their guidance to construct electrical machines and to try chemical experiments. In 1812, through the attention of Mr. Dance, Michael Faraday was taken to hear some of Davy's lectures in the Royal Institution. "I took," Faraday writes to Dr. Paris, "notes, and afterwards wrote them out more fairly in a quarto volume. My desire to escape from trade, which I thought vicious and selfish, and to enter into the service of

* Bacon: 'New Atlantis.'

Science, which I imagined made its pursuers amiable and liberal, induced me at last to take the bold and simple step of writing to Sir H. Davy, expressing my wishes, and a hope that, if an opportunity came in his way, he would favour my views; at the same time I sent the notes I had taken at his lectures." Davy was kind and generous, he saw Faraday and procured for him the situation of assistant in the Laboratory of the Royal Institution, then just vacant; but, writes Faraday, "he smiled at my notion of the superior moral feelings of philosophic men, and said he would leave me to the experience of a few years to set me right on that matter."

It has been most unjustly stated that Davy soon grew jealous of his assistant, and that during a visit to Paris, in October, 1813—Faraday having been appointed assistant only in March of the same year—he was annoyed at the attention which the French chemists paid to the young man; and that in 1824 Davy showed much unwillingness to Faraday's being elected as a Fellow of the Royal Society. The first statement is so absurd that it carries its own refutation; of the second, it can only be said that Davy never exhibited any unwillingness to the election of Faraday to the honours belonging to F.R.S.; but we have reason to know that Davy was slightly annoyed that the certificate proposing Faraday for election should have originated with Richard Phillips, and that he should not have been consulted before that gentleman was allowed to take the matter in hand.

It is not possible to trace out here the progress of Faraday as an experimentalist, or as a discoverer. His early devotion to Chemical Science was richly rewarded. Passing over several smaller matters, we may mention the discovery of Benzole in 1825, to which "we virtually owe our supply of aniline with all its magnificent progeny of colours." Such is the judgment of Hofmann, who demands, "Who, then, discovered benzole?—England may well be proud of the answer, Michael Faraday." He was ever a searcher after Truth, regardless of any money value belonging to a discovery; but he, doubtless, felt "that the search after the True for its own sake leads on to the discovery of its natural corollaries, the Useful and the Beautiful. For these, indeed, lie folded up in Truth, to be in due time evolved therefrom; even as the great tree unfolds itself from the little seed."*

Other fine chemical investigations were carried out, and other discoveries made, by Faraday about the same time. In 1821 was published his paper on the condensation of the gases, in which he proclaimed them to be simply the vapours of volatile liquids.

The important position assumed by the Science of Electricity, at this period, naturally won the attention of Faraday. In the same year, the 'Quarterly Journal of Science' contains a paper

* Hofmann.

"On some new Electro-Magnetical Motions, and on the Theory of Magnetism," in which was announced the brilliant discovery of the rotation of a wire under electrical excitation round a magnetic pole. This paper is in every way remarkable; but it is especially so in being the precursor of a series of Memoirs which certainly stand as the finest exemplification of the value of inductive science which the world has received since it had birth from the mind of Bacon.

It is impossible to give even a sketch of the remarkable series of experiments which stand recorded in the "Experimental Researches in Electricity," or to record the chain of discoveries which, link being added to link, led us from the most simple phenomena of electricity up to the very threshold of what we may, without presumption, believe man is permitted to know of its connection with animal life.

Without these "Experimental Researches," we should not now be employing Electro-Metallurgy as a practical art. The Electric-Light,—especially as evolved from magnetic arrangements,—would never have been brought to that degree of certainty and steadiness, as well as brilliancy, which has recommended its adoption in the light-house economy of England and of France; and, beyond all, the electric current, with even the extraordinary mechanical powers of Wheatstone to promote its application to the purposes of telegraphy, would never have been brought under control; and neither the wires which now girdle the world, nor the cables which, lying hidden in the ocean, bind Europe and America together, would have had existence.

But none of these applications were made by the discoverer of most of the truths upon which they depend. The mind of Faraday was of that order which could not bend itself to the labour of making science a stepping-stone to commercial enterprise. The feelings shadowed out in his letter to Davy, which has been quoted, followed him to the end. If ever any man pursued Truth for its own exceeding great reward, with an entire abandonment of all selfish feeling, that man was Faraday. Not that he disregarded the value of science in its practical applications—he rejoiced to see those discoveries which appeared abstract brought to the test of usefulness—but he worked earnestly in the elucidation of the great mysteries of Nature, feeling certain that no truth could be born into the world which would not sooner or later become of value to mankind as an ameliorating or a refining agency.

Faraday was an Inductive Philosopher—nothing can be more beautifully precise than the method of his Experimental Researches. Step by step he advanced, making sure of each fact by testing it under all conditions, before he allowed it to support him in his attempt to reach another. Nothing can show this more satisfactorily than his paper on "Definite Electro-chemical Action," in which he arrives at his remarkable conclusions "On the absolute quantity of Electricity associated with the particles or atoms of Matter." To this series of his Researches we are indebted for the enunciation of the startling truth that "The Chemical Action of a grain of water upon four grains of Zinc can evolve Electricity equal in quantity to that of a powerful thunderstorm," and that this enormous quantity of the Electrical Element is exactly that which is required to maintain the atoms of Oxygen and Hydrogen in the condition of a grain of water.

Faraday was not a Deductive Philosopher. As long as he solicited nature with his wands,—his experimental and ever beautifully contrived apparatus,—he was the Arch-evocator who proudly compelled an answer to his evocations, but, when he laid aside his wands and endeavoured *to think* out truths, he was still as noble as Prospero, but as powerless as the Duke of Milan, when he "his magic did abjure," breaking his staff to "bury it certain fathoms in the earth."

No other evidence of this is required than Faraday's "Speculations touching Electrical Conduction and the Nature of Matter,"* and his clever papers "On Magnetic Hypothesis,"† and "On some points of Magnetic Philosophy."‡ In these, and in other which might be named, Faraday displays his remarkable genius, in picking up the threads of an argument and weaving them together into a symmetrical cord, but when he casts that from his hand as a lasso to entangle a distant and flying truth, he shows that he is not practised in the art. His early education (and "the child is ever father of the man") unfitted him for large generalization. In this he stood on a lower pedestal than Davy, and why? The circumstances of the place of birth had much to do with this. Faraday was born and educated at Newington, and apprenticed in Soho. Davy was born on the beautiful heights of Ludgvan, looking down upon a bay, unrivalled in the world; and he was educated at Penzance, where nature has been lavish of her charms. Faraday learnt to love nature in the mechanical aspects which she assumes in the fuliginous metropolis,

> "But 'midst the crowd, the hum, the shock of men,"

Davy's boyish delight was

> "To sit on rocks, to muse o'er flood and fell,
> To slowly trace the forest's shady scene;"

and thus, in the day-spring of life,

> "to hold
> Converse with Nature's charms and view her stores unroll'd."

* 'Philosophical Magazine.' 1844, vol. xxiv.
† 'Experimental Researches,' vol. iii.
‡ 'Philosophical Magazine,' Feb., 1855.

This gave to one mind that Poetry, without which there can be no Deductive Philosophy, which was denied to the other.

Faraday's powers as a lecturer were surpassingly great. The secret of his power was earnestness, an intense desire to be the Minister of Truth, and a determination to make every one familiar with her mysteries, so far as he was permitted to be their interpreter. He spared no labour to ensure a correct understanding of each fact. He never supposed anything to be known. When the writer of these remarks was preparing to deliver his first lecture in the Theatre of the Royal Institution, "Do not," said Faraday to him, "suppose that your audience will know anything of the subject you are about to bring before them," and taking a stone from the table, "was I about to tell them that this stone when set free from my hand will fall to the ground, I should let it fall." This was a brief lesson, but one of incalculable value.

Faraday was great as an Experimental Philosopher, he was even greater in all the relations of life. He might have been proud of the position which he occupied as an investigator of Nature; but, to the end of his days he was all humility as a man. We may be allowed to apply to Michael Faraday those lines addressed by Dr. Johnson to the Electrician, Grey:—

> "Long hast thou borne the burden of the day
> Thy task is ended, rever'd Faraday!
> No more shall Art thy dextrous hand require,
> To break the sleep of elemental fire!
> To rouse the power that actuates Nature's frame
> The momentanous shock, the Electric flame.
>
> "Now, hoary sage! pursue thy happy flight,
> With swifter motion, haste to purer light,
> Where Bacon waits with Newton and with Boyle,
> To hail thy genius and applaud thy toil;
> Where intuition breathes through time and space,
> And mocks experiment's successive race;
> Sees tardy science toil at Nature's laws,
> And wonders how the effect obscures the cause.
>
> "Yet not to deep research or happy guess,
> Is show'd the life of hope, the death of peace;
> Unbless'd the man whom philosophic rage
> *Shall tempt to lose the Christian in the sage*:
> Not Art, but Goodness, poured the sacred ray
> That cheer'd the parting hours of FARADAY."

CHRONICLES OF SCIENCE.

1. AGRICULTURE.

The country has now for a month or two been free from the Cattle Plague; and we may hope, that if the requisite precautions be taken at the ports of debarkation for foreign cattle, we may remain free from it for the future. In Cheshire, Norfolk, and Berwickshire—three widely separated counties—cases have been reported, and districts have been declared by the local authority to be infected; but in every instance, a further investigation, by the Veterinary professors sent down by the Government, has shown that the disease has not been Rinderpest, but some malady which has generally arisen from maltreatment. The provision of a metropolitan market exclusively for imported cattle near the point of landing, which is now contemplated, with extensive lairage there for young and breeding stock imported to be fed in England, will, we hope, reduce the risk of any reintroduction of the infection to a minimum. Meanwhile, however, we may place on record, that the history of the *last great attack of the disease*, which occurred at Lodge Farm, near Barking, in August last, proves that strict isolation and the abundant use of hot lime on roads and of carbolic acid in and about the cowsheds, enable us to insulate infected places, so that the mischief shall not spread. On a farm where 237 cows had been fed in six or seven separate sheds, two of these sheds, containing 111 cows, were kept free of it in this way, notwithstanding that the disease was raging on all sides of them.

The close of the Paris Exhibition enables many of our agricultural readers to look back upon the unequalled illustration it has afforded of the implements and farm economy of many nations. There was certainly something in the dairy and general homesteads, of which specimens were given from Holland, to instruct the English agricultural spectator; but it was to the British section of this department chiefly that not only we, but the agricultural machine-makers of all other countries, looked for guidance. Now that the display is over, exhibitors are discussing both the relative and the actual value of the awards of medals and of merit which have been made by the examining juries. One thing seems certain: they bear no relation whatever to either the relative or the actual professional status of the several exhibiting countries. We are accustomed here to consider that the productiveness and enterprise of our agriculture is in direct proportion to the quantity of live stock maintained upon a given area of land. Guided by the application of such a test as this, the relative standing of English and French agriculture may be read with greater accuracy in the agricultural exhibition of them out of doors, than in the awards of an international jury examining the agricultural contents of the Exhibition building and its annexes. There are more cattle and sheep seen on the return journey of the English tourist within eight miles of the landing at Newhaven than are visible all the way from Paris to Dieppe.

Among the topics which receive attention in the current number of the 'English Agricultural Society's Journal,' is the agricultural value of town sewage. It appears that nitrogen equal to 200 ozs. of ammonia passes annually from every average individual of a general population, and this being mixed with the usual annual water-supply to our towns of 40, 60, or 80 tons per head, gives only 9¾, 6½, or 4¾ grains to every gallon of the resultant sewage. If the average be taken at 7 grains to every gallon, which is equal to one in every 10,000 parts of the drainage water, then that is worth about as much as half-a-ton of Peruvian guano for every 1,000 tons, or between 1½*d.* and 1¾*d.* per ton. Nothing like this valuation has, however, ever yet been realized in agricultural experience. The large quantity of water with which the guano in sewage is diluted, spoils its fitness for our more valuable crops. It has hitherto indeed been applied almost exclusively to grass, which is not worth more than 6*s.* or 8*s.* a ton in country districts, rising, however, to 15*s.* or even 20*s.* a ton near towns, where it can be used in cow feeding. The calculation from experience near Edinburgh and at Rugby does not result in one-half the estimated return indicated by the chemistry of the subject. During the past year, however, on Lodge Farm, near Barking, a better result has been obtained from its use in growing Italian rye-grass on thin and gravelly soil. From 300,000 tons of North London sewage passed over 55 acres of Italian rye-grass, 2,400 tons of grass have been obtained. And as much of this land had been sown down only this spring, and a good deal of what was sown last year had been much injured by last January's frosts, all of it ought not in fairness to be taken into the account. Off 13¼ acres, the extent which was in good bearing order, 800 tons of grass was cut between April and November this year; and, as a good deal of the sewage had been wasted (in the carriers cut through gravel) before it could reach the plant, it is believed that one ton of grass has been produced over and above the natural and unassisted growth of the land for every 100 tons of sewage that was applied. If further experience shall justify this conclusion, then we shall at length have realized in agriculture something like the chemist's valuation of this manure; and a profit will be available for towns from their drainage waters, which recent legislation very properly requires them to keep out of the rivers. It is also reported from Lodge Farm that the sewage has been successfully and profitably used in the growth of mangold wurzel, cabbages, Lucerne, potatoes, and celery; and that, where applied in dry weather, it has largely increased the yield of wheat. In all these cases, however, the experiments were on a small scale, and require confirmation. The area in grass, on the other hand, is quite enough to enable a trustworthy inference to be drawn.

It is in some degree connected with this subject (for the large addition to our supplies of succulent grass which is certain to be the first result of sewage utilization, will be somewhat difficult to turn to account), that the question of artificial haymaking and harvesting has occupied a good deal of attention during the past season. Mr. Gibbs, of Gillwell Park, Sewardstone, has patented an apparatus by which air heated in a furnace (and the ordinary agricultural locomotive engine may be used not only for the heat but the power required) is driven by a fan through sheaves of corn, which, wetted purposely for the experiment, were dried at the rate of 250 an hour. And this speed would, no doubt, be much greater if only the last portions of natural moisture had to be driven off, which hinder the completion of harvest work in a difficult season. Even, however, if the reported speed of four sheaves per minute should not be exceeded, that would be equal to the clearance of an ordinary crop at the rate of four or five acres a day; and this would often be of great service to the farmer in a wet harvest.

As regards the grass and other green crops of the farmer, it is an improvement of them, as the food of cattle, to get rid of a large proportion of the water which they naturally contain. And this is especially the case when they are used as winter food. It is somewhat interesting, therefore, to find that an attempt to produce a dry, or nearly dry cake from pulped, dried, and pressed mangold-wurzel roots, has been made, and that it has been found extremely nutritive in an experiment reported by Mr. Hugh Smith, of Great Hadham, Herts. Five sheep put up on May 26, to feed on oilcake and pasture, made 262 lbs. of increased live weight during twenty weeks, having consumed 7¾ cwt. of oilcake; and other five sheep fed on similar pasture, along with mangold cake, prepared from 3 tons 3 cwt. of raw mangold root, made 266 lbs., almost exactly the same increase, in the same time. The oilcake cost 4*l.* 9*s.*, and if the 3 tons 3 cwt. of mangold wurzel can be credited with having done as much as that value of oilcake did, certainly the roots were doubled in efficiency and value to the farmer by being dried. It can hardly be contended that this is so; but we may safely gather from the experiment that if a certain advantage is obtained in the warm summer months by removing a large proportion of the cold water which is given to our fattening stock in mangold wurzel and other roots, a much greater advantage would undoubtedly be obtained in the winter season when so large a bulk of cold and watery food as is often given must not only waste but injure the digestive powers of the animal.

A recently published report of Messrs. Lawes and Gilbert affords a good illustration of the fact that living things have to obey the laws of their nature, and cannot be manipulated by treatment according to the arbitrary will of their cultivator. The experience of many years at Rothamstead has taught that special manurings have hardly any appreciable effect on the composition of the ash of wheat, which maintains its uniformity, whatever variation may have been artificially presented in the mineral food with which the crop has been fed. This fact tallies perfectly with the whole course of agricultural experience in teaching that the farmer cannot with impunity set himself to be the master of his circumstances. If he be wise he will only endeavour to be their intelligent servant, trying to turn them to account, but avoiding the costly and wasteful process of opposing them. A living thing must be preserved in health if it is to yield abundant produce, and with that view it must be treated according to its nature; and so, whether it be plant or animal that is cultivated, the maximum of produce will be obtained not necessarily by presenting it with abundance of the ingredients or elements of which that produce consists, but by taking care simply to provide the conditions of healthy growth, leaving the produce to develop as it may.

Dr. Voelcker's researches into the composition of town milk have lately been published in the columns of the 'British Medical Journal,' which has startled its readers with proof of the scandalous adulterations generally practised by the milk-dealers. Of only one out of ten samples analyzed from as many different shops, could it be said that the milk was pure; though sold at 4*d.* and 5*d.* a quart it was really in general worth only from 1*d.* up to 3*d.* for that quantity. In one case examination proved that artificial colouring had been added, that one-fourth of the cream had been removed, and one-sixth of water added! In another, the "new country milk" was skim-milk, with one-third water added! In a third, one-fourth of the cream had been taken, and 33 per cent. of water added! Genuine country-milk contains 4 per cent. of fatty matter, 3 per cent. of casein, and nearly 5 per cent. of milk-sugar; but of these three ingredients the figures were 3, 2¾, 4—1·6, 2·8, and 4·1—1·62, 2·68, and 4·09 respectively—in some of the examples investigated by Dr. Voelcker. And in the second of these instances the price charged was 5*d.* a quart, and the profit per annum must have been 200*l.* a year on every ten gallons sold per diem. It is plain that all classes dealing with the shops from which these samples were obtained are being victimized, and the robbery falls heavily upon the poor. If the results thus obtained represent the average truth, then one milk dealer out of every ten is an honest man! We hear with pleasure that a company is being started in Switzerland for the preservation of milk in the form of cakes, and we are told on good authority that such cakes, dissolved in England, produce beautiful rich milk.

During the recent autumnal meetings of local agricultural societies, the subject of agricultural education, including that of the future tenant-farmer as well as that of the future agricultural labourer, has occupied attention. Members of both Houses of Parliament, and landlords as well as tenant-farmers, have concurred in urging the importance of instructing boys in the principles of the art by which they are to be maintained in after-life; and whether it were Mr. Read, M.P., addressing agricultural labourers at North Walsham, or Colonel Kingscote, M.P., addressing a farmer's club in Gloucestershire, or Earl Spencer and Earl Leicester speaking at an agricultural meeting in Norfolk, the advantages of technical education were not only admitted by them but insisted on. It is in accordance with this opinion that the educational efforts of the English agricultural body are for the future to be confined to the promotion of the strictly professional branches of an agricultural education.

A preliminary statement issued by the Board of Trade, anticipating a fuller report which has yet to appear, announces that there were in England and Wales in corn crops of all kinds this year, 7,941,578 acres, against 7,921,244 acres returned in 1866; and in Scotland, 1,367,012 acres, against 1,366,540 acres last year. The land under wheat is returned for England and Wales at 3,255,917 acres, against 3,275,293 acres in 1866; and for Scotland, as 115,118 acres, against 110,101. The number of cattle in England and Wales is 4,017,799, an increase of about 150,000 within the year; and in Scotland, 979,170, an increase of 40,000. Sheep are returned for England and Wales at 22,097,286, an increase of nearly 6,000,000 over the previous return; but this is owing to the return for 1866 having been required before lambing time, for the purpose of the Cattle Plague inquiry. There were 6,893,600 sheep in Scotland at the date of the inquiry this year.

Among the noteworthy agricultural incidents of the past quarter we may record here the prices reached at a public sale of shorthorn cattle, chiefly yearlings, imported from the United States. Animals of the pure "Duchess" family of shorthorns had been purchased in England ten or fifteen years ago by American breeders, and now their surplus stock are being returned to us, and eight sold by Mr. Strafford at Windsor the other day, averaged 408*l*. 3*s*. 9*d*. a-piece; a young heifer reaching the extraordinary price of 700 guineas!

2. ARCHÆOLOGY AND ETHNOLOGY.

The most important event of the past quarter in Pre-historic Archæology is no doubt the opening of the Blackmore Museum, at Salisbury. The value of this museum lies in the fact of its being a *special* collection of antiquities—characterizing a particular period—with illustrative modern examples. Mr. William Blackmore stated, at its opening, that the nucleus of this museum is the renowned "Squier and Davis" American collection, which was purchased by him in the year 1864. To this has been added a valuable collection of stone implements from the various caves and drift-deposits of England and the Continent, with a most interesting illustrative series of the modern stone implements at present used by various savage races. Mr. Blackmore has munificently given this remarkable collection to his native town; he has also built a museum for its reception, and has provided for its future maintenance. Its management has been undertaken from year to year by the committee of the Salisbury and South Wilts Museum, with the consent of the Blackmore Museum Trustees, in whom the property is vested. The trustees are three in number, namely, Mr. Blackmore, Dr. Blackmore (brother of the founder, and well known for his researches on the drift deposits and the flint implements contained in them), and Mr. E. T. Stephens: the last two being also the honorary curators. Henceforth those who wish to learn the evidence which is known respecting the antiquity of man and collateral questions connected with it will find this museum a most valuable, and indeed indispensable, aid. It was opened in the beginning of September with great *éclat*, the proceedings, which occupied two days, including the reading of papers, a conversazione, and the formal presentation at its opening by Mr. Blackmore.

No account of the proceedings of the "Congrès Paléoethnologique" seems to have been published; but Mr. Boyd Dawkins has printed in the 'Intellectual Observer' for October a paper read by him, entitled "Man and the Pleistocene Mammals of Great Britain." It consists chiefly of an historical account of the various discoveries of flint implements in Great Britain, and especially of his own findings at Wookey Hole. He makes, however, one statement, which it may be useful to reproduce, as showing that these indications of man's coexistence with extinct animals are not so wonderfully abundant as we seem, almost unconsciously, to have been brought to believe:—"Out of the thirty caverns explored in Great Britain, the contents of which I have classified, *four only have yielded human remains;* while out of forty river-deposits containing mammalia, only three have furnished any trace of man. Had man been very abundant in those days, we might certainly have hoped to have found his implements more widely spread, and especially as they were fashioned out of a material that is almost indestructible."

In the same and the succeeding number of the 'Intellectual Observer,' Mr. Jewitt gives the first two portions of a most interesting description of the Grave-mounds of Derbyshire and their contents. He divides them into three divisions, according to their age, namely, the Celtic, the Romano-British, and the Anglo-Saxon, by far the greatest number belonging to the first-named period, and the smallest number to the second. In these two instalments he describes the barrows of the Celtic period, the various modes of interment, and the objects of flint, bone, stone, and pottery found in the graves. The barrows contain interments by inhumation and cremation. In the former case, "the body is mostly found in a contracted position on its side," but occasionally it is found lying at full length. In the latter case, "the remains of the burnt bones, &c., have been collected together, and placed either in a small heap or in a cinerary urn." Referring to the immense amount of heat which must have been used in burning the bodies, Mr. Jewitt asks, "Is it too much to suppose that the discovery of lead may be traced to the funeral pyre of our early forefathers?" The cinerary urns are either inverted over a flat stone, or are upright and the mouth covered by one. When the bones are placed in a heap they are often surrounded by stones. Frequently the interments have been made in cists, and a barrow may contain one or more of these chambers; but sometimes the barrows are formed almost wholly of earth. The flint implements are varied in form, and frequently of exquisite workmanship; the stone implements consist of adzes (celts) and hammer heads, as well as whetstones and other miscellaneous objects. Besides these, are beads, rings, studs, necklaces, &c., of jet; celts, daggers, awls, pins, &c., of bronze; and a variety of articles in bone, including modelling tools, personal ornaments, lance and spear-heads, whistles (?), hammers, &c. Not a single article of gold has been found in any Celtic barrow opened in Derbyshire, but a few have been turned up by the plough. The pottery consists of cinerary urns, food vessels, drinking cups, and the so-called incense cups. Mr. Jewitt considers that this pottery has been baked by the action of fire, and with regard to the "Incense Cups," he thinks it probable that they were used to receive the ashes of infants sacrificed at the graves of adults—their mothers, for instance.

The report of the Nottingham Meeting of the British Association, which was published as usual twelve months after date, contains the "Second Report of the Committee for Exploring Kent's Cavern, in Devonshire." The facts made known up to the present time may be briefly summed up as follows:—The present floor of the cave was strewn with immense boulders, which had fallen from the roof, between and beneath which was a deposit of black mould or mud, from three to twelve inches thick; beneath this was a stalagmitic floor, graduating downwards into a firm stony breccia, and beneath this again a thick accumulation of "cave-earth," of unknown depth, including a large number of angular fragments of limestone, but without any indication of stratification. In the black mould have been found objects of human workmanship in slate, stone, bone, and bronze; a few flint flakes, two fragments of plates of smelted copper, and numerous pieces of pottery. With them were associated bones of various existing animals, such as pig, deer, sheep, badger, fox, numerous rodents, &c.; pieces of charred wood, and shells of several kinds of snails.

Few remains have been discovered in the stalagmitic floor; they consist of terrestrial and marine shells of existing species, and bones of various recent and extinct animals. In the cave-earth a large number of bones of extinct animals have been found, including *Elephas primigenius*, *Rhinoceros tichorhinus*, *Felis spelæa*, *Ursus spelæus*, and *Hyæna spelæa*; with these were discovered nearly one hundred flint implements, excluding doubtful specimens and mere chips. This cave-earth has been worked to the depth of four feet, and the Committee have kept a record of what was discovered in each level of one foot deep. The flint implements and bones were most numerous in the first foot below the stalagmite, and the implements of most elaborate workmanship were found in the lowest levels, of three and four feet deep; those from the four-foot level being "the most elaborately finished tools of the cavern series."

Speaking generally as to the relative abundance of implements in the levels, the Committee state that "up to this time each level has been rather less productive than those above it." The explorations of the Committee have been scrupulously made in those portions of the cavern which have not been disturbed by earlier investigators, whose statements they have been able to confirm in every particular, except the asserted occurrence of *Machairodus* and *Hippopotamus*, and human bones, which they have not yet met with. We look forward to reading the conclusions at which the Committee have arrived in a future report.

In a pamphlet, entitled 'A Descriptive List of Flint Implements found at St. Mary Bourne, with Illustrations of the Principal Types,' Mr. Joseph Stephens records (at p. 23) his discovery of a spot which had evidently been the scene of flint working during a long period, occupying a small space in an open field, known as Breach-field, on a hill near the village of St. Mary Bourne. In a few visits he succeeded in finding "more than 100 cores, about 200 arrow-head and spear-head flakes, a score of axes, besides a quantity of so-named scrapers, sling-stones, awls, drills, wedges, hammers, crushers, and a heap of pot-boilers." He states that all the implements are of the "surface-type," and mostly of very rude workmanship; that they possess a "strong family likeness," as if they were the work of a particular tribe or family; and that they are diffused through the soil, fresh specimens appearing after heavy rains.

An important work, entitled "L'uomo fossile dell' Italia Centrale," by Signor Igino Cocchi, has been published in the third volume of the 'Memoirs of the Italian Society of Natural Science.' The author describes the Post-pliocene and Recent deposits of Central Italy, and the Pliocene strata of the Val d'Arno and Val di Chiana, with the fossil mammals, mollusks, and plants, obtained from the latter. The Recent deposits he divides into Modern, consisting of various alluvial formations, and an Ancient alluvium, yielding obsidian implements. The Post-pliocene deposits are divided into Upper and Lower, the former comprising the Loess as its upper member, without any fossils or human remains, but probably belonging to the Reindeer-period; and as its lower member, various deposits known as the Diluvium of Central Italy, &c., containing remains of *Bos primigenius* and its variety *B. trochoceros*, &c., together with stone knives. The Lower Post-pliocene strata are subdivided into an upper portion, consisting of ferruginous conglomerate, &c., without human remains, but otherwise containing similar fossils to the underlying deposit. The lower portion consists of lacustrine clays of great thickness, with layers of peat towards its superior margin; it contains bones of *Elephas primigenius*, *Cervus euryceros*, *Bison priscus*, and a species (probably new) of *Equus*; it has also yielded stone implements, and a human cranium, the latter from the plain of the Aretino. It is satisfactory to learn that at last a fossil human cranium has been discovered associated with remains of extinct animals in a true stratified deposit, and whether this deposit be termed Lower Post-pliocene, or anything else, there seems little room for doubt that the cranium was imbedded contemporaneously with the remains of *Elephas primigenius*, &c., and that Man lived in Italy contemporaneously with those animals.

M. Pierre Béron has devoted a portion of the third volume of his 'Physique céleste' to a discussion, entitled "La Terre et l'Homme avant et après le Déluge." So many wonderfully far-fetched ideas are crowded into 150 pages, that they would render the ancient cosmogonies commonplace by comparison. To Anthropologists this book will be a curious study, and will show them how very wild the imagination of a clever man can run; beyond this we cannot see that it has any scientific value.

Mr. Rose's extensive collection of implements and weapons illustrative of the Stone Age in Denmark has been exhibited in the museum of the Anthropological Society during the past month. It is perhaps more remarkable for the number of specimens it contains than for the variety of types illustrated, although in the latter respect also it has a certain value.

3. ASTRONOMY.

(*Including the Proceedings of the Royal Astronomical Society.*)

WE regret to have to record the death of three distinguished astronomers—Sir James South, Lord Wrottesley, and Lord Rosse.

Sir James South was one of the founders of the Royal Astronomical Society, and for some time its President. We are indebted to him for a valuable catalogue of double stars, which he compiled in conjunction with Sir John Herschel. Of late, his great age and increasing infirmity have prevented him from taking any important part in furthering the progress of Astronomy; but he has continued to take great interest in the science.

Lord Wrottesley was also one of the founders of the Royal Astronomical Society. He received the Society's Gold Medal for his 'Catalogue of Stars.' He was President of the Royal Society from 1854 to 1857.

William Parsons, Earl of Rosse, was born in 1800. He took first-class mathematical honours at Oxford in 1822. In 1843 he presided over the meeting of the British Association. From 1849 to 1854 he was President of the Royal Society. He is chiefly celebrated for the ingenuity and mechanical ability displayed in the construction of the great Parsonstown reflecting telescope. In 1831, Lord Rosse had erected a telescope, one yard in diameter, and nine yards in focal length, smaller, but probably more efficient than Sir W. Herschel's great reflector. Not only was the construction of this instrument superintended by Lord Rosse, but he had worked upon the speculum with his own hands. Encouraged by the success of this instrument, he commenced the construction of a more gigantic telescope. The new instrument was fifty-two feet in focal length, and seven feet in diameter, with a six-feet speculum. It was first applied to the survey of the heavens in 1845. We could not spare one-tenth part of the space which would be required even to summarize the work of the great reflector. It must therefore suffice for us to say, with the late Professor Nichol, that "it has converted what was twilight into daylight and has penetrated into regions of space formerly enveloped in utter darkness." It has also brought within our ken a new and wider circle of twilight, and has enlarged correspondingly our estimate of the unknown—of the boundary of darkness lying beyond the penumbral band that encloses our "circle of light."

We were not favoured, as had been hoped and expected, with a display of the November shooting-stars. We hear of countless meteors having been seen in Paris, but the account is not confirmed by trustworthy authorities. In England there was certainly no *display*, though several shooting-stars were seen. We do not hear that a shower was seen in Canada or the United States, where it was supposed there was a more favourable prospect of a noteworthy display being observed. It is just possible that we may still hear of the shower having been seen in the eastern parts of Asia. But we must remember that the presence of the full moon was sufficient in any case to have prevented a large number of shooting-stars from being seen. For it was noticeable in the display of November 14, 1866, that most of the shooting-stars were not brighter than stars of the third magnitude, and as fixed stars of this magnitude can scarcely be seen on a hazy moonlit night, such as that of November 13–14, it seems probable that all the smaller shooting-stars would escape notice altogether. It is to be considered also that Jupiter has now been for several months in a position which brings his attraction to bear very efficiently on that part of the shooting-star system traversed by the earth in November. And as his influence acts now to sway the system *outwards*, it is far from being unlikely that the earth may have passed inside the ring of meteors, instead of through it as she did last year.

The opinion we have seen expressed, that the absence of a great display ought to throw doubts on the general conclusions of astronomers respecting the November shooting-star system, is wholly erroneous. Even if it were absolutely certain that there had been *no shower of falling-stars, all that could be learned from this would be what astronomers have long since inferred, that the band of small* bodies forming the system is not continuous.

A careful examination of the observations made upon Jupiter on August 21, when he was (apparently) without satellites, reveals some noteworthy results. The best observers differ as to the relative dimensions of the shadows of the third and fourth satellites. But it is remarkable that those who used refractors considered that the shadow of the fourth looked larger than that of the third satellite, or, where no comparison is directly instituted between the shadows, that the shadow of the fourth satellite seemed noticeably larger than the satellite itself. On the other hand, the best observers with reflectors, considered that the shadow of the third satellite was larger than that of the fourth. As it is readily demonstrable that the real shadow of the fourth was much smaller than that of the third, and the penumbra much larger, it seems to result that reflectors are less efficient than refractors in exhibiting faint shadows and half-lights. Even refractors, however, did not exhibit the distinction of tint between the penumbra and the true shadow.

The dimness of the fourth satellite was a very noteworthy feature. It looked as dark, says Mr. Dawes, as its shadow, but smaller. One observer suggested even that the fourth satellite suffered eclipse by the third, during a part of the transit, but this certainly did not happen. At the time mentioned by this observer, the fourth satellite hid a small part of the third satellite's shadow on the disc,—but, of course, an eclipse of one satellite by another would be indicated by the coalescing of the two shadows, which did not and could not happen on August 21st last, since the apparent paths of the shadows across the disc were separated by a considerable interval.

Lastly, a strange dark space divided by a narrow channel of light occupied one-half of the third satellite's disc, and this space resembled one seen in 1860 by the same observer—Mr. Dawes—but was on the opposite side of the disc. This observation seems conclusively to overthrow Sir W. Herschel's theory, that the satellites turn always the same face towards the planet, as our moon towards the earth.

A strange amount of doubt still clings to the supposed discovery of volcanic action within the lunar crater Linné. At a late meeting of the Astronomical Society Captain Noble expressed the opinion that the changes supposed to have taken place in Linné are due entirely to variations in the state of the earth's atmosphere, and of the moon's illumination and libration. Mr. Buckingham, on the contrary, judged from his observations that real changes had taken place. On August 6, he detected a convexity in the white cloud, which after it entered the terminator appeared as an egg-shaped convex disc. On October 19, he saw parts of the whole ring and fragments of a broken ring with his 20-inch refractor. On November 5, he could still see the summit of the small crater, which seemed larger than before. He considers that the crater is considerably larger than at the beginning of the year, and nearer the centre of the cloudy spot. Mr. De la Rue controverted the opinion expressed by Mr. Proctor, that photographs of the Moon afford evidence of change (the photographs referred to being those by Messrs. De la Rue and Buckingham).

At the same meeting the discussion of the circumstances attending the eclipse of the Moon on September 13, elicited from Mr. Buckingham the interesting statement that a portion of the unobscured part of the Moon was absent from the photographs. Mr. De la Rue, who has before observed this peculiarity, expressed its nature by saying that *more of the Moon is eclipsed chemically than optically*.

It is perhaps hardly necessary that we should make even a passing reference to the so-called Newton and Pascal controversy. Never before, we imagine, has so barefaced an attempt been made to impose upon the scientific world. The chief care of the author of this contemptible affair appears to have been devoted to the concentration of every possible absurdity and blunder within the range allotted to the correspondence he has been at the pains to invent. French scientific men, generally, have acted in this matter in a manner very creditable to themselves. It is painful to have to note as an exception one eminent mathematician, who having assumed a false position, seems to be ashamed to withdraw from it.

An annular eclipse of the sun will take place on February 23rd. It will be invisible at Greenwich, but the northern line of simple contact will pass very close to England, so that in the northern parts of France the eclipse will be visible as a partial one.

Venus will be well situated for observation during the ensuing months, as an evening star. She will attain her greatest easterly elongation on May 6th.

We have to announce the discovery of two more Asteroids, both detected by Professor Watson, of Ann Arbor (U. S.)—one on the 24th of August, the other on the 6th of September, 1867.

The twenty-five inch object-glass, which has been for some time in the hands of Mr. Cooke, the eminent optician, is at length completed. This is the largest refractor that has ever been constructed, and we may look for important discoveries through its application to the observation of celestial objects. For it has been shown satisfactorily that the object-glass is optically excellent. On November 5th, 1867, the telescope was directed to the star γ Andromedæ, and the small companion was seen distinctly divided, with the spurious discs of the three stars of this triple system perfectly round. "To those who know what a telescope is," says the President of the Astronomical Society, "and how the difficulties of making it are enormously increased with extension of aperture, this statement is enough." He added that in his opinion there were several opticians in London who could make a glass of the same dimensions and optical accuracy, and that therefore it was quite unnecessary to seek out of England—as is frequently done—for any optical instrument whatever.

Mr. Dawes has at length completed the list of double-star observations, which has been one of the results of his long and most valuable labours with the telescope.

Proceedings of the Royal Astronomical Society.

Dr. Edmund Weise supplies an important and valuable paper on the total eclipse of August 17th, 1868. He has computed the position of the central line of the eclipse and of the limits of the totality, by Hansen's formulæ. He finds that the shadow touches the earth near Gondar, in Abyssinia, crosses the Straits of Bab-el-Mandeb, including Perim, Mokha, and Aden; leaves Arabia by the *Cape Râs-Furtak*, and enters the peninsula of India between Goa and Rajahpoor. We have already described the path of the shadow across India. The maximum duration of totality occurs in the

Gulf of Siam, when it reaches on the central line no less than 6′ 50″, the altitude of the sun being 87½°. On its further progress, the shadow runs through Borneo, Celebes, the Islands Bouru, Amboyna, Ceram, and the Arrou Archipelago; covers completely the southern part of New Guinea, and moves then towards the New Hebrides, where the totality begins at sunset.

What renders this eclipse so important an object of attention to astronomers, is the fact that the totality lasts almost as long as is possible under any circumstances. For at the commencement the Moon will have just passed a perigee of uncommon proximity, and she reaches during the eclipse the ascending node of her orbit. Thus the eclipsed sun rises nearly to the zenith of those countries where the eclipse takes place at noon; and therefore the augmentation of the moon's diameter (due to her altitude) is a maximum, and the rate at which the shadow sweeps over the surface of the earth is a minimum. The result of the coincidence of all these favourable circumstances will be an eclipse without rival in the records of past eclipses. There are to be found only two which may be compared in size with that of August 17, 1868, and none in which the totality lasts so long. The first is the eclipse of Thales (May 28, 585 B.C.), said to have been the first predicted, and to have concluded a fierce engagment between the Medes and Lydians. The second was visible on June 17, 1435, in Scotland, and the time of its occurrence was long remembered by the people of that country as "the black hour."

But besides its enormous size, the eclipse deserves special attention in another respect. In researches on the nature of the red protuberances and other phenomena visible during total solar eclipses, it would certainly be of the highest importance to learn something about the nature of changes to which these appearances may be subject. On a single place upon the shadow's path, the time of visibility is too short to permit of the hope of perceiving processes of physical change in these objects; but it is far from being improbable that observations, obtained at several places along the line of totality, might afford the information we seek on this point. In the present instance the shadow touches a series of accessible regions, as we have seen. It is also very probable that favourable weather will prevail at the time of observation.

It would certainly be well that efforts should speedily be made to take advantage of so favourable an occasion for extending our knowledge of solar physics. Centuries will pass before we have such another opportunity.

Turning to Major Tennant's remarks on the subject of the same eclipse, we find that much has been done in the way of preparation. The Council of the Astronomical Society has decided that there should be provided for photography a silvered-glass reflector, equatorially mounted and driven by clockwork. The Astronomer Royal also offered to lend Major Tennant two telescopes from the Royal Observatory.

As respects Photography, the conditions as to time rendered it unadvisable to attempt to use a speculum of more than 9¼ inches diameter. The picture will be taken at the side of the tube, the telescope being a Newtonian one. Provision has been made to obtain a field of more than one degree in diameter, so that, if possible, some traces of the structure of the corona may be obtained in the photograph. The important difference between the position of an equatorial used in such low latitudes as the central parts of India and one used in our latitudes, have rendered new designs necessary for almost every part of the mounting. Hence many unavoidable delays have taken place with respect to this part of the arrangements.

Measures have also been taken to apply tests for the polarization of light from the coloured protuberances and the corona, the following three methods being applicable:—

1st. The extinction of the polarized portion of the light by means of a Nicol's prism, reducing the intensity of the image to a minimum.

2nd. Savart's test, where parallel fringes are formed by the interference of the polarized rays, the central one being either dark or light, as its plane is in or perpendicular to the plane of polarization.

3rd. By a double-image prism and analyzing plate, giving images of complementary colours with polarized light.

The first two of these tests can be instantaneously interchanged, and there is no difficulty in using all these tests successively in two minutes.

For spectrum observations, the Astronomer Royal has lent Major Tennant one of the old collimators of the Transit-Circle at Greenwich Observatory. An equatorial mounting is being constructed for this, to follow any object steadily, but without clockwork. The spectroscope will allow of the spectrum being compared with a scale of equal parts, by means of which its peculiarities can be referred to the lines of the solar spectrum.

All the estimates for the expenses of the proposed operations have been duly sanctioned.

Mr. Proctor gives the elements of his new determination of the Rotation-period of the planet Mars. A comparison of pictures taken by Mr. Browning in February of the present year with Hooke's observations in March, 1666—giving a period of nearly two hundred and one years—have enabled Mr. Proctor slightly to correct his former estimate—in obtaining which one or two small errors had crept in. He now gives for Mars' sidereal day the period 24h. 37m. 23·73s., in place of the period 24h. 37m. 27·745s., first obtained.

Mr. Cayley gives an expression for the angular distance of two planets, the sun being the centre of reference. Those who are interested in questions of this sort, will be able to judge of the nature of the paper from the statement that,—v and v' being the longitudes of the two planets in their orbits, θ and θ' the longitudes of their nodes, and φ and φ' their inclinations, then Mr. Cayley finds an expression for the required angular distance, in terms of cos $(v - v')$, sin $(v - v')$, cos $(v + v')$, and sin $(v + v')$, the coefficients involving the quantities θ, θ', φ, and φ'.

Mr. Gill supplies a note on the Trapezium of Orion. He was able, with a good achromatic only 3⅜ inches in aperture, to detect the exceedingly minute star 7 of the Trapezium. He also suspected the presence of a more minute star similar in R. A. to 9, and having the same declination as δ. It may be noticed in passing, that 6 of the Trapezium has been seen, with an achromatic only 3¼ inches in aperture, by Cooke.

It appears that, after all, the variable T Coronæ, whose sudden appearance so startled the astronomical world in May, 1866, may have been visible before evening set in, in England, on May 12th. For Mr. Walter, surgeon of H.M.'s 4th Regiment, in North India, saw the star shining at least as brightly as Alphecca at eight o'clock on the evening of that day, an hour corresponding to about half-past two in the afternoon at Greenwich. It seems possible therefore that Mr. Stone was mistaken in rejecting the evidence given by Mr. Barker, of Canada; evidence, however, which we are bound to say bore a very questionable appearance.

Mr. Weston supplies a paper on the appearance of Jupiter's satellites and their shadows when transiting Jupiter's disc, on the evening of August 21st, 1867. He records the apparition of false satellites adjacent to the true ones, and distinct from the shadows. Such appearances, which have been observed by others, must, we think, be referred to optical delusion, since Mr. Dawes and other observers of the first class have failed to notice them. Mr. Weston, using a 9-inch Newtonian reflector, noticed that the shadow of the third satellite seemed larger than that of the fourth, an appearance which—as we have already said—seems to have been presented in almost every case, to observers who used reflecting telescopes.

Mr. Leeson Prince, in a paper on the same phenomenon, calls attention to the fact that the remarkable darkness sometimes observed in the fourth satellite when transiting Jupiter's disc, was observed and recorded nearly a century-and-a-half ago by Mr. J. Pound. This well-known astronomer took the satellite for its shadow, so dark was the former; and was surprised—soon after seeing the dark spot which he thus mistook—to see another and darker shadow pass on to the planet's disc. The first, when in the middle of the disc, was almost as dark as the second when near the edge of the limb, but somewhat less in size. "From which it is very plain," he adds, "that the first of these spots was the fourth satellite itself, and the second its shadow. We have seen the first and second satellites appearing, not as dark spots, but as bright ones (somewhat differing from the light of Jupiter), for some little time after they have entered the disc; but as they approach the middle we lose sight of them; and we have frequently observed that the same satellites appeared brighter at some times than at others; and that when one of them hath shined with its utmost splendour, the light of another hath been considerably diminished. From whence it is very probable, at least, not only that the satellites revolve upon their proper axis, but also that some parts of their surfaces do very faintly—if at all—reflect the solar rays to us," an interesting passage, considering the date of the observation.

4. BOTANY AND VEGETABLE PHYSIOLOGY.

AMERICA.—*Vibrios in Hot-water.* Dr. Jeffries Wyman has been making some experiments on the appearance in hot-water of living organisms, which have some interest as touching upon spontaneous generation and some problems of Cryptogamic Botany. He concludes—

1. In thermal waters, plants belonging to the lower kinds of algæ live in water, the temperature of which, in some instances, rises as high as 208° F.

2. Solutions of organic matter boiled for twenty-five minutes, and exposed only to air which had passed through iron tubes heated to redness, became the seat of infusorial life.

3. Similar solutions contained in flasks hermetically sealed, and then immersed in boiling water for periods varying from a few minutes to four hours, also became the seat of infusorial life. The infusoria were chiefly Vibrios, Bacteriums, and Monads.

4. No ciliated infusoria, unless Monads are such, appeared in the experiments referred to in the above conclusions.

5. No infusoria of any kind appeared if the boiling was prolonged beyond a period of five hours.

6. Infusoria having the faculty of locomotion, lost this when exposed in water to a temperature of from 120° to 134° F.

7. If Vibrios, Bacteriums, and Monads are added to a clear and limpid organic solution, this becomes turbid from their multiplication in from one to two days. If, however, they have been previ-

ously boiled, the solution does not become turbid until from one to two days later.

The experiments of Dr. Child, of Oxford, and of other recent observers, are referred to by Dr. Wyman.

ENGLAND.—*A new Arctic Conifer.* In the 'Journal of Botany,' Mr. Andrew Murray describes the most northerly tree that has been met with on the north-west coast of America. It was found in the voyage of H.M.S. 'Herald,' forming forests on the banks of the rivers Noatak and Buckland, on the American side of Behring's Straits. This latitude is nearly seven degrees farther north than the limits of the woods on the eastern side of the American continent. This tree was described originally by Dr. Seeman as a variety of *Abies alba*, but Mr. Murray thinks that certain differences in the bract of the scale warrant a separation, and calls the new species *Abies arctica.* The desolate country where this tree is found is thus described by Dr. Seeman:—"There is nothing to relieve the monotony of the steppes. A few stunted Coniferous and Willow trees afford little variety, and even these, on passing the boundary of the frigid zone, are either transformed into dwarf bushes or disappear altogether. About Norton Sound groves of White Spruce trees and *Salix speciosa* are frequent; northwards they become less abundant, till in latitude 66° 44′ north, on the banks of the Noatak, *Pinus alba* disappears."

An Edible Fungus from Tahiti.—Mr. Brander, of Tahiti, gives an account of a fungus which is largely exported to Sydney. It is found principally in the Society and Leeward Islands, on decayed trees. The Tahitians call it "Teria iore" (*i.e.* "rat's ear"), from a fanciful resemblance of shape. The fungus first began to be collected in 1863, and fetches in China, where it is much esteemed and made into soups, from eighteen to twenty cents a pound.

Excellent articles (chiefly technical) occur in the same number of the 'Journal of Botany,' on the Plants cultivated or naturalized in the valley of Caracas, and on the staple products of Jamaica.

Weeds and their Characteristics.—Dr. Henry Trimen has made some very sensible remarks on the use of the term "weed," in reply to some observations on the same point by Dr. Seeman. Dr. Seeman says that a weed signifies a naturalized herb, which has a soft and membranaceous look, grows fast, propagates its kind with great rapidity, and spreads to the prejudice of endemic or cultivated plants, in places in some way or other disturbed by the agency of man. Dr. Trimen urges that the popular idea of a weed is any plant, irrespective of origin or appearance, occurring in cultivated ground, in addition to, and therefore more or less interfering with and injurious to the crop intended to be grown. This is the idea of a weed in the mind of horticulturists and farmers, and as it is sufficiently definite Dr. Trimen objects to the restricted sense given by Dr. Seeman. The essential thing about a weed is, that it is *out* of place. A sunflower in a field of turnips is as much a weed as *Brassica napus* in a flower-garden, but reverse their situations, and the term is inapplicable to either. So when waste land, such as a heath, is enclosed and brought under cultivation, the species composing its original flora become weeds in the new fields. With regard to the term "weedy." Dr. Trimen thinks that it means something more than "soft and membranaceous," many weeds being quite the reverse of this. From the situation of many "weeds" in rich and manured soil, and amongst other and taller plants, they acquire a luxuriant and rapid growth and a straggling habit. It is these characters which are especially implied in the term according to the old proverb, "Ill weeds grow apace." Etymologically no doubt, as Dr. Trimen and others before him have remarked, "weed" is connected with the Anglo-Saxon "weód," which means clothing or covering either of earth or man. Hence our expression "widow's weeds."

Fungi and Gregarines in the Hair.—A somewhat acrimonious correspondence on the chignon parasite has been going on in the 'Journal of Botany' between Dr. Beigel and Dr. Tilbury Fox. After the occurrence of small organic growths on prepared hair had attracted public attention, Dr. Beigel appears to have obtained specimens of the parasite, and sent them to the distinguished German algologists, Rabenhorst and Küchenmeister. These gentlemen named the little plant—which is the simplest possible aggregation of highly refracting minute cells—*Pleurococcus Beigelii*—and Dr. Beigel related what they had done in the 'Journal of Botany.' Dr. Tilbury Fox, who is known as an observer and writer of great ability on skin diseases, published his opinion that the specific or even generic distinction of the parasite could not be maintained, and that like other fungoid growths, it was a function of the nidus rather than of the spore from which it sprang. The consequence has been a reiteration of the distinctiveness of his *Pleurococcus* by Dr. Beigel. The term Gregarine was unfortunately made use of by Lindemann, originally, in speaking of this growth; it is really, as admitted both by Drs. Fox and Beigel, most inappropriate—*Gregarinæ* being indubitably animals, and of endo-parasitic habit.

Mr. John Bishop has described another case of Fungoid disease affecting the hair, to the Edinburgh Botanical Society. This occurred in the hair of the beard which, under its influence, broke off short, curling up and assuming a dried-up appearance as though singed. It appeared to be almost impossible to extirpate the fungus. Examination with the microscope showed a cellular fungus-growth within the hair—causing the destruction of the part by disrupting it from within. Sporules and mycelium branching among the broken fibres of the hair are occasionally to be seen.

Gases in Plants.—Messrs. Faivre and Dupré have experimented on this subject and submitted their results to the Edinburgh Botanical Society. They examined more especially the mulberry and the vine, and have arrived at the following conclusions:—1. The presence of gases in the interior of the root, stem, and branches in the mulberry and vine is a normal and constant fact. 2. The composition of these gases changes with the epochs of vegetation. 3. During the period of inactivity, carbonic acid is in very small proportion, and is scarcely appreciable. Oxygen is present to the same extent as in atmospheric air. During the phase of activity the contrary takes place, and the changes are more marked in proportion as the vegetation is more energetic; with the progress of vegetation, the proportion of oxygen diminishes. 4. In the roots during the epoch of vegetation, the quantity of oxygen is not so great, while that of carbonic acid is greater than in the branches examined under the same circumstances. 5. In the branches, as well as in the roots, there is an inverse relation between the oxygen and the carbonic acid; by adding to the normal oxygen that disengaged under the form of carbonic acid, we obtain a number which is scarcely above the proportion of oxygen in the air. 6. In the mulberry and vine, injections do not penetrate the pith or the bark, whether in the branches or roots. The ligneous layers are alone permeable to mercury. The more the formation of the vessels increases, the easier and more complete are the injections. The injections are fuller in the roots than in the branches; they are also more in the branches than in the young herbaceous shoots. In the old stems of the mulberry, the central layers cease to be permeable. 7. Microscopic examination proves that the injection specially penetrates the pitted and reticulated vessels, and also the spiral vessels in the young herbaceous shoots. 8. The pitted vessels show distinctly the mercury in the areolæ, as if in so many little pouches formed by thin portions of the wall; the same observations have been made in regard to the reticulated vessels.

FRANCE.—*Absorption by the Roots of Plants.*—It is still a vexed question as to how far the roots, of plants absorb certain elements of their food, such as carbonic acid. M. Corenwinder has applied himself to the solution of this problem, believing that very rash statements as to the functions of the roots have been lately made by M. Boussingault and others. He states it as his conviction that plants have not the power of absorbing carbonic acid from the soil by their roots, or that at least the quantity which permeates the tissues from this source represents but a very small proportion of the total amount of carbon their tissues contain. Boussingault stated that in the air contained in an ordinary soil he found no less than ten per cent. of carbonic acid. M. Corenwinder asks what is the source of this large quantity of gas, and replies that it arises from the mass of decomposing organic matter, leaves, &c., which in the processes of agriculture and by the influence of the earth-worm, &c., become embedded in the soil. M. Corenwinder, however, does not say what becomes of this carbonic acid. Liebig and other chemists answer the question better in showing that the carbonic acid is taken up by water which percolates through the soil, and that it is then used in eroding rocks and dissolving up otherwise insoluble mineral matters.

Aëriferous Vesicles of the Utriculariæ.—S. B. Schnetzler publishes an account in the 'Annals of Natural History,' of these curious appendages to the leaves. The genus *Utricularia* consists of aquatic plants which are found in the stagnant waters of ditches, marshes, &c. The leaves are submerged and divided into fine lacinæ furnished with the remarkable utricles. De Candolle states that when the plant is young these vesicles are filled with a mucilage which is heavier than water, and the plant held down by this ballast remains at the bottom. Towards the period of flowering, the leaves secrete a gas which makes its way into the utricles and drives out the mucilage by raising an operculum or lid with which the utricles are furnished. The plant thus becomes furnished with a multitude of air-bladders, and rises slowly and at last floats at the surface. After flowering in the air, the mucilage is again secreted and the plant sinks again to ripen its seeds below water. M. Schnetzler has carefully investigated the morphology and history of these organs, and concludes that they play the part at once of organs of respiration and of a hydrostatic apparatus. The organs do not appear at a given moment and for a particular purpose, but as a natural consequence of the anatomical structure of the plant and the action of the surrounding medium. After some philosophical generalizations the author observes, "The totality of the forms in which life manifests itself upon the earth, during a given epoch, appears to us like a magnificent mosaic, of which the different pieces brought together mutually determine their nature."

The Fall of Leaves.—Dr. Maxwell Masters has recently discussed this subject in a very seasonable article in the 'Popular Science Review.' It appears from the researches of M. Trécul (published in the 'Comptes Rendus') and others, that in many plants a phenomenon occurs just before the fall of the leaf, which is not unlike the process which accompanies the shedding of horns in animals. It consists in the obstruction of the proper vessels at the base of the petiole or leaf-stalk. This obstruction is caused by the multiplication of cells, which first occurs in the parietes of the vessels. The cells increase and multiply, till at last the vessels are completely choked up in the neighbourhood of the insertion of the leaf, and thus a differentiated plane is formed, across which the leaf-stalk breaks, and the leaf accordingly falls.

Movements of the Sensitive Plant.—M. Bert and M. de Blondeau have published accounts of some investigations into this highly interesting matter in the 'Comptes Rendus.' It is to be regretted that more critical examinations of the phenomena of movement in the higher plants have not been made. M. Bert shows that the natural and regular movement of the leaves, which takes place in the Sensitive plant, is produced by a different cause from that to which the sudden contraction is due when the plant is touched by the fingers. M. Blondeau's observations are exceedingly curious, and are well worth further examination. He submitted three plants to the influence of an electric current from a Ruhmkorff's coil. The first he acted on for five minutes; when left to itself, the plant seemed prostrated, but after a quarter-of-an-hour, the leaves opened, and it seemed to recover itself. The second specimen was acted on for ten minutes. The specimen was prostrate for an hour, after which it slowly recovered. The third specimen was galvanized for twenty-five minutes, but it never recovered, and in twenty-four hours it had the appearance of a plant struck by lightning. A fourth plant was etherized and then exposed to the current. Strange to say, the latter had not any effect, the leaves remained straight and open; thus proving, says M. Blondeau, that the mode of the contraction of the leaves of the Sensitive plant is in some way allied to the muscular contraction of animals.

5. CHEMISTRY.

(Including the Proceedings of the Chemical Society.)

Among the papers calling for special mention this quarter are those by Dr. A. W. Hofmann, "On the Production of Formic Aldehyde." The method by which the author has succeeded in forming this hitherto unknown body was shown at a meeting of the Chemical Society, and will be described in our Report of the Proceedings. Other papers of great scientific value have been communicated by the same author to the Royal Society, "On the Homologues of Prussic Acid."* These also were briefly referred to at the meeting of the Chemical Society.

Dr. E. Schunck has also contributed to the Royal Society a valuable series of papers "On the Chemistry of Urine." These, as well as the paper by Dr. Hofmann, do not admit of abridgment, and we must refer our readers interested in the subjects to the Proceedings of the Royal Society.†

The past quarter has not been marked by any specially interesting discovery, and but few facts call for notice. M. E. Duclaux‡

* 'Proceedings of the Royal Society,' vol. xvi., p. 144. † Vol. xvi., p. 73.
‡ 'Comptes Rendus,' t. lxv., p. 1099.

has noticed the formation of what he believes to be a Hydrate of Sulphide of Carbon. If a little water is placed on a glass plate, and a watch-glass full of the bisulphide is set in the midst and then blown upon, the water soon congeals, and the watch-glass is filled with snow-white flakes of the supposed hydrate. A lighted coal brought to the snowy mass sets fire to the bisulphide, which burns away, leaving the water with which it had united. The author has several times determined the amount of the water, and finds it to be constant, and just the quantity required by the formula $2\ C\ S_2,\ H_1\ O$.

The formation of this substance, we may add, is easily shown in another way. If a stream of the bisulphide is made to trickle down a piece of loose twine, the twine quickly becomes covered with a thick crust resembling hoar-frost. The substance, whatever it may be, rapidly evaporates, leaving the twine perfectly dry.

A new process for the production of sulphuric acid has been patented in France, and probably in England, by MM. Tardani and De Susini. Its great recommendation is that it dispenses with the large leaden chambers necessary to the English process. We must refer our readers to the source indicated below* for full particulars, and need only say that the Sulphur or Pyrites is burned in compressed air, and the sulphurous acid is first washed to free it from arsenic and other contaminations, and is then brought in contact with the nitric vapours in a small leaden chamber of peculiar construction. The reactions are precisely the same as in the old mode: the apparatus, however, it is said, occupies forty times less space, and an acid is obtained free from the ordinary impurities.

A new process for the manufacture of Soda has also been patented in France by M. Kessler. As in Leblanc's process, the inventor starts with common salt. This is intimately mixed with sesquioxide of chromium, either alone or with peroxide of manganese, and then roasted in a current of steam. The result is the evolution of hydrochloric acid, and the formation of chromate of soda. When the evolution of hydrochloric acid has ceased, the charge is drawn from the furnace, mixed with a proportion of charcoal or coal, and then reburnt. In this way the chromate of soda is converted into carbonate with the reproduction of sesquioxide of chromium. The soda is separated by lixiviation, and the sesquioxide is reserved for a future operation.

Two other technical processes deserve a short notice. One is for the extraction of indigo from rags dyed with that substance. The rags are first saturated with a weak solution of caustic soda, then placed in a boiler with a double bottom, and exposed for some hours to steam at 45lbs. pressure. The indigo in the rags is

* 'Bulletin de la Société Chimique de Paris,' Oct., 1867, p. 295.

reduced, and may be washed out. It may afterwards be precipitated from the soda solution, and recovered in a state equal to the best commercial sort.

Another inventor proposes to shorten the time of dyeing Turkey-red, by a previous oxidation of the oil used. This M. Bernard effects by heating the oil to 95° C. with a solution of chlorate of potash, and adding very gradually oxalic acid. The mixture is afterwards boiled for some hours. The oxidized oil, it is said, may be employed alone or in the form of an emulsion.

In connection with technical chemistry, we may mention the publication of a valuable paper "On the Cumberland Hæmatite Ores," by Dr. E. J. Tosh.*

A very delicate test for hyposulphite of soda has been published by Mr. Carey Lea.† A very dilute, but rather strongly acid, solution of sesquichloride of Ruthenium is first rendered alkaline by ammonia, and then boiled with the suspected solution. If hyposulphite be present, the liquid assumes a red colour, which varies in intensity according to the amount of hyposulphite. A solution containing one four-thousandth gives a clear rose-red; one containing a twelve-thousandth, a well-marked pink colour. A strong solution gives a colour so intense as to appear almost black. Such a test will be highly appreciated by photographers; but, unfortunately, ruthenium is yet a very rare metal.

Proceedings of the Chemical Society.

The first meeting of the present season was held on November 7. After the adoption of an address of condolence to Mrs. Faraday, Mr. W. H. Perkin read a paper "On the Action of Acetic Anhydride upon the Hydrides of Salicyl, Ethly-Salicyl, &c." A paper by Messrs. Chapman and Smith, "On Nitrous and Nitric Ethers," was next read. It gave an account of the methods adopted by the authors for preparing the nitrates and nitrites of methyl, ethyl, and amyl, and described the reactions and decompositions which these bodies undergo when treated in a digestion apparatus with metals, acids, and other re-agents. The most interesting part of the communications was the description of an easy mode of preparing nitrate of amyl in large quantities. Three measures of a mixture of one part of nitric and two sulphuric acid are placed in a beaker set in a freezing mixture, and to these is added very slowly one measure of amylic alcohol. The addition is best made with the aid of a dropping funnel, the stem of which, reaching nearly to the bottom of the mixture of acids, serves as a stirrer. The nitrate of amyl is

* 'Chemical News,' Oct. 18–25, 1867.

† 'Silliman's Journal,' Sept. 1867; and 'Chemical News,' Oct. 25.

produced without apparent action, and forms an oily layer on the surface of the acids. This is separated, washed with warm water, and rectified over chloride of calcium. The nitrate of amyl thus obtained is a colourless liquid, which boils at 147°–148° C., and at 7° or 8° C. has the same density as water. The inhalation of its vapour produces severe headache and other distressing symptoms.

Mr. Robert Warington then gave a short account of a long series of experiments, undertaken to determine the part taken by Oxide of Iron and Alumina in the Absorptive Action of Soils. The results may be summed up in a few words. Ferric oxide and alumina were found to withdraw nearly all the phosphoric acid from a carbonic aqueous solution of tricalcic phosphate. Hence the author believes that all the phosphoric acid applied to land in the shape of manure must ultimately become converted into phosphates of these bases; and, if sufficient iron is present, by preference into phosphate of iron. The absorptive action of the soil is thus seen to be dependent upon chemical affinity, and not upon physical attraction. As regards potassium and corresponding ammonium salts, it was found that the absorption was much greater in the cases of the phosphates, sulphates, and carbonates than with the chlorides and nitrates.

A discussion followed, in which Professor Way and Drs. Voelcker and Gilbert joined. The accuracy of Mr. Warington's results was not contested; but it seemed to be a general opinion that laboratory experiments of the kind described threw but little light on what happens in soils as they exist. Dr. Voelcker remarked that there was a remarkable tendency in nature for the soil to take care of itself; and if there should happen to be a deficiency of any one ingredient, it was quickly remedied by prior selection from a mixture of materials presented in the shape of manure. Dr. Gilbert agreed in believing that soils have almost an instinct to guide them as to what they should do.

The next communication was "An Analysis of the Water of the Holy Well, a Medicinal Spring at Humphrey Head, North Lancashire," by Mr. T. E. Thorpe. The water in question contains 508·5 grains of salts in a gallon, of which 331·75 grains is chloride of sodium, 88·49 grains calcium sulphate, 9·17 potassium sulphate, 24·39 grains sodium sulphate, and 43·48 grains magnesium chloride. The other ingredients need not be quoted.

An abstract of a paper by Dr. Wanklyn and Mr. A. Gamgee was next read. It was "On the Action of Permanganate of Potash on Urea, Ammonia, and Acetamide in strongly Alkaline Solutions." From the results obtained by the authors, it would seem that when artificial urea is heated in a pressure tube with a liberal amount of potash and permanganate, little or no oxidation takes place, and nearly all the nitrogen is liberated in the form of gas. Ammonia under the same circumstances is completely changed to nitrate, and acetamide to nitrate or nitrite.

The last paper of the evening was also by Professor Wanklyn, and entitled "A Verification of Wanklyn, Chapman, and Smith's Water Analysis on a Series of Artificial Waters." A short account of the method of analysis pursued by these gentlemen will be found at page 532 of our last volume. The verification consisted in submitting pure water containing known amounts of albumen and urea to the treatment there described. In the case of albumen, mere traces of ammonia were obtained on the distillation with carbonate of soda, and only an amount corresponding to two-thirds of the nitrogen in the final distillation with caustic potash and permanganate. In the case of pure urea, little or no ammonia was procured on distillation with carbonate of soda, and the addition of alkaline permanganate did not induce the evolution of more than one-fourth the nitrogen in the form of ammonia. The author stated, however, that when urea is present with albumenoid matter, as in a natural water, the surrounding impurities start the reaction, and much of the ammonia (·37 out of ·46) can be obtained by long boiling with carbonate of soda.

At the meeting held on November 21st, Mr. E. T. Chapman made a verbal communication "On the Relation between the Results of Water Analysis and the Sanitary Value of Water." He said that a drinking water should contain no ammonia. Lime-salts he did not consider injurious; and water with nitrates in solution, but otherwise pure, he believed to be harmless. But when these ingredients were found in a water together, such water favoured the development of the lower forms of animal and vegetable life, and if kept in a cistern quickly acquired purgative properties. He had verified the latter statement by experiments on pigeons, and confirmed the results by experiments on the human system. He argued the necessity of observing the relations between the several ingredients in a water before pronouncing an opinion upon its sanitary value. He also recommended the extended use of Clark's softening process as a means of removing the most objectionable forms of organic matter in waters containing carbonate of lime; fully six-sevenths of the nitrogenous matter would be carried down with the precipitated carbonate of lime.

In the course of the discussion Mr. Dugald Campbell stated that water containing much nitrate and carbonate of lime was astringent rather than purgative; and Dr. Stevenson said he had examined water of which cholera patients had partaken, and found no organic matter.

Mr. Spiller mentioned that water softened by Dr. Clark's process did not permit the growth of vegetable organisms; and

Mr. Abel explained that this resulted from the entire absence of free carbonic acid.

Dr. Gladstone afterwards read a paper "On the Pyrophosphoric Amides."

At the meeting of December 5th, Mr. W. H. Perkin read a paper "On the Artificial Production of Coumarine," which was a detailed account of the researches briefly referred to at page 400 of our last volume. It was there stated that by the action of acetic anhydride on the hydride of sodium salicyl, the author had obtained a product completely identical with the natural coumarine extracted from the Tonquin bean. A most remarkable fact established by the extended researches of the author is, that by acting on the hydride of sodium salicyl with homologous anhydrides, such as butyric and valeric, other coumarines are obtained, which differ in composition exactly as the anhydrides, but agree in possessing in a greater or less degree the same odour, and behave, chemically, precisely the same as the natural coumarine. For the theoretical considerations we must refer our readers to the chemical journals.

Professor Church then made a preliminary communication on a Singular Colouring Matter obtained from some Feathers of a Bird of the Touraco family. This bird has crimson feathers in its wings, and it has been observed by ornithologists that rain washes the red colour out. This statement has been confirmed by the experiments of Mr. Church, which show that the colouring matter of the barbioles is really soluble in water, and particularly in water rendered slightly alkaline. An acid precipitates the colouring matter from the alkaline solution, and when separated it is found to be insoluble in alcohol and ether, and to resist the action of acids, short of completely destructive agents. On incinerating some of this colouring matter, Mr. Church made the still more extraordinary discovery that it contains a large proportion of copper. The absorption spectrum of the coloured solution differs but little from that of arterial blood. Mr. Church is continuing his investigations, and will give a further account of the substance at a future meeting.

A short paper, by Mr. J. Williams, on the Preparation of Artificial Urea, was then read. The author finds that cyanate of lead digested at a gentle heat with sulphate of ammonia is the most convenient means to employ. The urea or cyanate of ammonia is of course easily separated from the sulphate of lead.

Dr. A. W. Hofmann, whose appearance was welcomed with acclamations, then showed some Lecture Experiments to the meeting. The first illustrated the formation of methylic aldehyde.* This body has only been recently obtained. Former attempts to procure it from methylic alcohol have only resulted in complete

* See 'Chemical News,' Dec. 6, 1867, p. 285.

oxidation, and the production of formic and acetic acids. Dr. Hofmann showed, however, that by suspending a heated platinum spiral over warmed methylic alcohol and sending a current of air through the bottle, a limited oxidation of the vapour of the wood-spirit took place with the production of a body, the chemical behaviour of which left little doubt of its being true methylic aldehyde.

The next experiment illustrated the fact discovered by Cloez, that ammonia is transformed into prussic acid by the action of chloroform. The speaker showed that when chloroform is heated with alcoholic ammonia and caustic potash, chloride and cyanide of potassium are produced. It was also shown that all the primary monamines lend themselves to a similar reaction. The experiment was made with aniline, by means of which a body isomeric with benzonitrile is produced. It possesses an intensely disagreeable odour, which is common, it seems, to all bodies of its class.*

It would not be right to conclude the Proceedings of the Chemical Society for the past year without noticing the decease of Mr. R. Warington, F.R.S., F.C.S. He was one of the founders, and we believe it may be said with truth, the projector of the Chemical Society; and in the early days of the Society one of its most active members. Mr. Warington was well known as one of the most able practical chemists of the day. He died on November 12th, 1867, aged sixty.

6. ENGINEERING—CIVIL AND MECHANICAL.

The depression in all matters of private enterprise, to which we have on former occasions referred, still continues, and the Engineering profession will for many a long year remember the financial crisis of 1866-67. The price of all railway stocks continues to be quoted at a very considerable discount, but we think we see at last a slight glimmer on the horizon, the forerunner of more prosperous days. New railway companies in this country would scarcely meet with a shadow of support, and, consequently, the Bills before Parliament include but very few relating to such works. Two Metropolitan Extensions in London and a revival of the attempt to construct tramways, to be worked by animal power, through the principal thoroughfares north and south of the Thames, constitute, we believe, the most important part of that class of Bill. But although few new works of any importance have actually been commenced during the past quarter, several have been successfully completed, others are still in active progress, and many new projects have been determined on.

* 'Proceedings of the Royal Society,' vol. xvi., p. 144.

Amongst the most important events connected with railway construction we may mention that the last connecting link of the extensive system of high-level lines at Battersea, which has been in course of construction since 1864, to improve the access to the Victoria Station, London, was opened for traffic in October last. The works on the Metropolitan Extension Railway are making good progress. The East London Railway from Liverpool Street, including the junction on the south side of the Thames, will be seven and a half miles long, and is to cost 1,866,000*l.*

In Scotland, the Denburn Junction Railway, connecting the Caledonian line with the Great North of Scotland system at Aberdeen, has been opened for public traffic. This line is only a mile and a half in length, but by its means there is now an unbroken communication between the extreme north and south of the kingdom.

In October last the Mont Cenis Tunnel was advanced 131·85 metres, or upwards of 140 yards; and up to the 31st of that month 7,664 metres had been excavated, leaving 4,555 metres to be done to complete the work. The progress during the first ten months of the present year was 1,329 metres against 1,094 metres excavated during the whole of 1866. If the rate attained during October can be kept up, this tunnel would be completed in 1870.

The Italian Government has been pushing forward the construction of a line to unite Marseilles, Genoa, and Leghorn, *viâ* the littoral of the Mediterranean, and it was expected that a section, from Genoa to Chiavari, would be opened for traffic in the course of last November. The works of the Foggia line and the port of Brindisi have been recently inspected by the Italian Minister of Public Works; a considerable portion of the Foggia line, it is said, might be opened in December, but obstacles are feared.

The Baden Government has recently brought out a loan of 12,000,000 thalers, or nearly 2,000,000*l.* for railway purposes.

Great activity continues to be displayed in connection with the development of railways in Russia. Three important sections have been opened of late, *viz.* from Odessa to Tiraspol, from Warsaw to Tiraspol, and from Balta to Obriopol. The concession has been granted of a line from Poti to Tiflis, while surveys have been commenced for another line from Rostow, on the Don, to the Black Sea. And a line is to be constructed, at the cost of the State, from Koursk to Karkhow and the Sea of Azoff.

An extension of privileges has recently been granted by the Government of New Granada to the New York Panama Railroad Company. This company, it is said, will now extend the road two or three miles out into the Bay of Panama, so that the largest ships and steamers may load and discharge alongside the track.

There has been a good deal of talk of late about public works in Turkey. The concession of a railway from Belgrade to Constantinople has been under consideration, as well as the construction of roads in Roumelia and Anatolia. A Franco-Belgian Company is said to be assured of a contract for docks at Constantinople, and the concession of the Roumelian Railways has been given to M. Van der Elss, of Brussels, who is to construct 450 kilometres of it before issuing any shares as bonds.

In India the past quarter has been conspicuous rather for the destruction than the construction of railway works. The great viaduct on the Bhore Ghaut suddenly collapsed, owing to imperfect construction, and many other bridges on the Great Indian Peninsula, and the Bombay, Baroda, and Central Indian Railways have been destroyed by the unusually high floods of the past season. Through communication between Calcutta and Bombay, *viâ* Jubbulpore and Nagpore, has been so far completed that it can now be effected in 116 hours. The only break of railway is between Jubbulpore and Nagpore, which, however, may be travelled by dâk gharry in 36 hours. It was expected that the north-west line of the Madras Railway would be opened as far as Gooty, some time last month. The works in connection with the construction of a tunnel under the River Indus, at Attock, have been ordered to be continued; but it has not yet been determined to continue the railway communication from Lahore to Peshawur. The Ceylon Railway was opened for goods traffic on 16th September last.

In Telegraphy we note the successful laying of the new cable between Placentia, Newfoundland, and North Sydney, Cape Breton; thus completing a new route from Nova Scotia to the Atlantic Cables, by which the Newfoundland land-lines are avoided. The Florida and Cuba Cable is at last at work, and it is now proposed to carry a line from the northern frontier of Florida to the port of Cherrara, situated at some leagues to the west of Havannah; various branch-lines are also contemplated. Mr. W. T. Henley, of North Woolwich, has successfully laid the Submarine Telegraph Company's cable from the South Foreland to La Paune, a small fishing-village in Belgium, close to the French frontier. The cable is a very heavy one, containing four conducting wires. All the principal police stations, and the principal station of the Fire Brigade in Watling Street, London, have at last been connected with the Chief Office in Whitehall by means of the telegraph.

The new Waterworks at Port Glasgow were opened with some ceremony on 15th October last. They consist of a large reservoir near the farm-stead of Leperstone, and a large filter and tank at the farm at Parkhill. The works are capable of supplying 12,000 people with 30 gallons of water a head per day. The waterworks for the town of Jedburgh are now in an advanced state; the reservoir at Blackburn is completed with the exception of the roofing, and the pipe track is finished. The tunnel through the Old Red Sandstone seam above Allar's Mill was completed early in November, and the distributing reservoir at the top of Castlegate is being proceeded with. The only drawback now is the Castle Hill tunnel, which has all along been a source of great anxiety to the contractors.

A company is to be shortly started for giving an improved water supply to Lisbon. It is proposed to bring to Lisbon the waters of the river Alviella by a canal 65 miles long. By this means it is calculated that a supply of 75 gallons a head per day will be assured to the population, which at presents amounts to 220,000 souls.

It is stated that contracts have already been let for the materials for the new bridge over the Niagara river. Its dimensions will be as follows:—height of towers 105 feet, width of span 1,250 feet, height above the water 175 feet, width of roadway 10 feet. A lattice-girder bridge has recently been erected across the Whitadder, about four miles from Berwick, the wooden one having been condemned; the estimated cost was upwards of 3,530*l*. A new iron bridge is also to be erected over the Clyde in room of the Hutchesontown stone bridge.

The Shipbuilding Trade on the Clyde has recovered in a wonderful degree, during the past quarter, from its recent depression. Several merchant vessels have been launched. Messrs. Robert Napier and Co. have commenced the construction of two iron-plated ships for the British Government; they have also in course of construction one iron ram, with a cupola for carrying two heavy guns, and a monitor for the Danish Government. A gunboat for the British Government has also been commenced at the yard of Messrs. Randolph, Elder, and Co. Messrs. Palmer and Co., of Jarrow, have undertaken the construction of an armour-plated monitor for the English Government; this vessel will be fitted with engines of 250 horse-power, which will also be supplied by the same firm.

The great event of the quarter with reference to dock construction has certainly been the opening of one of the Barrow-in-Furness Docks on 19th September. The site of the town of Barrow is separated by a channel from a small island, called Old Barrow Island, which forms the extreme point of the coast against the Walney channel, at its narrowest part, opposite the church on the Isle of Walney. This channel affords a dock accommodation of 105 acres in area, and it has been made use of for the construction of the new docks made by the Furness Railway Company. The first of these, called Devonshire Dock, with an area of thirty acres, and a stone quay of 2,500 feet in length, is the only one yet completed; while the second basin, Buccleuch Dock, has only been finished as far as the stone quay on one side is concerned. These docks comprise 1¼ miles in length of stone quays, and wharves of an area of 100 acres in extent.

On 3rd October a new dock was opened at Belfast, which consists of a large basin 700 feet long by 700 feet wide, called the Abercorn Basin, in which is a new graving dock 450 feet long by 80 feet wide at the coping, and 50 feet wide at the bottom. A new slip has been constructed at Messrs. Inglis' ship-building yard, which is the largest slip on the Clyde. It is 850 feet in length, and capable of accommodating ships up to 2,000 tons measurement, and drawing up to 16 feet forward. It is worked by at wenty-horse power engine and a hydraulic ram.

The British Fishery Company are engaged in the construction of a new harbour on a large scale in the Bay of Wick. This work has now been going on for some years, but owing to the great depth of water in which the breakwater is founded (about 30 feet at low water), and the interruption to the work in consequence of the heavy seas raised by easterly winds, the progress is slow, being only about 200 feet per annum.

It is proposed to spend a sum of 15,000*l*. on improvements of the river Ribble, so as to render it navigable for vessels of a large size, and in the construction of wet docks. A commencement has at last been made with the long contemplated docks at Lynn. The chief portion of the land required for the works has been purchased or arranged for, and the excavation of the diversion of the Fisher Fleet is well advanced. Works undertaken at Harwich, with a view to the improvement and protection of the harbour, have been attended with the best results. Already about four acres of the "beach end" have been washed away, and vessels of light draught can now enter the harbour at high water by the old leading marks.

At Brindisi it has at length been determined to form a dry dock 120 metres in length; the works are to be thrown open to competition, and offers are to be made under the obligation of constructing the basin sufficiently large to receive vessels of 2,000 tons.

Important works are being executed at Barcelona, the most considerable port of Spain on the Mediterranean. The depth of water is being increased to 33 feet, and the port will be protected by two jetties, to the east and west, so that it will comprise altogether a space of 286 acres, into which ships of the heaviest burden and war frigates will be enabled to enter. The cost of these works is estimated at 450,000*l*.

The Northern Lights Commission have determined to erect a new lighthouse on Dune Point, in the Island of Islay, and another at Scurdy Ness, at the south side of the entrance to the harbour of Montrose.

Preparations are being made for the erection of a complete system of lights and beacons along the Chinese coast; in all, fifteen points have been chosen.

American Tube Wells are beginning to attract attention in this country. They are constructed by driving an iron tube, perforated at its lower end, down to where water may be found beneath the surface of the ground. Trials on this plan have been made recently in Manchester and Glasgow; in the former case water was reached in five minutes from the commencement of operations, and in twenty-two minutes a depth of 10 feet had been reached. Several of these Tube Wells have been sent out with the Abyssinian expedition.

Mr. Charles Randolph, of the firm of Randolph and Elder, of Glasgow, has recently patented a new hydraulic propeller for vessels. This appartus consists of a fan, or centrifugal pump, placed in a casing connected with a couple of channels or ducts, leading the one to the head, and the other to the stern of the vessel. The fan-shaft is placed horizontally, and the fan is driven by a simply-arranged engine without reversing gear; the reversal of the action of the fan being accomplished by moving its shaft in the direction of its axis, which brings it alternately to one side or the other of a diaphragm, in a casing communicating with the bow and stern passages on either side of the diaphragm respectively.

An ingenious water-jet pump has recently been designed by Mr. E. Reynolds, one of which is now employed at Messrs. Vickers' works, at Sheffield, for raising water from the race in which the fly-wheel of the engine driving the tyre mill runs. The wheel-race from which the water is raised is 14 feet deep, and the pump is worked by water supplied under a head of 240 feet.

Sir John Brown, of the Atlas Works, Sheffield, signalized his new knighthood by rolling an armour plate 15 inches thick, 20 feet long, and 4 feet wide, which weighs no less than 21 tons.

Mr. Krupp is about to construct at his Works at Essen, a single-acting steam-hammer, far exceeding in size any now in existence. It will have a head weighing 120 tons.

7. GEOGRAPHY.

(*Including the Proceedings of the Royal Geographical Society.*)

The last six months have not been very fruitful in Geographical discovery. More has been done in investigating the works of ancient geographers than in adding to their knowledge.

In Africa Mr. Gerhard Rolphs and M. Miani are crossing the continent in different directions, but with what success tidings have not yet reached us. In Palestine the exploration under Lieutenant Warren, R.E., is continuing with increased success. Of late the principal attention has been directed to Jerusalem, where the improved feeling manifested by the authorities and people, now they discover that no irreverence is intended, and see that the Arabs under British superintendence conduct themselves with regularity and steadiness, has given facility for investigating many localities hitherto inaccessible to Europeans. A portion of the site of the temple and a few other spots have yielded curious results to the burrowings of the workmen, whilst the Lieutenant and his assistant, Sergeant Birtles, have penetrated beneath the earth up and down and along passages of all sizes, from halls of 200 feet in height, to drains through which a moderate sized man could just crawl. The expedition was nearly coming to an untimely end for want of funds, but of course this only had to be known and understood, when sufficient to keep them at work for some little time longer was immediately forthcoming. It is hoped that before long a tolerably complete plan of the ancient city will be possible, when the interminable disputes of architects and historians who have never been on the spot, and of travellers who know nothing of history and architecture, will be forcibly stopped, and conjecture will give place to certainty. In the meantime we would urge upon all interested in such subjects, the propriety of assisting in a work where every shilling expended shows some definite result.

Abyssinia swallows up all the interest that can be afforded for geographical purposes at the present time. Mr. Robert Lowe complained in his lecture on education at Edinburgh, that more educated men could tell him where Halicarnassus was than where Gondar is. There is not much fear that this ignorance will last long. No doubt educated men, Members of Parliament, and many of her Majesty's Ministers, too, know much more about the geography of Asia Minor than they do of Abyssinia, but they only share in the knowledge and ignorance of the world in general, and of geographers in particular. People naturally know more of places where great events have taken place or great men have lived, than of those localities where hereafter something is to happen. The new maps of the country over which our armies are travelling contain, no doubt, the best information to be obtained (and we would especially point to Mr. Wyld's lately published map), but in these there are immense tracts of land with scarcely a name, perhaps a river put in tentatively, and a camel route crossing an otherwise unmarked district of hundreds of miles. Promises have been given that scientific men shall accompany the expedition, and all the knowledge at the command of the Royal Geographical Society has been employed by the Government. Several books of course have been published on a subject so generally interesting. Besides Sir

Samuel Baker's book on the 'Nile Tributaries,' which was not intended to contribute much that could be useful for the present expedition, a fair account has been given by Mr. Dufton, an observant traveller, and a collection has been put together by Mr. Hotten. The expedition will be accompanied by Dr. Krapf, the missionary, as interpreter, a gentleman well acquainted with both the Amharic and Tigree languages; by Mr. W. Blanford, as geologist; by Dr. Doitch, of the British Museum, as antiquarian and archæologist; and it was said, but it has been since contradicted, by Mr. Clements Markham, as geographer. By making these appointments, the Government have entitled themselves to the thanks of scientific men. It remains to be seen whether a more popular Parliament will support this step in the right direction.

The volcanic disturbances at Santorin have already excited considerable attention. Since our last Chronicle, Canea in Crete, Iceland, and Vesuvius, have been visited by perturbations; Candia, by an earthquake; Iceland and Vesuvius, by eruptions. In the former of these two the outbreak has been in a part of the island far from human habitation, and the extent of the outpouring is as yet unknown, and the site of the disturbance is probably almost inaccessible. In Vesuvius a new crater has been opened, and several streams of lava are issuing from this new mouth.

As we stated at first, a good deal has been done in the way of studying the antiquities of geography. Colonel Henry Yule has published for the Hakluyt Society the accounts of many travellers of the middle ages in Central Asia, and has summed up in an introductory essay the information to be gained therefrom. His work is entitled 'Cathay, and the Way thither.' A book called 'Heroes of Discovery,' by S. Mossman, gives lives of Magellan, Cook, Park, Franklin, and Livingstone. These are interesting and inciting to young people to follow in the footsteps of the "Heroes." M. Léonce Angrand has been studying the monuments of Peru with a view to discovering the condition of civilization of the ancient inhabitants, and has lately published the result of his researches. Reimer, of Berlin, has issued a map of great philological and ethnological value, by Herr Kiepart, showing the nationalities of the various Austrian States. Messrs. Macmillan also have published an atlas, in the form of a book, a useful and portable work for reference. Guide books to Lough Corrib, by Sir W. Wilde, and a 'Murray' for Yorkshire have also appeared.

Proceedings of the Royal Geographical Society.

The President, Sir Roderick Murchison, in his annual address at the commencement of the session of 1867–68, confined his attention almost entirely to three points:—first, the fate of Dr.

Livingstone, and the boat expedition sent in search of him; secondly, the geography of Abyssinia; thirdly, the exploration of Central Greenland by Mr. E. Whymper. Mr. Young, in command of the expedition sent by the Government on the track of Livingstone, had met with every facility from the authorities at the Cape, had engaged a negro crew; entered the Congoni mouth of the Zambesi, and was progressing towards the accomplishment of his errand with all due speed. Still, no news could be expected from him until February or March in next year. In the meantime it is impossible to tell whither Livingstone may have betaken himself. With regard to the geography of Abyssinia, the value of this Society was likely to be now felt. Mr. Clements Markham, the honorary secretary, has prepared an account of the discoveries of the early Portuguese travellers, and the Society has been the centre around which all the geographical knowledge, now so important to the Government embarking in an expedition of which they are unable to realize the difficulties, has been collected, the whole nation in this way participating in the benefit accruing to scientific research, for which they are so unwilling to pay. Already the Topographical Department, under Sir H. James, have been busy in systematizing the information afforded by former travellers, whilst private geographers, Mr. Wyld, Mr. Keith Johnston, and Mr. Peterman have been engaged on maps that will elucidate the passage of the English army. Sir Samuel Baker has contributed somewhat to our knowledge of the water system of this country, and has especially shown that the fertilization of Egypt by the waters of the Nile is attributable to the soil carried down the Abyssinian tributaries, rather than to the more regular sources of the constant flow which traverse larger portions of the continent. It is expected that some new papers will be read on various explorations of Central America, and it is to be hoped that before long an account will be given by Mr. Whymper, of Greenland, whence he has just returned, having accomplished an inland journey not quite so extensive as he had intended, but which will considerably increase our knowledge of the animal and vegetable life of the interior of that country.

The first paper read this session was by Mr. Clements Markham, "On the Portuguese Expeditions to Abyssinia, from the Fifteenth to the Seventeenth Centuries." All that was known of Abyssinia down to the time of Bruce was the result of the discoveries of the Portuguese, who had performed wonders in discovery for such a small nation. King John II. despatched two of his subjects, one of whom penetrated to the court of the Negus or Emperor Alexander, in 1450, where he was detained by this predecessor of Theodorus, and never again allowed to quit the country;—rather a bad omen for Colonel Cameron and Mr. Rassam. This Portuguese was alive in 1520, when a second embassy arrived, who were detained six years, after which some members were dismissed. In answer to a request sent to Lisbon, a small Portuguese force was sent in 1541, to assist the Abyssinians against the Moors. They lost their leader and were defeated in the service, and after that were treated with great ingratitude by those whom they went to assist. They left behind them a fortified convent of Jesuits, who remained until they were expelled from the country in 1633, having made scarcely any converts from the primitive form of Christianity held by the natives.

At the next meeting of the Society, letters were read from Dr. Kirk and the Vice-consul at Zanzibar, giving some information about the existence of Dr. Livingstone. It seems that a native had arrived at the coast from Bagamoyo, who reported that when with a party who had travelled the regular route to Wemba and Maranga, he had seen a white man, who arrived at the village the caravans were passing through, with a party of thirteen blacks, which is the number of the young negroes Dr. Livingstone is known to have had with him. The white man was not a trader, for he refused ivory offered to him. On being shown a number of photographs, the native recognized one of Dr. Livingstone as that of the white man he had met, though he passed over another better likeness of the same person without remark. Dr. Kirk hoped shortly to see the head man of the caravan and the others who accompanied him, and thus obtain some further information—but this is sufficient to put an end for ever to the account of the man Moosa, whose lies it is extraordinary should ever have taken possession of men of understanding and knowledge of the subject. An artificial excitement on this one topic of the exploration of Central African lakes, engendered within the walls of the Royal Geographical Society, is the only explanation of the phenomenon that clever, cautious, and well-informed persons should be taken in by the mendacious accounts of men proved to be utterly unworthy of credit, and when once committed to an opinion, these men have maintained with sophistical arguments the opinion they had uttered, at the peril of their reputation for common sense.

A paper by Mr. Collinson, on a hitherto unexplored part of Nicaragua demonstrates the possibility of a railroad over that portion of Central America. The whole ground had been traversed, the gradients are moderate, the climate comparatively good, and the distance not great.

8. GEOLOGY AND PALÆONTOLOGY.

(Including the Proceedings of the Geological Society.)

THE last volume (xxii.) of the Memoirs of the Royal Academy of Sciences of Turin contains an important contribution to Fossil Botany, entitled "Matériaux pour servir à la Paléontologie du Terrain Tertiaire du Piémont. Première Partie: Végétaux." By M. Eugène Sismonda. The descriptions, and especially the numerous figures, of these Tertiary plants must possess the highest interest for botanists generally, and must be of great utility to those who make fossil floras their especial study. M. Sismonda has been able to distinguish in the plant-bearing deposits of Piedmont five different floras: namely, (1) Eocene, (2) Lower Miocene, (3) Middle Miocene, (4) Upper Miocene, and (5) Pliocene.

The Eocene flora is chiefly characterized in Italy by Fucoids, the species being but three in number: *Chondrites Targionii*, *C. furcatus*, and *C. arbuscula*. This poverty is not surprising when it is considered that the animal-remains of the same period are not at all abundant. The Lower Miocene deposits are very rich in plant-remains, and some of them include considerable beds of lignite. They belong to two classes: namely, (1) the lacustrine and lignitiferous beds; and (2) the litoral marine deposits, almost barren of lignite. The distribution of these two classes enables one to trace the Italian shore of the sea of the Older Miocene Period. Some discussion has arisen regarding the division of the Tertiary epoch to which these beds properly belong; but, as with all such discussions, no satisfactory termination seems possible; M. Sismonda has therefore done wisely, we think, in considering the two terms (Upper Nummulitic and Lower Miocene) as synonymous. The Middle Miocene deposits are the most rich in plant-remains of any in Italy; but they contain no beds of lignite. Their most celebrated locality is the Superga, near Turin, where no less than fifty species have been discovered. The deposit at Sarzanello appears to be slightly younger than that of the Superga. The Upper Miocene deposits are likewise rich in species, sixty-six being described by the authors. The Pliocene flora is very poor.

The interest of a critical comparison between the plants of these Miocene deposits and those of the same age found on the other side of the Alps would be very great, and would go far towards either proving or disproving the theory of the recent elevation of that range of mountains.

A new series of the 'Boston Journal of Natural History' has recently been commenced under the title of "Memoirs read before the Boston Society of Natural History," and in the first volume is an elaborate paper by Dr. A. S. Packard, jun., on the Glacial

Phenomena of Labrador and Maine. On the Laurentian and Huronian rocks of the Labrador Peninsula few superficial deposits occur, the region having evidently been exposed to the most intense denuding action of glaciers, prolonged over a period much longer than even in Canada. The whole of the Plateau has been moulded by ice to a height of at least 2,500 feet above the level of the sea; but owing to the extensive weathering of the rocks, glacial grooves and scratches occur very rarely below a height of from 500 to 800 feet from the sea-level, up to which point the action of the waves and of shore-ice has obliterated all traces of striæ, and also of loose drift. It is also important to notice that the present contour of the coast, from the sea-level to a height of 500 feet, also extends to at least 300 feet below the surface of the water. The whole surface of the country is strewn thickly with boulders, especially above the height already mentioned. About 400 feet above the present coast-line are some fine examples of raised beaches and rock-shelves, representing ancient coast-lines; and there are others, apparently of the same origin, at great heights in the interior of the southern part of the Peninsula. Some beaches were also observed by the author, apparently very recently raised above the sea-level, so as to be just beyond the reach of the waves; and he therefore infers that the land is slowly gaining on the sea. At the mouths of certain rivers, and situated just above high-water mark, there occur deposits of clay, known as Leda-clays, containing marine and estuarine fossils. The author draws some interesting conclusions from these phenomena, and supplements his paper by an account of the recent invertebrate fauna of the region.

In the same volume is a very able paper, entitled "An Inquiry into the Zoological Relations of the first-discovered traces of Fossil Neuropterous Insects in North America; with remarks on the difference of structure in the Wings of living Neuroptera;" its title is a sufficient index of its scope and character.

Dr. J. S. Newberry has examined the fossil plants from the Chinese coal-bearing rocks, discovered by Mr. Pumpelly, and has determined them to be of Mesozoic age. The collection includes Cycads of the genera *Podozamites* and *Pterozamites*, closely allied to known European and American species, if not identical with them. There are also representatives of the genera *Sphenopteris* and *Hymenophyllites*, and a species of *Pecopteris*, which is doubtfully referred to the well-known *P. Whitbiensis*. The *precise* age of the beds cannot be determined with certainty; but they are either Jurassic or Triassic.

The thirteenth volume of the 'Proceedings of the Somersetshire Archæological Society' contains a valuable paper "On the Middle and Upper Lias of the South-west of England," by Mr. Charles

Moore, which includes figures and descriptions of a large number of new species.

Another important descriptive paper, "Monographie paléontologique et géologique de l'étage Portlandien des Environs de Boulogne-sur-Mer," by MM. de Loriol and Pellat, is contained in the nineteenth volume of the 'Mémoires de la Société physique d'Histoire naturelle de Genève.' It is necessary to call attention to such memoirs, but abstracts of their contents can scarcely be given in our Chronicles.

Mr. W. H. Baily, acting palæontologist to the Geological Survey of Ireland, has commenced the publication of a work entitled 'Figures of Characteristic British Fossils with Descriptive Remarks.' The first part contains 10 plates and descriptive letter-press, embracing the characteristic fossils of the strata from the Cambrian to the Caradoc inclusive. This work will, no doubt, be of very great assistance to amateur geologists and to students. The Council of the Geological Society indeed recognized this fact, by awarding to the author the Wollaston Donation-fund at their last anniversary to assist him in publishing it. The author's reputation as a practical palæontologist and draughtsman is sufficient guarantee that the fossils will be judiciously selected and correctly figured.

M. Barrande has issued another volume of his great work on the Silurian fossils of Bohemia, which is devoted to the description and illustration of the Pteropoda, including no less than 68 distinct species, and 7 genera out of the 9 known to occur in Palæozoic rocks. The species of Pteropoda are known to have been very numerous in the Silurian seas; they are almost absent from Mesozoic deposits, but re-appear in the Tertiary; and in the existing fauna there are certain forms which have a striking analogy with those from Palæozoic deposits. M. Barrande asks the question whether this intermittence be real or apparent, that is to say, is it due to the Mesozoic Pteropods having been unprovided with a shell? If this be the case, another question suggests itself to him, namely, why is it that this order is the only one which, during its long "struggle for existence," successively carried, resigned, and resumed its testaceous covering? Such questions as these are much more easily asked than answered; but they nevertheless possess an interest which is almost a charm for those who are endeavouring to discover something of the real philosophy of palæontology.

The fourth edition of Sir R. I. Murchison's 'Siluria' has been published during the past quarter; but we must reserve our remarks on this important work until our next number.

The 'Geological Magazine' for September opens with a most interesting notice by Principal Dawson, "On some Remains of Palæozoic Insects recently discovered in Nova Scotia and New Brunswick." These insects have been discovered in Carboniferous and Devonian deposits; in the former have been found representatives of the orders *Neuroptera, Orthoptera*, and *Coleoptera*, in England, Westphalia, and the Western States of America; and last year Mr. Barnes, of Halifax, found a wing of a Neuropterous insect belonging to the *Ephemerina* on a piece of shale, partly covered by a frond of *Alethopteris lonchitida.* The Devonian insects consist of four species, all of which appear to be Neuroptera, although two of them cannot be referred to any existing family of the order. This paper is followed by one "On the Remains of Insects from the Coal-measures of Durham," by Mr. Kirkby, who describes portions of the wings of two Orthopterous species. Both authors draw attention to the fact that here again we have evidence of the Palæozoic Insects being synthetic types; in other words, the ancient genera possess combined certain characters which in recent Insects are found in distinct groups, either genera, families, or even orders. The other papers in this number are, "Railway Geology, No. 1," by Mr. D. Mackintosh, and "The Moulded Limestones of Furness," by Miss E. Hodgson, the latter being a description of the weathering of limestone by chemical atmospheric influences.

The October number commences with a paper "On the Chemistry of the Primeval Earth," by Mr. D. Forbes, in which the author expresses his dissent from some of the views advocated by Dr. Sterry Hunt in his lecture at the Royal Institution mentioned in our last Chronicle, especially Dr. Hunt's conclusion that the earth is "a globe solid to the core, which had solidified from the centre outwards to the exterior."* Mr. Forbes also combats Dr. Hunt's opinion "that granite is in every case a rock of sedimentary origin," and follows him closely in his argument on this head also. We cannot do justice to this subject in a Chronicle, and we therefore refer those interested in it to the reports of Dr. Hunt's lecture, and to this very able reply by Mr. Forbes. Professor J. Morris contributes an important paper, "On the Ferruginous Sands of Buckinghamshire, with remarks on the distribution of the equivalent strata," which is chiefly descriptive; the author, however, expresses his opinion that the Purbeck and Portland strata probably never extended far beyond their present limits, which is a point of some interest. The other original articles in this number are (1) "On the Gorge of the Avon at Clifton," by Mr. Jukes, in which it is shown that the same explanation, so ably given by the author, which accounts for the gorges of the rivers in the south of Ireland, is equally applicable to the Avon; (2) "On Subaërial Denudation, and on Cliffs and Escarpments of the Chalk and Lower Tertiary

* This opinion was held by the late Mr. Hamilton, although he supported it by a different argument from that advanced by Dr. Sterry Hunt. See 'President's Address to the Geological Society,' 1866; and 'Quart. Journ. Science,' No. xi., p. 420.

Beds" (continued in the next number), by Mr. Whitaker; and (3) "On some new Terebratulidæ from Upware," by Mr. J. F. Walker.

The first paper in the November number is by Mr. Ruskin; it is a continuation of the one in the August number, "On Brecciated Formations." Like all, or nearly all, Mr. Ruskin's geological papers, it is a burlesque of a scientific essay. For instance, "I suspect that many so-called 'conglomerates' are not conglomerates at all, but concretionary formations." Mr. Ruskin gives an example, namely, "red, rounded, flint 'pebbles,' much divided by interior cracks, enclosed by a finely-crystallized quartz," and he regards the "pebbles" as "secretions—the spots on a colossal bloodstone." Mr. Guppy has a paper on West Indian Geology, to the conclusions in which we should think other investigators will not subscribe. Dr. Von Koenen gives a valuable paper on the Belgian Tertiaries, in which he mentions that M. Cornet has discovered his error respecting the "Calcaire Grossier" of Mons, and is about to rectify it. Mr. Whitaker concludes his paper mentioned above, and Mr. Belt commences one "On the Lingula-flags or Ffestiniog Group."

These three numbers of the 'Geological Magazine' will thus be seen to contain many papers of great value, and we congratulate the editors on their success in sustaining its high character.

Proceedings of the Geological Society.

Several able communications on interesting subjects are contained in the November number of the Society's Journal, and demand some notice from us. Capt. Spratt's paper "On the Bone-caves of Malta" places before us in a very clear manner the points of agreement and of difference observed to exist between some of the Maltese caverns. He describes three, namely, those of Maghlak or Crendi, of Zebbug, and of Melliha. The first and last of these were found to contain remains of *Hippopotamus* (*H. Pentlandi*), with no traces of Elephant-remains. The Zebbug cavern, on the contrary, yielded abundant remains of the pigmy elephant of Malta, associated with some of a larger species, but without any indication of *Hippopotamus*. Notwithstanding this very pronounced distinction, there is one point of agreement noticed as existing between the Maghlak or Crendi and the Zebbug caverns. In the former, the stalagmite containing the Hippopotamus-remains was overlain by a layer without fossils, and this again by one containing bones and teeth of a large Dormouse (*Myoxus Melitensis*), bones of Birds, and land-shells of existing species. In the latter, the sandy clay containing the Elephant-remains also yielded bones and jaws of *Myoxus Melitensis*, bones of two large species of Swan, &c. We thus obtain an indication of the relative ages of the Hippopotamus and the Elephant, the former being apparently the most ancient.

Capt. Spratt discusses at some length the conditions under which an amphibious animal like the Hippopotamus could have lived on the island of Malta, believing that it was at that time at a much higher elevation, and was joined to Sicily and the Italian peninsula, but separated from Africa by a very narrow strait. An uplift of 250 fathoms would produce this result. The admixture of fragments of remains of Elephant and of marine animals with entire shells of terrestrial mollusks in the red earth, occurring in the fissures and hollows in various parts of Malta, the author attempts to explain by means of a "wave of translation." Geologists of the present day are very sceptical about such abnormal occurrences; but very recently, for a few days, it seemed as if the fate of the Island of Tortola had proved them to be terrible realities, whose rarity was mercifully proportioned to their destructive power.

A useful paper, by Mr. Tate, "On the Fossiliferous Development of the Zone of *Ammonites angulatus* in Great Britain," contains an account of the conditions under which this zone occurs in Lincolnshire, Warwickshire, Gloucestershire, Glamorganshire, Dorsetshire, and in Ireland, and a complete list of the fossils (corals excepted) which have been found in it. Mr. Tate also swells the list of Mr. Tawney's opponents, and discusses the relations and age of the Sutton Stone, taking exception also to Mr. Tawney's determinations of some of the fossils. His conclusions are, that the Sutton Stone is a part of the Lower Lias, and that its fossils belong to the Hettangian fauna. He also states that he regards the Sutton Stone and the Southerdown beds to be, jointly, the equivalents of the beds intermediate between the White Lias and the zone of *Ammonites Bucklandi*.

Another paper by Mr. Tate, "On the Lower Lias of the North-east of Ireland," and one by Mr. Burton, "On the Rhætic Beds near Gainsborough," will be read with interest by those interested in the geology of the districts described in them.

Dr. Duncan and Mr. Thomson have a paper on a new genus of corals (*Cyclophyllum*), which possesses a remarkably complex structure, and presents many points of interest in a classificatory point of view.

Dr. Dawson's note on the discovery of a new Pulmonate Mollusk [*Zonites* (*Conulus*) *priscus*] in the coal-formation of Nova Scotia, presents a most interesting confirmation of his former discovery of land-shells in those Palæozoic strata. As the *Pupa* formerly described did not differ in any essential respect from the modern representatives of that genus, so in this case we have a shell which can be referred to a subgenus of Zonites (*Conulus*), which includes several recent species, *Zonites* itself being a subdivision of the group of genera commonly termed Helix.

A paper on the Chemical Geology of the Malvern Hills, by the Rev. Mr. Timins, contains the results of nearly one hundred analyses of the rocks occurring in that range. They comprise the following varieties: (1) Lava and Volcanic Ash overflowing, or interstratified with, the Black Shale; (2) Eruptive rocks of the Hollybush Sandstone; (3) Shales; (4) Bedded Traps, Lavas, and Felstones of the Herefordshire Beacon; (5) Felstones north of the Herefordshire Beacon; (6) Quartzo-felspathic veins; (7) Trisilicated Felspathic veins; (8) Felspathico-hornblendic rocks; and (9) Intrusive Traps. Some of the author's conclusions are of general interest, especially: that the relative proportions of the several bases often characterize particular localities; that the chemical composition of the eruptive rocks does not vary according to their age; that the atomic proportion of the silica to the bases appears to be *highest* in the *largest* masses of trap (but this law, though very general, is not invariable); that in the same masses of trap there is an appreciable increase in the silica towards their centres; that the *primary source* of all the trap-rocks in the Malvern Hills was nearly a bisilicate. There are many other important inferences which we have no space to mention, and, indeed, this paper requires a most careful study to be properly understood or appreciated.

Mr. Townsend M. Hall's paper on the Relative Distribution of Fossils throughout the North Devon series, contains a valuable table showing the range of the species in the fossiliferous groups, both geologically and geographically.

In a paper on the sources of the materials composing the White Clays of the Lower Tertiaries, Mr. George Maw advocates their derivation from the chalk, by the gradual solution of the calcareous matter, the aluminous and siliceous portions being left, and forming the white clays in question. It has been generally considered that these clays have, in many instances at least, been derived from the decomposed felspar of granite; but Mr. Maw points out that Kaolin, which is the result of the decomposition of felspar, is perfectly implastic,—a character entirely opposed to that of the white Tertiary clays. An important chemical fact bearing upon this matter is, that the clays in question contain the alumina in a larger proportion to the silica than felspar would afford. Many other facts are urged by Mr. Maw in support of his theory, and he gives numerous analyses of clays, chalk, and chalk-marl, made chiefly by Dr. Voelcker, Prof. Way, and Mr. C. D. Blake, which support his statements respecting their chemical composition.

The last paper in this number which we have space to notice is one "On the Structure of the Postglacial Deposits of the South-east of England," by Mr. S. V. Wood, jun., in which the author gives an epitome of the results arrived at by him after a survey of the region mentioned, which results, and the maps and sections on which they are founded, are given fully in a manuscript memoir deposited by him in the Geological Society's Library. The principal view advocated is, that the "entire valley-system of the East of England originated in centres of arc-like or curvilinear disturbance, which immediately preceded the elevation of the bed of the sea from which was deposited the wide-spread deposit of Boulder-clay forming the latest of the Glacial beds of the South of England." We are glad to see that Mr. Wood now recognizes the ambiguity of the terms Upper Drift, Middle Drift, &c., which we pointed out in noticing a former paper of his, and has substituted for them the terms Upper Glacial clay, Middle Glacial beds, &c. Many other points of interest are also discussed, especially the relations of the Thames valley-gravel, the Brick-earth deposits, &c., for which we must refer our readers to the paper itself.

On December 1st the Society published a bulky Supplement number, the description of which we must reserve for our next Chronicle.

9. MINERALOGY, MINING, AND METALLURGY.

Mineralogy.

Among British mineralogists no one has latterly been more active, whether in laboratory work or in literary work, than Mr. David Forbes, F.R.S. Without referring to his writings on Chemical Geology, which, however, are full of interest to the mineralogist, it will be sufficient in this place to call attention to his purely mineralogical work. In introducing the first part of his "Researches on British Mineralogy,"* Mr. Forbes takes occasion to contrast the present backward state of the science in this country with the honourable position which it occupied in the early part of this century. The chemist now-a-days is attracted by the organic branch of his science rather than by mineral chemistry, while the geologist is usually allured by palæontological research; and hence but few labourers enter the field of Mineralogy. To correct this state of things, and to develop a wholesome taste for the study, Forbes protests against the too-prevalent notion that Mineralogy is occupied exclusively with the dry enumeration of species, and with the description of their physical characters and chemical composition. Taking a higher stand-point, he maintains that minerals should properly be studied with reference to their mode of occurrence, origin, paragenesis, and especially the relations of their associated rocks. When thus prosecuted, the study cannot fail to prove a valuable aid both to the geologist in his examination of rock-masses in the field, and to the miner in his investigation of the

* 'Philosophical Magazine,' Nov., 1867, p. 329.

laws of mineral deposits. As an illustration of these advanced views, our author refers to his own researches which, although confessedly imperfect, tend to the remarkable conclusion that, in eruptive rocks, most minerals present themselves under similar conditions, accompanied by the same associated minerals, and in rocks of corresponding geological age. Hence he believes that certain minerals may serve to identify contemporaneous outbursts of eruptive rocks, in the same way that fossils serve to determine the age of sedimentary deposits. When, as often happens, the same mineral occurs in rocks of different age, he finds that in each situation it is marked by distinctive characters of its own, either physical or chemical. Thus, mica is distributed through rocks varying widely both in character and age; but while in granite it usually occurs as muscovite or potash-mica, in limestone and serpentine it appears as phlogopite or magnesia-mica, in zircon-syenite as astrophyllite or titaniferous mica, and in volcanic rocks as biotite. Generalizations of this kind are sufficient to show that the field of labour which Mineralogy affords is after all not so unattractive as many are inclined to think. As an earnest that the author himself is willing to bear a fair share of the work, he gives us a paper devoted chiefly to a notice of British Gold. Although public attention has from time to time been directed to the occurrence of gold in this country, and considerable excitement has been aroused by the recent workings in North Wales,* no analysis of British Gold has hitherto been recorded. Mr. Forbes has therefore visited the Welsh mines, and has analyzed specimens from the celebrated Clogau lode with the following results:—

	I.	II.
Gold	90·16	89·83
Silver	9·26	9·24
Iron and Copper	trace.	trace.
Quartz	0·32	0·74
Loss	0·26	0·19
	100·00	100·00

The metal from this mine is therefore an alloy of gold and silver, closely agreeing with the formula—Au_6 Ag. After fully describing the character of the lode in which it occurs, Mr. Forbes discusses the probable age of the gold. He has already classified all known auriferous veins in two great groups—the *older* or *granitic*, which were formed at some time between the Silurian and the Carboniferous period, and the *newer* or *dioritic*, probably of Cretaceous age: it is to the former of these classes that the author is inclined to refer the gold-veins of North Wales.

* See a paper in this Journal on "British Gold with especial reference to the Gold Mines of Merionethshire, by Robert Hunt, F.R.S.," vol. ii., p. 635.

Mr. Forbes has also analyzed some Welsh stream-gold from the river Mawddach, about eight miles above Dolgelly. The metal yielded 84·89 per cent. of gold, and 13·99 of silver.

In the "Rowley Rag," a well-known basaltic rock from the South Staffordshire coal-field, the same chemist has detected minute grains of a black mineral, which, on analysis, proved to be *Titanoferrite*, or titanate of iron, having the following composition:—

Titanic acid	34·28
Oxide of iron	65·72
	100·00

Mr. Forbes brings his paper to a conclusion by noticing a newly-discovered silver ore from the Foxdale mines in the Isle of Man. This ore, which contains 13 per cent. of silver, occurs in sufficient quantity to form an object of considerable commercial importance. The mineral is an argentiferous fahlerz, such as the Germans would call *Weissgiltigerz*, but which the author describes under the rarely used name of *Polytelite*.

Among the recent reports on the advancement of French literature and science, published under the direction of the Minister of Public Instruction, it comes within our province to notice only the "Report on the Progress of Mineralogy," drawn up by M. Delafosse.* By giving a *résumé* of nearly all the mineralogical work which has been conducted in France within the last quarter of a century, the reporter shows that his countrymen, led by such men as Dufrénoy and Descloiseaux, have played a part in the advancement of our science by no means discreditable to the fatherland of Haüy and De l'Isle.

Those who love to speculate on the ultimate constitution of matter, and to study the recondite laws of crystallogeny, will find much to interest them in an essay on the "Molecular Constitution and Growth of Crystals," recently published by Dr. Adolph Knop, of the Polytechnic School of Carlsruhe.†

It is well known that certain varieties of sandstone enjoy to a limited extent the curious property of flexibility. Such flexible sandstone—known to the mineralogist as *Itacolumite*—is usually found in association with the diamond, and, so far as our knowledge at present extends, appears to be restricted to the mining districts of Brazil and the Ural Mountains, to the neighbourhood of Delhi in India, and to the gold-bearing States of Georgia and North Carolina. As itacolumite always contains more or less disseminated talc or mica, its flexibility has usually been referred to the presence of these elastic scales. This opinion has, however, been lately

* 'Rapport sur les progrès de la Minéralogie.' Paris, 1867. 4to. pp. 97.

† 'Molekularconstitution und Wachsthum der Krystalle.' Leipzig, 1867. 8vo. pp. 96. 48 woodcuts.

opposed by Dr. Wetherill, whose observations show that while the micaceous or talcose mineral determines the cleavage of the rock, it bears no relation whatever to its flexibility. "This flexibility," says the doctor, "is due to small and innumerable *ball-and-socket joints*." The grains of silica composing the sandstone, instead of cohering into one uniform mass, are arranged in definite groups separated from one another by intervening cavities; and when the projections of one cluster engage in the corresponding cavities of a neighbouring group, there is produced an articulated structure, permitting motion within certain limits. By experiment the author has found that grains of sand, if saturated with petroleum, will cohere into groups separated by such intervening cavities; and hence, applying this fact, he conceives that the very gradual removal of the hydrocarbon might be attended with the separation of crystallized carbon in the form of diamond. As the jointed structure is quite characteristic of flexible sandstone, the author proposes to introduce the term *Articulite*—apparently a needless multiplication of synonymes since the mineral is already well-known as Itacolumite.*

Rarely does the mineralogist meet with a crystal presenting that perfect symmetry of form which the laws of crystallography demand. As a rule crystals are more or less distorted, the appearances presented by such irregularities being in many cases extremely deceptive. Some curious examples of such monstrosities have lately been described by Dr. Scharff, in a paper "On Deformed Crystals of Rock Salt."† Instead of the six faces of the cube being all equally developed, certain faces were drawn out in some crystals and depressed in others, thus giving rise on the one hand to prismatic forms and on the other to tabular crystals. Moreover, the angles of the cube occasionally deviated from right angles—an irregularity giving a rhombohedral aspect to the crystal. In all cases, however, the true form was easily discoverable by the cubic cleavage.

In a specimen of Wolfram from Auvergne, Dr. Phipson has detected the presence of Columbite. When the mineral is attacked by aqua regia the wolfram is dissolved, leaving an insoluble residue, which consists of angular fragments of a black non-magnetic substance having the composition of Columbite.‡

Some curious numerical relations between the atomic constitution of a mineral and the symmetry of its crystalline form have recently

* "Experiments on Itacolumite (Articulite), with the Explanation of its Flexibility and its Relation to the Formation of the Diamond."—'Silliman's American Journal,' xliv., No. 130, p. 61.

† 'Ueber missbildete Steinsalz-Krystalle.' Leonhard und Geinitz's Jahrbuch. 1867. Heft vi., p. 670.

‡ "Sur la présence du Columbite dans le Wolfram."—'Comptes Rendus,' 1867, No. 10, p. 419.

been worked out by the American mineralogist, Professor Dana.* Hitherto we have been unable to explain why a given substance should crystallize in a certain definite system in preference to any other; why, for example, a piece of tin-stone should invariably crystallize in forms belonging to the tetragonal system rather than in those of the other crystallographic groups. Dana shows that this symmetry of form is immediately connected with the chemical constitution of the mineral. Taking, as an example, this tetragonal or pyramidal system, we may remind the reader that the solids belonging to this order are bounded by 4, 8, or 16 sides; and hence the symmetry of the forms is characterized by the number 4, or a multiple of 4. Now it is found that in most minerals belonging to this system the number of atoms of the electro-negative or non-metallic element is in like manner 4, or a multiple or submultiple of that number. Hence a piece of tin-stone crystallizes in tetragonal forms, in virtue of its constitution as a binoxide, $Sn\ O_2$; the number of atoms of the electro-negative oxygen being 2, a submultiple of 4. So again, zircon, wulfenite, scheelite, and scheelitine, are all tetragonal species, each containing 4 atoms of oxygen, their formulæ being respectively—$Zr\ O$, $Si\ O_3$; $Pb\ O$, MO_3; $Ca\ O$, WO_3; and $Pb\ O$, WO_3: or, combining the oxygen of the acid with that of the base, according to the fashion of modern chemists, their composition may be expressed by the following formulæ, which more clearly show the 4 atoms of the element in question—$Zr\ SO_4$, $Pb\ MO_4$, $Ca\ WO_4$, and $Pb\ WO_4$.

Turning to the hexagonal or rhombohedral system, we find the relations to be equally curious. The symmetry of this system is related to the number 6; its prisms, pyramids, and other forms, being bounded by 3, 6, 12, or 24 sides. Here the number of atoms of the electro-negative element is consequently 3, or a multiple of 3. Thus, the sapphire and the ruby—varieties of crystallized alumina—assume hexagonal forms, since alumina is a sesquioxide containing 3 atoms of oxygen, $Al_2\ O_3$. In like manner specular iron-ore is hexagonal, being a sesquioxide of iron, $Fe_2\ O_3$. The same is the case with the large class of rhombohedral carbonates, including those of lime, magnesia, and the protoxides of iron, manganese, and zinc; forming the species known respectively as calcite, magnesite, chalybite, diallogite, and calamine ($Ca\ CO_3$, $Mg\ CO_3$, $Fe\ CO_3$, $Mn\ CO_3$, $Zn\ CO_3$.)

While the professor thus establishes his position with regard to the tetragonal and hexagonal systems, he is by no means so happy in his attempts to deal with the other orders. In the cubic system the number of atoms of the electro-negative element appears to be

* "On a Connection between Crystalline Form and Chemical Composition, with some Inferences therefrom."—'Silliman's Journal,' xliv., No. 130, p. 89; 'Phil. Mag.,' p. 178.

far from constant, while in the oblique systems the results are so discordant as to show at once that their symmetry is dependent on something more than the mere chemical constitution of the species. For other illustrations of Dana's curious theory, and for the manner in which he overcomes difficulties and reconciles discrepancies, the reader must refer to the original memoir already quoted.

In a subsequent paper* Professor Dana follows up his subject, and discusses the chemical composition of the mineral silicates, reducing this complex class of bodies to two well-defined groups—the unisilicates and the bisilicates.

Yet a third paper by this indefatigable author claims the attention of the mineralogist.† The present state of mineralogical nomenclature undoubtedly calls for reform, and Dana does not hesitate to take the first step towards effecting so desirable an object. Advocating the uniform adoption of the termination *ite*, he proposes to change the existing names of minerals in all cases where it can be done without great inconvenience. Such a change has indeed been contemplated by other mineralogists, who have ventured to write galena *galenite*, and fluor *fluorite*. Tracing the origin of this ending *ite* to the Greek and Roman naturalists, our author shows by examples from Pliny that every variety of name now applied to minerals was then in vogue, with the single exception of that introduced in honour of individuals—a class of names which, originating with Werner, has latterly grown to vast proportions. Dana further shows that it is chiefly the French mineralogists who have to answer for that want of systematic termination which disfigures our present nomenclature. Unfortunately, the Abbé Haüy was extremely careless in this respect—"giving names to minerals as a gardener might to his varieties of pinks and roses." To show his utter disregard of uniformity, attention may be called to the following examples of his word-coining:—amphi*bole*, anal*cime*, cymo*phane*, dial*lage*, dip*yre*, epid*ote*, harmo*tome*, id*ocrase*, meso*type*, pleon*aste*, sph*ene*, &c. Introduced under the prestige of so eminent an authority as Haüy, such names were at once accepted in spite of their incongruous terminations; and many subsequent mineralogists in France, following the example of their great master, have indulged in equal laxity of expression. But while the French mineralogists have thus troubled the science with their neglect of systematic nomenclature, it is pleasing to observe the persistence with which the Germans have adhered to the use of the termination *it*. Even amid the multitude of minerals named by the veteran species-maker Breithaupt, this canon is but rarely departed from; the most notable departures being in the case of the mineral gemini, Castor and Pollux, and of

* 'Silliman's American Journal,' xliv., No. 131, p. 252.
† Ibid., p. 145.

the felspars—orthoclase, oligoclase, &c. In advocating a uniformity of termination, the professor would not seek to alter such long-established names as quartz, garnet, diamond, and the like. After all, the names requiring amendment are comparatively few in number, and all of modern introduction, none of them dating beyond the last sixty years. If any alteration is really contemplated, the sooner it is accomplished the better: "Mineralogy," says the professor, "is far from being so stiffened with age as not to admit of progress in the direction contemplated."

Another point insisted upon by Dr. Dana is the necessity for a distinction between the names of simple minerals and those of *rocks* or mineral-aggregates, a distinction which could easily be marked by terminating the latter in *yte*, as already done in the case of *trachyte*.

Having devoted so much space to an analysis of these important papers, our remaining notices—relating chiefly to so-called new species,—must necessarily be brief. Among the rubbish-heaps of an old silver-lead mine worked by the Romans near Paillières, in the Dept. du Gard, there has been detected a new mineral, to be called *Pastréite*, in compliment to the President Pastré, of Marseilles: it occurs as an amorphous yellow substance, and is apparently an impure hydrous sulphate of iron containing arsenic and lead.*

Stetefeldtite is the name by which Mr. Riotte, a German mining engineer in Nevada, proposes to distinguish a new silver-bearing substance found in that state. It appears to be a sulphide of silver and copper, with an antimoniate of copper and iron.† Herr Igelström describes two minerals from the iron-mine of Langban, in Wermland, Sweden: one under the name of *Pyroaurite*—in allusion to its behaviour before the blowpipe; and the other, as *Lamprophane*.‡ A new mineral-resin, remarkable for its occurrence in hexagonal crystals, has received the name of *Valáite*, after Herr Vála.§

Under the name of *Cyrtolite*, Mr. W. T. Knowles notices an American mineral, which is apparently a hydrated silicate of zinc with the protoxides of iron and of the cerium metals.‖ An American iron ore, mistaken for red hæmatite, has been referred by Professor Brush to the rare species called *Turgite* by Hermann, and *Hydrohæmatite* by Breithaupt.¶ Mr. J. P. Cooke has lately examined several chloritic minerals from the chrome-iron mine of Texas, Pa.; but his observations simply confirm those already published by Descloiseaux.**

Several analyses of potash-micas have been made by Professor

* Verhand d. naturhist. Vereins d. preuss. Rheinlande. xxiii., p. 17.
† Berg-und Hüttenmän. Zeitung. 1867, No. 30, p. 255.
‡ Leonhard's Jahrbuch. Heft V., p. 607.
§ Jahrb. d. k. k. geol. Reichsanstalt. 1867, No. 2, p. 195.
‖ Silliman's Journal,' xliv., p. 224.
¶ Ibid., p. 219. ** Ibid., p. 201.

Rammelsberg, and communicated to the German Geological Society.* A specimen of sand from the island of Santiago, in the Cape Verd group, has been examined by M. Silva, and found to consist of titaniferous iron; as it occurs in considerable quantity it promises to become of commercial importance.† Some new analyses of Norwegian iron ores have been published by Mr. David Forbes.‡

Von Haidinger has laid before the Imperial Academy of Sciences of Vienna, two reports on an extraordinary shower of meteoric stones which fell on the 9th June, 1866, in the neighbourhood of Knyahinya, in the north-east of Hungary.§

The 'South Durham and Cleveland Mercury' speaks of a newly discovered deposit of gypsum, which within the last few months has been very successfully worked by Messrs. Jackson, Brayshay, and Jopling, of Lackenby.

A small pebble picked up some time ago by a little girl at Hopetown, in Cape Colony, and used for a while as a child's plaything, has turned out to be a diamond of the value of 500*l.* Several others have since been found, and the 'Society of Arts Journal,' quoting a Cape paper, says that people are now prospecting in all directions for diamonds in the neighbourhood of Colesberg. Garnets have also been found in the Colony in considerable numbers.

Amber—or at least a resinous substance reputed to be such—must be added to the long list of mineral products already furnished by Australia. It occurs in a large deposit, described as "a mine of amber," at Grass Gulley, near Rokewood, and is said to correspond in all respects with the European mineral.||

Mining and Metallurgy.

Of practical Metallic Mining we have only to chronicle a continuation of that depression to which we referred in our last number. The consequence of this is the extension of that distress which naturally arises from the want of labour. Happily, the benevolent have taken the serious question in hand, and it is to be hoped that the severities of winter will be ameliorated by their efforts.

The most striking feature in Metalliferous mining has been the anxiety to supplement the labour of the Miner by machinery. At the late meeting of the Royal Cornwall Polytechnic Society, a large number of Boring Machines were exhibited and described, and we now find that some of these are about to be introduced into the

* Zeitschrift, xix. Heft II., p. 400.
† 'Comptes Rendus.' 1867, No. 5, p. 207.
‡ 'Chemical News,' Nov. 23, 1867, p. 259.
§ Sitzungsber. d. k. ak. d. Wiss., Bd. LIV., p. 200 and p. 475.
|| 'Journ. Soc. Arts,' Sep. 20, Oct. 4, 1867.

mines around Camborne. We shall therefore shortly learn if they fulfil the conditions required for driving levels, or for sinking shafts.

The Reports of the Colliery Inspectors have been published. These tell a melancholy tale of the loss of life in Mining for coal, the numbers being largely increased during last year by the terrific casualties at the Oaks Colliery, in South Yorkshire, and at Talk o' th' Hill, in North Staffordshire.

The returns of deaths are as follows:—

Inspection Districts.	No. of Collieries.	Male Persons Employed.	Separate Fatal Accidents.	Lives Lost.	Tons of Coal raised per Life Lost.
1. Northumberland. North Durham. Cumberland	160	25,647	91	99	108,725
2. South Durham	155	35,720	84	115	129,826
3. North and East Lancashire	265	25,440	58	69	98,173
4. West Lancashire. North Wales	180	30,000	105	150	55,666
5. Yorkshire	434	35,500	61	425	22,235
6. Derbyshire. Nottinghamshire. Leicestershire. Warwickshire	196	27,100	55	58	131,034
7. North Stafford. Cheshire. Shropshire	220	20,210	47	181	30,387
8. South Staffordshire. Worcestershire	544	27,000	96	109	94,495
9. Monmouthshire. Gloucester. Somerset, &c.	228	26,000	75	81	74,074
10. South Wales	338	29,200	113	120	78,137
11. East Scotland	254	21,200	29	32	190,625
12. West Scotland	218	20,046	43	45	131,880
Total	3,192	323,063	857	1,484	
And averages	..	..	..	..	67,877 Tons

Total of Lives lost from different causes.

	1865.	1866.
Explosions of Fire Damp	168	651
Falls in Mine	381	361
In Shafts	163	162
Miscellaneous underground	179	203
On Surface	93	107
	984	1,484
Increase of deaths in 1866		500

On the 9th of November a terrible explosion occurred at the Ferndale Colliery, in the Rhondda Vach, Glamorganshire, by which nearly two hundred lives were sacrificed. This accident, in all probability, arose from some act of gross carelessness on the part of some of the coal hewers, as Safety Lamps were found with their caps off, and it is said keys for opening them have been discovered hidden in the dresses of some of the dead men.

It has been repeatedly stated that colliery explosions have been connected with a sudden depression of the atmospheric column, and this, there can be no doubt, has often been the case. Although it has been so reported with regard to the Ferndale explosion, it is curious to find that really a very high barometer prevailed both before and at the time of the explosion. At Clifton the mercury stood at 30·60 inches; at Bristol at 30·69; and over every part of the British Isles the barometer exhibited that high reading which marks the passage of the great November atmospheric wave.

In connection with mines and quarries, a very important decision has been given by Vice-Chancellor Malins. In a codicil to Lord William Powlett's (the Duke of Cleveland) will it was said, "I bequeath all shares, debentures, or securities, in railways and mines, of which I shall die possessed, to my wife, Lady William Powlett, absolutely." Upon this the question arose whether the bequest included shares in the Welsh Slate Company. It was contended on the part of Lady Wm. Powlett that the quarry had been worked for the last eight years underground, and had therefore become *a mine;* while the opposing party showed that the property was rated as a quarry up to 1866, whereas if it had been considered a mine it would have been exempt from rating. The Vice-Chancellor said that the only thing to distinguish a mine from a quarry was *the mode of working*. This one was worked as a mine; and therefore it would go to the plaintiff.

In Metallurgy there is really nothing of interest to communicate. Every branch of the metal trade suffers severely; and there is but little prospect of any speedy amendment. Yet our spirited Iron-masters, not discouraged, are building blast-furnaces of gigantic proportions, and fitting them with all the appliances of science. The Rosedale and Ferry Hill Company have just completed two blast-furnaces of the height of 105 feet by 28 feet, blown by four powerful blast-engines, and fed by two hydraulic lifts constructed by Sir Wm. Armstrong.

Puddling by Machinery still engages attention. Mr. Thomas Roper, of Ulverstone, has specified a process of manufacturing Iron and Steel, in which a modification of the processes of Nasmyth and Bessemer are involved. High-pressure steam is blown through the iron, in a puddling furnace, to remove the sulphur as sulphuretted hydrogen, and then air to decarbonize the iron. The puddling furnace employed is of a complicated structure, but its principal features, as we understand them, are a circular bed, which holds the iron to be operated on, and a hollow vertical shaft, capable of being raised or lowered, which is fitted with two or more horizontal arms. This represents the "rabble." These arms dip into the melted metal—the shaft revolves, and, either steam or air being forced down it, passes from the arms through the iron, and, by the combined operation of the steam, air, and motion, puddling is rapidly effected. We shall wait for further experiments before we enlarge on this arrangement.

We regret to have to chronicle the death of Dr. E. H. Birkenhead, F.G.S., lecturer on Science at the Free Library School of Science, and Royal Infirmary School of Medicine, Liverpool, and Master of the Wigan Mining School. He was the ablest of all the Science teachers certificated by the Science and Art Department. His loss is deeply felt in Liverpool and Wigan, and in both towns successful efforts are being made to raise a fund for his widow.

10. PHYSICS.

Light.—Some valuable experiments on solar radiation have been made by M. Soret on the Glacier des Bossons and the summit of Mont Blanc. He finds that the increase of the radiation with the altitude is less rapid than the diminution of the barometric pressure, or than the diminution of the atmospheric thickness. This result is contrary to what can be deduced from the observations made by Professor Forbes in 1832 on the Faulhorn and the Brientz.* The atmospheric pressure being the same, the radiation observed at an elevated altitude is more powerful than at a lower elevation. The ratio of the intensity of the solar radiation on Mont Blanc and Geneva is as about 6 to 5.

Father Secchi has examined the flame of the Bessemer converter, and has observed several points of resemblance between its spectrum and that of certain yellow and red stars. It is well known that the Bessemer flame in the spectroscope when the iron is completely decarbonized, presents a series of very fine and numerous lines, which remind one of α Orionis and α Herculis, only reversed. This results undoubtedly from the great number of metals burning in the flame, and the spectrum presents several lines well known and determined. This flame seems to be the only one comparable with that of the coloured stars, and there is nothing improbable in this when we consider how largely iron predominates in aerolites.

The same artificial spectrum—that of the flame of the Bessemer converter—has likewise been examined by Professor Lielegg. This flame is supposed to be carbonic acid gas in an incandescent

* 'Phil. Trans.,' 1842, part ii., p. 225.

state, and the spectrum of this gas being yet unknown, the observations of M. Lielegg have served to fill up a gap in the series of spectra produced by the gases in ignition. The apparition and the disappearance of some of the luminous fixed lines is closely connected with the metallurgical operation. At the moment the decarbonization of the iron is nearly terminated, the spectral lines undergo essential modifications. The apparition of a group of lines and of an isolated line in the violet-blue portion of the spectrum marks a particular reaction, during which the soft iron is being formed, and these lines disappear sooner than all the others; their appearance and disappearance serve therefore to indicate the termination of the process.

The same indefatigable observer has also ascertained that the spectrum of the colour of sea water is deprived of its red portion at small depths, and successively of the yellow and green, for the greater depths, until it appears of a violet-blue. In trying to ascertain whether the same was the case in glaciers, he has made some interesting experiments in an artificial grotto in the Grindenwald glacier. This cavern is 100 mètres deep, transparent in its walls, through which the solar light penetrated. The light was of a fine blue tint, the red being extremely weak, so that in the grotto human countenances assumed a cadaverous aspect. On looking towards the entry, at a certain distance in the cavern, it appeared to be lit up with a red light, doubtless the effect of contrast. The thickness of the superposed mass was not enough to show a greater effect than the almost complete absence of the red, and a great diminution of the yellow. The ice was said to be 15 mètres thick, but was probably less; it was perfectly compact and limpid, but with a few air-bubbles.

M. Felix Lucas concludes from theoretical considerations that the luminous distance at which the electric spark is visible is greater than that of a permanent light, the apparent intensity of which would be 250,000 times that of the spark. The light actually employed to illuminate modern lighthouses gives a brilliancy equal to 125 carcel lamps. An electric spark possessing the illuminating power of the 200th part only of a carcel burner is superior as to its power of projecting light. Hence we can conceive the immense effect of a warning light composed of intermittent flashes of the electric spark proceeding from a strong Leyden battery. M. Lucas states that, in an experiment made in a laboratory two apparatuses were established, one voltaic battery equal to 125 carcel lamps, and another spark-battery equivalent to only the 1-2000th part of a carcel lamp. The photometer (such as is employed in the lighthouse administration) showed a marked superiority in favour of the spark.

Photographers will read with interest the announcement by M. Prat of the discovery of a compound of silver more sensitive to light than the chloride. This chemist has been for some time past investigating the chemical constitution of fluorine compounds and the isolation of fluorine. M. Prat starts from the fact that the fluorides are really oxyfluorides; that the fluoride of calcium, for example, is formed of two equivalents of calcium, one of oxygen, one of fluorine; and that, in consequence, the true equivalent of fluorine is 29·5, and not 19. In order to obtain fluorine, it is only necessary to treat the fluoride of calcium with chlorate of potassium, or, what is better, perchlorate of potassium, for it is only with this last salt that the reaction takes place. Oxygen is disengaged, and a gas is produced, which silver absorbs, giving rise to a fluoride of silver, insoluble in water, soluble in ammonia, from which it is precipitated by nitric acid, and which is altered by the action of light more rapidly than the chloride of silver; the formula of the real chloride is Ag Fl, whilst that of the soluble fluoride of chemists is Ag Fl, Ag O.

Several new instruments, suitable for the observation of different organs of the eye, have been described by M. Robert Houdin. They serve also for the examination of entoptic images, or the shadows thrown on the retina by intra-ocular bodies. Seven instruments of this class have been invented by M. Houdin; these are: 1, the *Iridoscope*, for the manifestation of entoptic images; 2, the *Diopscope*, by the aid of which the inversion of the images on the retina are determined; 3, the *Pupilloscope*, demonstrating in a magnified form the dilations and contractions of the pupil; 4, the *Pupillometer*, which gives the diameter of the pupil to within a quarter of a millimetre; 5, the *Diopsimeter*, for measuring the extent of the field of vision; 6, an *Optometer*, for the use of any persons who wish to determine the distance of distinct vision; 7, the *Retinoscope*, an instrument with which one can see the vesicular group in his own eye.

In all stereoscopes there is an optical arrangement by which the right eye sees an image of one picture and the left eye that of another. These images ought to be apparently in the same place, and at the distance of most distinct vision. In ordinary stereoscopes these images are vertical; the observer has to place his eyes near two apertures, and he sees the united images, as it were, behind the optical apparatus. Professor J. Clerk Maxwell, F.R.S., has recently had made by Messrs. Elliott, Brothers, a real-image stereoscope, in which the observer stands at a short distance from the apparatus, and looks with both eyes at a large lens, the image appearing as a real object close to the lens. The stereoscope consists of a board about two feet long, on which is placed:—1, a vertical frame, to hold the pair of pictures, which may be an ordinary stereoscopic slide turned upside-down; 2, a sliding piece near the middle of the board, containing two lenses of six feet focus, placed side by side, with their centres about one inch and a quarter apart; 3, a frame, containing a large lens of about eight inches focal length, and three inches diameter. The observer stands with his eyes about two feet from the large lens. With his right eye he sees the real image of the left-hand picture formed by the left-hand lens in the air close to the large lens, and with the left eye he sees the real image of the other picture formed by the other lens in the same place. The united images look like a real object in the air, close to the larger lens. This image may be magnified or diminished at pleasure, by sliding the piece containing the two lenses nearer to or farther from the picture.

HEAT.—Herr C. Sching has investigated the subject of fusible silicates, and the temperature required for forming and melting the same. He finds by application of a thermo-electric pyrometer that silicates are formed and melted at the same temperature, and that the formation of the silicates depends more on time than on temperature, *i. e.* it depends, in fact, on the conducting power of heat which the materials composing the silicates possess. He also finds the temperature required for melting metals and metallurgical products to be lower than usually stated, 1,431—1,445°, for melting the same. Sching now finds that a temperature of a glass furnace in operation is only 1,100—1,250° C.; that crystal glass is worked at 833°, and becomes completely liquid at 929°. A Bohemian green glass tube softens at 769°, and becomes liquid at 1,052°. Pure limestone loses its carbonic acid by heating for several hours at a temperature of 617—675°. An increase of the temperature will shorten the time.

Mr. C. Tomlinson, F.R.S., in a communication to the 'Chemical News,' has stated his opinion that the Camphor Storm-Glass is useless as a meteorological instrument. The frequent reference made to it by the late Admiral Fitzroy gave an almost official sanction to its use, and induced some instrument makers to manufacture it largely, and even to attach it to the ordinary barometer and thermometer. This led Mr. Tomlinson to examine the storm-glass with some care. One was made on a large scale in a quart bottle, placed on the window ledge, and a journal of its behaviour kept during some months. The conclusion arrived at was that the storm-glass is not acted on by light, or atmospheric electricity, or wind, or rain, &c., but solely by variations in temperature; that it is, in fact, a rude kind of thermoscope, vastly inferior to an ordinary thermometer, and has no meteorological value whatever.

The subject of the transparency of red- or white-hot metals was referred to in our last Chronicles. It is generally believed amongst scientific men that the supposed phenomenon is merely an optical delusion. A correspondent of the 'Chemical News' has, however, adduced an observation on the opposite side. He says a few weeks ago he went over some steel works in the North of England, and there the manager spoke of it as a well-known fact that steel at a white heat was transparent. In proof of this he showed that when the molten metal was being poured out, the edge of the crucible appeared to be distinctly visible through the molten metal. This could only be seen directly the crucible was taken out of the furnace before it had cooled in the least.

Mr. A. E. Fletcher, Government Inspector of Alkali Works for the Western District, has constructed a most useful instrument for measuring the velocity of a current of air. He uses it for measuring the speed of air in flues and chimneys. The construction of the apparatus is based on the fact that a current of air, passing across the open end of a straight tube, causes a partial vacuum in it. An application of this principle is seen in a small toy in common use, in which a liquid is made to ascend several inches in a vertical tube, by blowing through another tube across its open end; it rises by virtue of the partial vacuum caused by the current of air which crosses it. If then a straight tube is inserted through a hole in the brickwork of a chimney or flue, so that the current of air in the flue passes across its open end, a partial vacuum will be formed in it, greater or less in proportion to the velocity of the current. A tube in such a position will, however, communicate a suction arising from that of the chimney itself, besides that suction produced by the current of air passing across its open end, and for the present purpose these two must be distinguished. To effect this, *two* tubes should be inserted in the chimney, one of them having a straight, and the other a bent end, the bend to be turned so as to meet the current of air; both tubes are open. In each of these tubes will be experienced the partial vacuum due to the suction of the chimney itself. In the straight tube, however, this will be increased by the suction caused by the passage of the current of air across its open end, while in the case of the bent tube this will be diminished by the pressure caused by the current of air blowing into it. The difference therefore between the suction in the two tubes will be due to the action of the current of air in the chimney, and it remains only to measure this difference in order to measure the velocity of the current itself. After many trials, Mr. Fletcher adopted the following plan for measuring this suction. The tubes were connected with a U-Tube, and means were adopted for accurately seeing and measuring its slightest indications. In the first place, the limits were increased until they were no longer small tubes of about 0·4 inch internal diameter, but cylinders of 4 inches diameter; these were connected at the bottom by a small tube. Thus the power, exerted by the pressure communicated through the connecting tubes, operating on the extended surface of the liquid in the cylinders, was increased a hundred-fold over that operating in the smaller U-Tube; but the friction could only have been increased ten-fold, giving therefore a ten-fold increase of delicacy. In order to observe accurately the rise and fall of the liquid in the cylinders, floats were introduced, on each of which was engraved a very fine horizontal line; and to measure accurately the comparative elevation or depression of these two lines, a finely divided scale and vernier were added, working with a delicate screw adjustment. With this it is possible to measure an elevation or depression of $\frac{1}{1000}$th inch, which is sufficiently accurate for the purpose in view.

On trying now to apply the instrument so constructed, and attempting to measure very minute variations of pressure, failure still seemed imminent; for although the motion of the water in the increased limbs of the U-tube could be measured to $\frac{1}{1000}$th inch, the water refused to move except under pressures exceeding that which would be indicated by so small a column: in other words, the water seemed to stick in the cylinders. After substituting ether for water the action of the manometer was quite satisfactory; the lines on the floats always returned exactly to their original position after any disturbance, and its indications could be relied on to $\frac{1}{1000}$th inch.

By the aid of this ether manometer the speed of any current of air in flues or chimneys can be measured by simply boring a hole one inch in diameter through the brickwork, and inserting two tubes, one with a bent, the other with a plain end as already described, and making the necessary observation of the floats; and in this operation neither soot, heat, nor corrosive vapours can prove any hindrance.

So sensitive is the apparatus, that on a windy day the effect of each successive gust of wind is observable, as it causes variations in the draught of the chimney. The instrument may be used as a wind gauge, by fixing through the roof of an observatory a small vertical pipe presenting a plain open end to the wind. The lower end of this pipe brought down into the observatory and connected with the ether manometer, would communicate the varying pressures due to the varying speed of the wind.

Electricity.—M. Rondel has examined a phenomenon which has been noticed more than once by workers with induction coils. If while the current of a pile passes through the primary wire of a coil, one of the extremities of the secondary wire is brought near one of the extremities of the iron core, sparks can be drawn of remarkable intensity and brilliancy; if at the same time, the other end of the secondary wire is put in communication with one of the poles of the pile, a great increase takes place in the brilliancy of the spark. Then, on touching with the hand the iron core, and placing the free end of the wire in contact with the skin, a redness takes place, and a smart stinging sensation is felt. This last experiment was made upon a coil, the core of which, completely isolated in a tube of varnished glass, was eight millimètres in diameter. M. Rondel made the same experiment with another bobbin, the soft iron of which was twelve centimètres long, five centimètres wide, and eight millimètres thick. The sparks were produced with detonations. A single Bunsen element of small size was sufficient to produce these phenomena.

A note on the Polarization of Electrodes—a subject of considerable interest to telegraphists and electricians—has been presented by M. Gaugain to the Academy of Sciences. Several savants have sought to determine the part which each of the electrodes takes in the polarization, and have arrived at different results: M. Poggendorff found that the two electrodes contributed equally to the production of the electromotive force developed; MM. Lenz and Sarvelgen found, on the contrary, that the part of the cathode is greater than that of the anode. M. Gaugain has tried, in his turn, to resolve the question by making use, as he did on former occasions, of the *method of opposition*. The following are the results thus obtained by a series of experiments carried on with a mixture of nine parts by volume, of distilled water, and one part of sulphuric acid :—

Polarization of the anode	193
" of the cathode	157
Total polarization	350

It appears to be of little consequence, if more or less sulphuric acid be added to the electrolyzed water, provided that this proportion does not fall below a certain limit; but when it becomes extremely small, the polarization of the cathode increases, without the polarization of the anode being sensibly modified. The following are the results obtained by electrolyzing pure water :—

Polarization of the anode	193
" of the cathode	243
Total polarization	436

M. Matteucci recently * called the attention of the Academy to an experiment which he made in 1838, and upon which he

* 'Comptes Rendus', Jan. 14, 1867.

depended to prove that the polarization proceeded from the gases adherent to the electrodes. In fact, polarized metals should be considered as fugitive combinations formed by the metals and gases, and the author is of opinion that in polarization couples as well as in Grove's gas pile the electro-motive force is the affinity exerted on one of the elements of the water by a gas associated in a particular manner with a metal.

Dr. Henry Morton, of the University of Penna, Philadelphia, has lately described an important adjunct to the induction coil. He prepares the arrangement in the following manner:—Take eight plates of glass, about 11 inches by 14 inches, and attach to both sides of each plate, sheets of tinfoil, 7 inches by 10 inches in size, with rounded corners. Set these plates upright in a box (provided with grooves for the purpose) about 1½ inches apart; then rolling up some balls of paper large enough to fit between the plates, and wrapping a strip of tinfoil around each ball, thrust them between the plates, and, lastly, make an outside pole to the terminal sheets of foil, by means of wires enclosed in glass tubes passed through the side or top of the box. It is evident that we have here a compact form of Leyden battery, arranged for "cascade." With the ordinary electrical machine such an arrangement would be worthless, from its want of insulation. With the induction coil, however, which developes an entire charge in an instant, it becomes of great value in a certain class of experiments, because it gives us at once the concentrated charge peculiar to the Leyden battery, combined with a spark length, which it would otherwise have lost. (This property of long spark in the "cascade" arrangement of jars is well known.) If such an apparatus as here described be connected with the secondary poles of an induction coil, and other wires are then led off (with a break in the circuit, however, of ¼ to ¾ inches) to some piece of apparatus for the illustration of electric discharge in vacuo, such as Gassiot's cascade (especially with a canary goblet), the aurora tube, an electric egg of canary glass, &c. (but not a Giessler tube), the brightness of the illumination and volume of the discharge will be immensely increased. Thus a goblet invisible at 30 feet, when the unaided coil is used, becomes *brilliant* at 50 feet with this attachment. The author has used two coils with the above apparatus, both made by Mr. E. S. Ritchie, of Boston, one yielding a spark of 8 inches, the other, which gives, in its present mounting, sparks of 16 inches, to provide against accident; such a length being abundantly sufficient for use. Geissler tubes, unless of very large area, are not benefited in appearance by this arrangement, because the unaided coil can supply all the electricity they are capable of transmitting, and this excessive charge only tends to develop inductive resistances in the glass tubes themselves, which resistances this *momentary* current is the least fitted to overcome.

The author mentions another little practical detail in this connection. It is generally assumed that the induction-coil is unfit for the exhibition of those experiments of attraction and repulsion which especially characterize statical electricity. A great number, however, may be very satisfactorily exhibited by charging Leyden jars, and using them as the sources of electricity. Thus:—Connect a chime of bells with the knob of a large jar; connect the outer coating with the earth and with the negative pole of the coil; then bring the positive pole within striking distance of the knob, and charge by a few sparks. The electrical flyer, orrery, sportsmen, and birds may be successfully operated in this way, even in summer weather. The coil should not be of less than six inches spark length.

M. J. E. Balsamo has presented a memoir to the Academy of Sciences on a new Voltaic Pile. It is formed of two plates of iron, one plunged in dilute sulphuric acid, the other in a solution of chloride of sodium, separated from the acidulated water by a porous diaphragm. The iron of the acidulated water acts as zinc, and that of the saline solution acts as copper. The current, constant and of considerable intensity, proceeds from the property possessed by iron of polarizing itself differently in certain solutions, between which osmogenic action takes place. M. Balsamo has also tried another experiment of considerable theoretical interest. He plunges at the same time in oxalic acid two small magnetized bars of the same surface and of the same weight, one having its north pole in the liquid and its south pole out of it. The second bar is in the contrary position. The first acted as zinc, the latter as copper, and a current of electricity was the consequence.

M. Becquerel, sen., has continued his electro-capillary researches to which we drew attention in our last Chronicles. He shows definitely that—1. The alteration is exerted on the sides of the capillary spaces between two liquids. 2. The electricity is disengaged at the contact of these liquids in the capillary spaces. He has modified his method of experimenting. Instead of forming the fissures in the tubes, he fastens at their extremity a strong stopper very tightly fixed, made with filtering paper soaked in water; a platinum wire traverses the stopper and connects the two liquids together.

M. Bouchotte has examined the electrolytic power of the currents of the magneto-electric machine made by the Alliance Company. When the current sent by the commutator is always in the same direction, the electro-motive power is that of 144 Daniel elements with sulphate of copper; but when the current is alternate, as in the production of the electric light, the electro motive power is *nil*.

10. ZOOLOGY—ANIMAL PHYSIOLOGY AND MORPHOLOGY.

Physiology.

Work and Food.—A new phase of this question has been brought about by the very valuable experiments of Dr. Parkes (of the Military Hospital and Medical School at Netley) on the Elimination of Nitrogen during rest, an account of which he has communicated to the Royal Society. We have in a previous Chronicle noticed the views and experiments of Fick, Wislicenus, Frankland, and the first series of Dr. Parkes' researches.* Dr. Parkes has found that during a period of work a man excretes less nitrogen than during a period of rest—whether he feeds on nitrogenous food or carbonaceous only. He also finds that after nitrogenous food has been cut off from the system and again supplied, there is a retention of that nitrogen showing that it is needed to fill up some waste; also, that during the first rest after exercise, where nitrogenous food had not been cut off, there was an increase in the elimination of nitrogen. The experiments on which these statements are founded may be thoroughly trusted, and lead to important considerations, Dr. Parkes having experimented on two soldiers, and having every means of analysis at hand. It will be seen that they place the question in quite a new aspect, and no theory of the relation of food, muscle, and work can be now tenable which does not account for them. Dr. Parkes' view is, that when a voluntary muscle is brought into action by the influence of the will, it *appropriates* nitrogenous matter and grows; the stimulus on the act of union gives rise to changes in the non-nitrogenous substances surrounding the ultimate elements of the muscular substance, which cause the conversion of heat into motion. The contraction continues until the effete products of these changes arrest it (as they have been shown to do by Ranke and others), a state of rest ensues, during which time the effete products are removed, the muscle loses nitrogen, and can again be called into action by its stimulus. Dr. Parkes does not believe in the efficiency of carbonaceous foods when alone, which recent experiments might seem to indicate. Fick and Wislicenus, he says, drew upon the store of nitrogenous matter in their *system* when they cut it off in their *food*, and he maintains that carbon foods can only be efficient in the presence of nitrogenous matter also. When a muscle loses nitrogen, fat is probably formed, and thus a muscle, disintegrating during the period of rest, may form a store of fat in its texture, which may become efficient at the next addition of nitrogenous matter as a source of force. The argument as to the *oxidation* of nitrogenous matter being insufficient to account for work is true enough, but

* See also Dr. Hinton's paper in the July number.

oxidation is not the only chemical change taking place in the blood, as Berthelot has shown; the appropriation of albumen-nitrogen, and its change into muscle-nitrogen, may, and probably does initiate the other chemical changes in which carbonaceous foods become efficient as sources of force. Dr. Parkes' view is very satisfactory, as striking the mean between the old and new views; it harmonizes with the teaching of experience, and restores to the rules of diet their old significance. One thing is to be regretted in all experiments upon this subject made with human beings: in them the evolution of cerebral force is as variable as that of muscular force, and cannot be regulated or taken into account. It must—equally with muscle-work—modify the elimination of nitrogenous matter and carbonic acid, and yet there appears to be no means of guarding against it as a source of error. The brain *may be more active* during the period of muscular rest than during muscular exertion.

Animal Mechanics.—The Rev. Samuel Haughton, of Trinity College, Dublin, has offered some experimental proofs of two elementary principles in animal mechanics:—first, that the force of a muscle is proportional to the area of its cross-section; and, second, that the force of a muscle is proportional to the cross-section of the tendon that conveys its influence to a distant point. Dr. Haughton concludes that the contractile force of muscle is ordinarily 109·4 lbs. to the square inch of cross-section. He compares his results with those of Donders, of Utrecht, made on the Biceps and Brachiæuss, whilst he has observed most of the large muscles of the leg and arm. A most ingenious and noteworthy method of estimating the cross-section of the muscle in square inches was made use of. A piece of card was cut exactly of the shape and size of the area of the divided muscle, and this was then carefully weighed in a balance against square inches and fractions of square inches of the same sort of cardboard; thus by means of weighing, the most complicated calculations of area were avoided.

Blood.—Preyer believes that cruorine (hæmoglobin) is an acid. When frozen *in vacuo* with a solution of carbonate of soda, the carbonic acid is given off and a cruorate of soda formed, retaining the peculiar absorption spectrum of cruorine. Alkaline sulphides have been shown by Nawrocki and Preyer to first reduce cruorine, and then give a new pair of absorption bands indicating a distinct and stable combination. German observers, and Dr. Arthur Gamgee in Britain, seem very hard at work with the spectroscope, examining various reactions of blood colouring matter. The first number of the new volume of the 'Journal of Anatomy and Physiology' contains a very excellent summary of, and reference to, these researches. Dr. Thudichum's observations with the spectroscope on the fluids of cholera patients (published with illustrations in the Privy Council Report) are interesting in this connection.

Salamander Poison.—Dr. Zalesky has found an alkaloidal active principle in the poisonous secretion of the spotted salamander. He calls it Salamandrine, and remarks that it has much the same effect on animals as strychnia; but the spasms produced by the former are clonic, whereas by the latter they are tonic.

The action of Antiseptic Agents.—Some time since we drew attention to experiments on this subject made by Mr. Chapman, of Oxford. Dr. Binz, of Bonn, has been investigating the effects of antiseptics on animalcules found in vegetable infusions, and has obtained some satisfactory results. The antiseptic was allowed to come into contact with the animalculæ (Colpoda), while in the field of the microscope. Binz distinguishes two destructive actions, an osmotic one, causing the creature to burst, as with chloride and hyposulphite of sodium, chlorate of potassium and alum; and a directly poisonous action observed with nitric, sulphuric, tannic, and acetic acids, creosote, permanganate, corrosive sublimate, iodine, bromine, chlorine, and quinia. Acetic was the powerful acid poison. Quinia had a very powerful effect, but salicine was not found to exert any influence, nor nitrate of strychnia, in the course of two hours.

Digestion by the Pancreas.—Dr. Kühne, of Berlin, Virchow's assistant, in his physiological laboratory, has obtained some interesting results in this matter. He took the pancreas of a large dog, and having washed it, immediately placed it with a quantity of fibrin in hot water to digest. The whole of the fibrin was in six hours dissolved into a pepton, which was further almost entirely converted into tyrosin and leucin. It was found that alkaline pancreatic infusion will not only digest proteids, but will digest them at a rate and to an extent compared with which gastric digestion seems a slow and feeble process. It takes the collected ferment of a whole stomach days to digest half the amount of fibrin which the pancreas will digest in as many hours. The pepton produced, differs in no essential respect from gastric pepton. The interesting thing is the enormous production of tyrosin and leucin, at the expense of the pepton. For, if the process was delayed, Kühne found that a much larger proportion of pepton was produced. In the body the pepton diffuses away as fast as made, and hence no excess of tyrosin or leucin can be formed. It would be a satisfactory thing if Kühne could try his experiment again, making use of a dialytic medium. An ordinary dead animal membrane could not be used as it would itself be digested.

Morphology.

The fibres in the muscular wall of the stomach are stated by Dr. J. B. Pettigrew to resemble in man and other mammalia that which he has already described in the heart and bladder. The most external and internal fibres are more or less longitudinal, and the deeper or more central fibres become more and more oblique as the centre of the parietes is reached. The longitudinal intersect the very oblique at nearly right angles; the slightly oblique and oblique at more acute angles. Dr. Pettigrew considers that there are indications of seven layers of fibres, three external, three internal, and one intermediate; but he uses the term layer in a more restricted sense than in his former papers on the heart and bladder, and now admits that there is a mutual interchange of fibres between the different layers.

Minute Structure of the Liver.—New views with regard to this matter have lately come before the world, and seem to be very generally accepted by the leading histologists. Hering, Eberth, and other foreign observers, have renounced Dr. Beale's view, as also that which attributes to the bile-ducts the formation of distinct capillaries within the lobules, having a membrana propria like the blood capillaries, and in contact only externally with the liver-cells. Professor Turner supports the new view, which is, that the bile passes to the periphery of the lobule in channels, which lie between and have their walls formed by the liver-cells, and which communicate with the interlobular branches of the hepatic duct. Preparations of rabbit's liver, in which the bile-ducts have been injected immediately after the death of the animal, are the data which have lead to this new conception. Professor Hering has also studied the lives of many other mammals and reptiles.

The Gall-Bladder.—The gall-bag is a most strangely variable organ. Dr. Macalister states that it is constantly present in bimana, quadrumana, cheiroptera, insectivora, carnivora, marsupialia, monotremata; absent from cetacea; variable in edentata, pachydermata, rodentia, and ruminantia. As a rule it is present in birds and reptiles, and almost universally in fish. An explanation of its variability (varying sometimes even in the same species) is that it is required in those animals whose intervals of feeding are protracted, and is of little use in those in which the bile flows continuously from the liver, to aid in the almost constant process of digestion.

The Axolotl and its Gill-tufts.—It has been long thought that the Mexican perennibranchiate Salamander might prove to be merely a larval form, and develop into a true Salamandroid. Moreover, the presence or absence of gills or their apertures in the adult state has been found to be merely a question of degree, and not of much taxonomical value. Van der Hoeven pointed out that the giant proteid of Japan could not be separated from the American Menopoma, though in the first the gill apertures are lost in adult life, and in the second they are persistent. From the experiments of M. Auguste Duméril on the Axolotls now alive and breeding in the ménagerie at Paris, it appears that in this creature the persistence of the gills is purely accidental: they are of no functional importance, and may be cut off without injuring the animal. When cut, they grow again, and may be again cut. Persistence in cutting the gills causes the Axolotl at length to undergo certain changes in colour and appearance, and to approach more closely to the fully-developed Salamandroid. It is a remarkable thing that even whilst these gills, evidently the mere relics of larval structure, are attached to the Axolotl, it becomes sexually mature, and breeds (as it has done at Paris). M. Duméril appears to show that sometimes an Axolotl may lose its gills at an early period of life—in other cases, perhaps not at all—and there is great variability in the time when the supply of blood to these parts is cut off, and an absorptive process commenced. Perhaps the diminution of accessible nutriment might have some effect in causing an earlier absorption of the appendages. The most important of M. Duméril's observations—zoologically—is the discovery that the Axolotl does spontaneously lose its gill-tufts and tail crest, and becomes a true Salamandroid—approaching certain North American forms. In fact, M. Duméril says the Axolotls are only the tadpoles of the *Amblystomi*, and, most strange to say, have the power of sexual reproduction as tadpoles. Does not this open up a case for the students of natural selection? The tadpole of a northerly Batrachian, when placed in a tropical clime, tends to retain its tadpole form, and to acquire sexual maturity in that condition (or *vice versâ*). But there are almost the same remarkable facts with regard to our own common newt.

Amphioxus and Nerve Termination.—M. P. Bert has some remarks on this lowest of vertebrates in the 'Comptes Rendus.' It has been taken this year for the first time on the oceanic shores of France, though many specimens have been observed on the English south coast. M. Bert corrects some of the errors made by M. de Quatrefages. He denies the existence of the lateral canal opening at the side of the mouth, and describes the position of the abdominal pore and its relation to the body cavity. Like all other fish, Amphioxus has the generative glands early developed, and it has been strangely asserted by Agassiz that it is an immature form. M. Bert has seen it spontaneously discharge the spermatic fluid, which proves the assertion to be baseless. He also speaks of the termination of the nerves in corpuscular bodies. This gives us an opportunity to refer to a paper on the same termination of nerves in various animals published in M. Robin's Journal. In these, also, corpuscular terminations are described closely connected with muscle fibres. M. Bert very properly maintains that in *Amphioxus* there is a retiform or endless disposition of the finer nerve twigs as well as these corpuscles. No doubt the reconciliation between the views of Dr. Beale and of his opponents (who are now becoming very few in number) will be found in admitting fully both methods of termination. It seems not at all improbable that the corpuscular bodies in connection with nerve-ending and muscle fibre may be connected with sensation—that form of it, which is called the muscular sense, just as other corpuscular bodies (tactile, &c.) are connected with the more obvious perception of heat, cold, and other vibrations. "Plaques motrices" will have to be abandoned as such, and regarded merely as corpuscles of muscular sense.

Development of Cuttle Fish.—The distinguished Russian observer Mecznikow has been studying the development of Sepiola—a little Cephalopod common at Naples. He is led to deny some statements of Kölliker, and shows that the development proceeds from two layers. The skin and sense organs are developed as in Vertebrata, and what is most remarkable, a relationship between the Vertebrate's notochord and the so-called "cuttle-bone" is maintained. M. Mecznikow rejects all analogy between the foot of ordinary mollusks and the siphon, as advocated by Huxley. He is equally adverse to the hypothesis of Häckel (a natural philosopher of the Darwinian school) that the Pteropoda are the immediate ancestors of the Cephalopoda.

Insect Architecture.—A curious example of the weaving powers of insects is recorded by Mr. Tomes, of Christ Church, Oxford, in a recent number of the 'Microscopical Journal.' Mr. Tomes found in ponds on Hampstead Heath small cases made of green conferva and an animal basis; the fibres of conferva were very regularly and neatly interwoven, forming a tube open at each end. In this an insect-larva was found, which is minutely described and figured with its case in a coloured plate. Mr. Tomes considers that the larva belongs to the Trichopterous genus *Hydroptila.* He describes the habits of the animal and its method of building the case it inhabits. The perfect insect is not known to Mr. Tomes.

Structure and Differences of Egg-shells.—Dr. Blasius undertook the microscopic examination of birds'-eggs, in order to ascertain whether they presented any characters which would serve to separate the larger groups of birds. An account of his researches, which have been most extensive and detailed, appears in 'Kölliker's Zeitschrift,' 3rd part. It appears that the microscopic differences are not constant or reliable, and that oology must stand just where it did as regards systematic ornithology, even after such careful observations as those of Dr. Blasius.

THE PUBLIC HEALTH.

If any one wishes for a demonstration of the need of change in the Municipal Management of London, he should visit the Metropolis just after a snow storm. Such a storm visited London on the night of the 8th of December, 1867. The next morning, although hundreds of poor men were begging in the streets, being thrown out of work by the snow, there was no effort made to clear the streets and pavements of that snow; and the consequence was that, snow being trampled by the feet of men and horses into ice, numerous accidents to men and horses occurred. That the streets are allowed to remain in this disgraceful state does not arise from want of legal power to put them in a safe condition, but from an entire neglect of duty. Thus the police have the power to fine every person forty shillings who does not cleanse the footway in front of his house before a given time after a fall of snow; but they seldom or ever exercise this power. The greatest sinners in this respect are the government offices and the authorities who preside over our public parks. The footway around these parks is never swept. The vestries try to clean the streets, but their surveyors never have organizing skill enough to get the poor unemployed men together to do this necessary work. If the snow cannot be got away, an immense saving of horse flesh and horse pain would be effected by throwing gravel or sand down the principal thoroughfares. But the vestries will not see what they have to do with protecting strangers' horses passing through their thoroughfares. The *loss* by the payment for gravel and labour would appear against them in the rate book, and as the *saving* of life would not appear, they will have nothing to do with it. We should not have referred so much in detail to this London grievance if it were not that it illustrates a principle. London is badly managed because it is split up into forty Vestries, no two of which will act in concert, and none of them will do anything for the public good. Above all things we want in London *public-spirited* men, men who will sacrifice their own private interests and that of their parishes for the public good. It is too much to expect that the forty or fifty little parliaments by which the Metropolis is governed, with their two or three thousand members should ever produce a majority of public-spirited men. The present system is the worst possible that could be devised for securing the public good. What we really want is that the Metropolis should be governed as a whole, and that it should not be split up into forty or fifty parishes, each having its own narrow-minded parliament, bent on opposing every advantage to its neighbours, on the ground that it would injure itself. It is to break up this system that Mr. J. S. Mill brought forward a measure for the Reform of the Municipal Government of the Metropolis. It is not necessary that we should here enter into any details of this measure. We must regard it as a means to an end. The concentration of authority which he proposes in this bill, and the administrative power which it gives to bodies having larger powers and wider administrative districts than at present exist in London, would undoubtedly be the means of effecting an immense amount of benefit. This excellent measure has been opposed by nearly every vestry in London. The great excuse for opposition has been that it would increase the *expense* of the Local Government of the Metropolis. This is regarded as a sufficient ground for opposition to any measure. The cry of expense is raised against any measure, whatever may be its promise of prospective gain. The fact is, that when a thoroughly careful examination is made of Mr. Mill's bill, it will be found that a great economy will be ultimately effected. Instead of the multitude of officers with small salaries, which are now the burdens of London parishes, a few effective officers with larger salaries will be appointed. For instance, instead of a large number of medical officers of health, half of whom are confessedly paid for doing nothing, there would be five or six men appointed, who would attend to their duties, and not be allowed to hold sinecures, as is at present the case. In the interests of public health we advocate this measure. As an instance of how the present vestries treat their medical officers, we may give a report of what occurred in the Vestry of St. James's, Westminster, on the 5th of December last, when the medical officer of health, calling attention to the deaths from typhoid fever among the wealthy inhabitants of that parish, said, "Several cases have come under my notice where life has been lost amongst this class. No one should take a house without a certificate of the drains being properly laid; and bricklayers and builders, neglecting their duties in this respect, should be liable to prosecution and fine." The very idea of a man being prosecuted for killing his neighbours in this way was ridiculed; and the report in the 'Marylebone Mercury' of the 7th of December, says "The reading of this passage was received with cries of 'Oh, and laughter.'" There can be no question that in order that the duties of the medical officer of health should be carried out efficiently, his appointment should be independent of such bodies as the present vestries of London. No effectual sanitary measures can be carried out in many districts of London till the medical officer of health is made independent of the influence which the vestry is now capable of exercising over him.

The question of the position and duties of the Medical Officer of

Health is every day assuming more importance. This subject has attracted the attention of Dr. Letheby, the able and energetic Officer of Health to the City of London, and in a paper contributed by him to the 'Medical Press and Circular,' he has given his views. He insists on the necessity of every district in the country being under the supervision of such an Officer. He points out the danger of conferring this office on medical men engaged in private practice, leading, as it often does, to a confliction of interests most unfavourable to the public health. He advocates a wide extension of the duties of the Officer of Health. To him should be referred the Certificates of Death, and he should be entitled to call for the investigation of the Coroner's Court in cases of suspicion and doubt. He should be also appointed assessor in the Coroner's Court, and to him might be committed the necessary inquiries into the cause of death. These inquiries in the Coroner's Court are often of the most slovenly kind, arising from the want of requisite skill on the part of the medical witnesses, now almost entirely depended on by the Coroner in his inquiries. Dr. Letheby's paper is well worth the consideration of all sanitary reformers.

At the meeting of the British Medical Association, held at Dublin, Dr. Rumsey read a paper on 'State Medicine in Great Britain and Ireland,' which, on account of the reputation of the author as one of the ablest writers on State Medicine in this country, demands attention. This paper has now been published separately.* It embraces an account of our registration system, our medico-legal institutions, and our Sanitary laws. Under these heads, Dr. Rumsey points out various defects, and suggests improvements. It is especially to the Sanitary parts of Dr. Rumsey's paper that we would call attention. No one can have watched the efforts that have been made by the English legislature in the interests of public health without feeling that they have proceeded on no principle, have effected but little good, and that our Sanitary laws are at the present moment a worthless piece of patchwork. For want of anything like power to deal with sanitary evils, nuisances of the most injurious and gigantic kind exist in all our large towns, whilst in our country districts, where typhus, typhoid, and scrofula carry off their tens of thousands annually, not even a show of legislature is even made to ward off those evils. With regard to the appointment of Medical Officers of Health alone, Dr. Rumsey points out the utter destitution of anything like principle in their appointment. There are no fixed districts, no duties laid down, no qualifications required. Even in London, where the Metropolitan Act requires that Medical Officers of Health should be appointed: there is no law pointing out their numbers, their salary, or their duties. The consequence

* Ridgway, Piccadilly, 1868.

is, that in half the parishes of London the post is a sinecure, and in the other half the Officers of Health are insulted and persecuted, if they dare to perform duties which they themselves think are connected with their office. Several of these gentlemen have conscientiously thrown up their offices rather than be paid for *not* doing what they felt they ought to do.

Dr. Rumsey advocates the division of the Country into Registration Districts upon the plan of Dr. Farr, and to each of these districts appointing a *specially* educated State Physician. He points out the utter impossibility of educating every medical man in the kingdom in such a way as to perform the duties of a State Physician. He would give the appointment of this officer to local bodies. He thinks that nothing is so likely "to damp or even extinguish local research and local action," so much as continual Government interference. "The public medical officer," he says, "of each extensive district closely observing, verifying, collecting, and revising his facts, making his examinations and reports, directing his subalterns, inspecting public institutions, and advising the magistrates and the executive bodies within his sphere, would give a true value and force to local action which it has never yet attained: would elicit facts, and establish conclusions from local physical conditions and phenomena which might remain for ever unnoticed under mere central action."

If anything were wanted to show how imperfectly the best appointed Central Boards may act, it would be seen in the almost entire failure of the Poor Law Board to fulfil them. Here we have a great department of Government appointed on purpose to overlook the actions of Boards of Guardians and superintend the Workhouse officers, and yet under their very noses in London, a system of abominations was practised in Workhouses, that have led to a complete revision of the whole system. It now appears that the same cruel treatment of the poor, the sick, and the aged, has been going on in our Country Workhouses. It seems to be of no use to appoint new Inspectors. These gentlemen, as soon as Government pay crosses their palms, assume a new position. They turn round upon their old philanthropic brethren, and submitting to the power of red tape, call dirt and neglect, economy, and disease and death, the necessary lot of the poor. The English public, those at least who have heart enough to care for the sorrows and sufferings of the less opulent amongst us, are deeply indebted to the members of the medical profession, and the editors of medical journals, who have been instituting inquiries into the working of some of our Country Workhouses. The result of their inquiries has been to expose in the country a worse system of neglect than existed even in London. We need not go into the details of the result of these inquiries. They have been given in the

Daily Newspapers. We wish, however, to suggest two practical measures. The first is the improvement of the class of persons from whom the masters and matrons of workhouses are selected. It is quite impossible that the class of people who are now generally selected should ever superintend efficiently the large establishments over which they preside. As a rule, they are ignorant and conceited, and often avaricious and dissolute. They in fact spring from the very class whom they have now to rule, and the men win their positions not by any special adaptation for their office, but frequently by failure in business, by success as soldiers or policemen, and their wives are appointed matrons without any reference to their qualifications at all.

It is the constant practice to contrast our jails, where we keep our criminals, with our workhouses, where we keep our honest poor. The jail is a perfect institute as compared with a workhouse. In the one all is order, cleanliness, and care for the welfare of the inmates. In the other the rule is the opposite of all this. Now how do they manage in jails about masters? Why by appointing a gentleman, a man of education, and a man who knows what he has to do in ordering and directing those who are classed under his control. We wonder what would happen to some of our country jails if the master of the country workhouse were appointed to its control. Yet the management of a workhouse requires more knowledge of human nature, a greater power of adaptation of circumstances to changing conditions, than any demanded of the master of a jail. So much is this the case, that we question whether it would not be a wiser plan to appoint at once as master in our workhouses a medical man, who should combine the qualities of master and medical superintendent. Such appointments are always made in Lunatic Asylums, which perhaps in their requirements more nearly resemble workhouses than prisons.

A second suggestion, that we would make as an improvement in our present workhouse system, is the introduction of the Coroner's Court to inquire into the causes of death. The revelations which first excited public attention with regard to the workhouses of London, were the inquiries before the Coroner, in the cases of the deaths of Daly and Gibson. It is very clear that some of the iniquities at Farnham would have been prevented had the Coroner's Court been summoned. At that place a girl was actually scalded to death by carelessness, and no Coroner summoned to inquire. In the workhouse the Master has power, under present circumstances, to send for the Coroner or not. The medical officer is under his control, and for him to refuse a certificate is to bring upon himself punishment or dismissal. One of the most humiliating positions for the medical profession, is the absolute power which Boards of Guardians and Masters of Workhouses have over them. The law ought not to leave to accident the discovery of the crimes of public servants. In prisons, a Coroner's Jury is summoned on the death of every prisioner, and neither Masters of Prisons nor Country Magistrates can prevent this public inquiry. In county lunatic asylums notice of the death of every patient is obliged to be sent to the Coroner. Can it be doubted that the presence of the Coroner and his jury in these places is the cause of preventing much abuse? If it could be doubted, the comparison of the abuses in our workhouses with our prisons would set the matter at rest.

The practical difficulty of holding so many inquests as would be required in workhouses has been suggested, but this is really imaginary. It is usual in workhouses for the dead to be buried in one or two days in the week, and it would be very practicable for the Coroner's Jury to meet the day before the burying-day and inquire into all causes of death. In most cases the inquiry would be formal, but it would give an opportunity for any person aggrieved to come into court and complain. The jury would not always be the same men, and many of them would take care to look round the building, and being ratepayers, would see if they were having their money's worth for their money. They would have an opportunity of looking at the bread and tasting the soup and seeing the actual condition of the paupers themselves. This would be a very much more effectual way of inquiring than the farcical tribunals conducted by a Poor Law Inspector. At the inquiry conducted by Mr. Farnall into the death of Gibson at St. Giles's Workhouse, he directed a loaf of bread to be brought and shown a medical witness, and then asked him if he did not think it very good. The loaf might or might not have been brought from the workhouse stock, but this is a specimen of the way in which Government inquiries are conducted.

But even were it not thought desirable to hold an inquest on every person that dies throughout the United Kingdom, there is no doubt that an advantage would arise from the Coroner having sent up to him a fully filled-up information in the case of every death in a workhouse. He could then examine the details and decide for himself as to whether an inquest should be held or not.

Whilst on the subject of Prison and Workhouse management we may refer to the very unsatisfactory state of the Dietaries in Irish prisons. This subject was brought before Parliamement during its last summer Session by Mr. John A. Blake, Member for Waterford. The subject was also brought before the Health Department of the Social Science Congress at Belfast* by Dr. Lankester. The complaint of Mr. Blake was that the diet was scanty

* See abstract of a paper "On Prison and Workhouse Dietaries," by Dr. Lankester, in 'British Medical Journal,' Nov. 2, 1867.

and innutritious, and Dr. Lankester pointed out its deficiencies, as also that the food was administered to the prisoners only twice a day. The great argument employed in favour of the exceedingly low dietaries of the Irish prisons is, that if it were better the people would commit crimes in order to be taken into prison to get a better diet than they could get out. Now the Irish prison dietaries cost many of them as little as twopence-halfpenny a day for each prisoner and seldom reach the cost of fourpence. If this diet, as is stated, is not lower than the diet the people of Ireland get out of jail, it reveals a feature in Ireland that is much worse than a deficient prison dietary, and that is a really starving people. If such dietaries as those of the Irish prisons are fixed at the present low nutritive value lest people should be tempted to commit crime to partake of them, the Irish destitution must be worse than any thing England has ever yet contemplated. The apologists for the low diet at the Belfast meeting stated that the majority of prisoners were only confined for short periods, and that low diet for a short time did no harm. We would call the attention of philanthropists to this dangerous doctrine. If men have been living upon so low a diet that a little better diet in a prison may tempt them to commit crime in order to get it, what must be the effect of a low diet on such systems but that of lowering them still further, and rendering them unfit for the performance of the work by which they get their daily bread? An inducement to the commission of petty theft is that feebleness of body which makes work impossible, and the object of punishment for such crimes should be the rendering a man more able to work than he had been. Besides, these miserably low diets depress the powers of the nervous system, and make men much more liable to become the prey of despair, and to a tendency to commit crime. To withhold from men the means of vicious indulgence in eating and drinking in prison is undoubtedly the duty of a Government, but to give men a diet that is insufficient to support the health of the body is to inflict a punishment that defeats its own objects, and frequently leads to the remote consequences of disease and death, which the spirit of our criminal law condemns as unjust.

Quite independent of the low dietaries of the Irish prisons is the question of the times at which the food is served, the way it is cooked, and its quality. From the last report of the Inspector of Prisons, there is reason to believe that at least occasionally the food is not so good as it ought to be, and that it is not cooked so well, nor served so hot as it ought to be; whilst universally the practice is to give but two meals a day. Now it ought to be known everywhere that food served hot goes further than food served cold; and that the same quantity of food given three or four times a day goes further than when given twice a day. It is often death to old persons, in prisons and workhouses, to go from four or five p.m. one day, to eight or nine a.m. the next day, without food?

We have received accounts of sanitary proceedings from various parts of the country. A copy of the 'Scotsman' has been forwarded to us, containing a letter, printed in prominent type, concerning the sanitary improvements about to be made in that city. It is the old story—large sums of money have been voted for the amelioration of the condition of the lowest classes, by improving the closes and alleys; and that money is now said to be expended in work, no doubt in itself useful, but of a far less pressing nature. In Worcester a great battle is being fought on the question of appointing a medical officer of health. Although Worcester has been recently drained, and has got a good water supply from the Severn, its annual mortality is large. During the last three years it has been as high as twenty-seven in the thousand, and this has alarmed some of the more thoughtful and prudent of the inhabitants. In the end of the year 1866 the Sanitary Committee of Worcester appointed a sub-committee to report on the condition of the town. They report that many parts of the town, in addition to obvious abominations—such as general want of cleanliness—present nuisances, "such as overflowing privies and cesspools; imperfect drains, or an entire absence of them; houses dilapidated and rooms injurious to health for want of proper whitewashing and ventilation; which may be taken as a sample of what is always, to a greater or less extent, prevalent in the midst of the population." The same report says that, "Many dwellings are greatly overcrowded;" that "typhoid fever is endemic in Worcester, and it is clearly traceable to foul drains and privies, and the use of polluted well-water." Amongst the evils in this fine cathedral city—although amply supplied with water from the Severn—is the use of wells for the supply of water. There are certain people in Worcester, as in London and other places, who believe that the water from wells, surrounded by drains and cesspools, and supplied by water from the leakage of these places, is better than any other water: the consequence is, they pay for their temerity with their lives. All this comes out in the report of the Sanitary Sub-Committee referred to, and they very properly recommend the appointment of a medical officer of health, whose duty it shall be to watch the health of the town, and immediately carry into effect the various sanitary laws which have for their object the saving of the lives and healths of the community. But somehow or other, the Town Council do not see their way to put down disease and death by spending money. They seem to think that doctors, and undertakers, and grave-diggers have a right to live, as well as other people. To diminish the death-rate of Worcester from twenty-seven to seventeen in the thousand (a thing easy to be done), would be to save the lives of 400 people in the year, and 8,000 illnesses into the bargain. To be sure, that would be an enormous gain to Worcester, equal, at least, to a sum of 10,000*l.* per annum, when properly calculated; but then it would not appear in the rate-books. Town councils and vestries are everywhere alike, utterly *regardless* of the health and lives of their fellow-creatures, but particularly anxious to keep down the rates.

We are glad to report that the New Drainage at Hastings and St. Leonards has just been completed. The works have been executed by Mr. Bazalgette. The sewage is now taken out to such a distance into the sea as to render it impossible that it should ever return to the shore, and the sea will be now uncontaminated with the sewage of the town. It is to be hoped that the local authorities will take care that every house in the town is supplied with drains and a water-closet, so that all those diseases which are dependent on the retention of sewage-matters near houses may be for ever abolished.

A report comes to us from Sandown, in the Isle of Wight, of a very extraordinary character. Sandown is one of those watering-places on our coast which are very likely to become unhealthy through the grasping economy of the tradespeople, who prey upon their visitors who come for health. Fortunately, however, for Sandown, a portion of its land became possessed by a leading barrister on the Northern Circuit, distinguished for his attainments in natural science and his practical knowledge of sanitary measures. Principally through his agency, Sandown has been thoroughly drained and supplied with an abundance of pure water. The consequence has been, that ordinary epidemics are unknown in Sandown, and the bills of the mortality in the last five years show a death-rate *of only eleven in the thousand.* We would call general attention to this remarkable case, as it clearly shows what may be done by ordinary sanitary activity. This is, probably, the lowest death-rate on record. Every local body in the kingdom would do well to study Sandown. It is not a rich place. It is not a place of palaces alone. It has poor and rich, and closely resembles other towns in the character of its population, but it has this peculiarity, its drainage and water supply are perfect.

As an instance of how an otherwise healthy village in the country may be made to rival the largest towns in its filth, disease, and death, we may mention the village of Child's Hill, in the parish of Hendon, in Middlesex. The village has no system of drainage; to many of the houses there are privies with open cesspools, which overflow into the neighbouring ditches, which ultimately empty themselves into the Brent. The population is about 1,000. During the summer of 1860, dropping cases of typhoid fever occurred in this village, and in 1867 this disease became an epidemic, so that during the months of July and August last, the mortality of the district was equal to seventy in the 1,000 per annum. We are glad to hear that the village has now constituted itself a sewage district under the Sanitary Act of 1866, and that a vestry for the district has been appointed, and that a perfect system of drainage will be completed before the next summer. Would that parishes would be wise in time, and act before so much life and health has been destroyed. There must be many thousand villages in England suffering in the same way as Child's Hill. It cannot be too widely known that typhoid fever is the child of deficient drainage, and that it cannot arise or be propagated where this agent does not exist.

Quarterly List of Publications received for Review.

1. Miscellanies: being a Collection of Memoirs and Essays on Scientific and Literary Subjects, published at various times. By Charles Daubeny, M.D., F.R.S. 2 vols. 8vo. *James Parker & Co.*

2. Siluria. A History of ıe Oldest Rocks in the British Isles and other Countries; with Sketches of the Origin and Distribution of Native Gold, the General Succession of Geological Formations, and Changes of the Earth's Surface. By Sir Roderick I. Murchison, Bart., K.C.B., D.C.L., LL.D., F.R.S. Fourth Edition. 600 pp. 8vo. 42 *Plates and* 206 *Woodcuts.* *John Murray.*

3. The States of the River Plate. By Wilfred Latham. Second Edition. *With a Map.* *Longmans & Co.*

4. Practice with Science. A Series of Agricultural Papers. Vol. I. 400 pp. 8vo. *Longmans & Co.*

5. Handbook of the History of Philosophy. By Dr. Albert Schwegler. Translated and annotated by James Hutchinson Stirling, LL.D. 420 pp. Post 8vo. *Edinburgh: Edmonstone & Douglas.*

6. The Darwinian Theory of the Transmutation of Species Examined by a Graduate of the University of Cambridge. 400 pp. 8vo. *Nisbet & Co.*

7. Germinal Matter and the Contact Theory: an Essay on the Morbid Poisons, their Nature, Sources, Effects, Migrations, and the Means of limiting their Noxious Agency. By James Morris, M.D. (London), Fellow of University College. Second Edition. 120 pp. Crown 8vo. *John Churchill & Sons.*

8. Results of Astronomical Observations made at the Melbourne Observatory, under the Direction of Robert L. J. Ellery, Government Astronomer to the Colony of Victoria, Australia. *Melbourne: Blundell & Ford.*

9. Report of the Secretary of War, with Accompanying Papers. Washington, U.S.A.

10. Schriften der königlichen physikalisch-œkonomischen Gesellschaft zu Königsberg (for 7 years). 4to. *With numerous Illustrations on Stone, Copper, and Wood.* *Königsberg: Graefe & Unzer.*

11. The Botany of Worcestershire, by Edwin Lees, F.L.S., F.G.S. 290 pp. 8vo. *With Map.*
The Worcestershire Naturalist's Field Club.

12. Outlines of Physiology, Human and Comparative. By John Marshall, F.R.C.S. 2 vols. Crown 8vo. 1,300 pp. *With 122 Woodcuts.* *Longmans & Co.*

PAMPHLETS, PERIODICALS, &c.

On the Recent Zoology and Palæontology of Victoria. By Frederick M'Coy, Professor of Natural Science in the University of Melbourne. 24 pp. 8vo.

Observations and Experiments on Living Organisms in Heated Water. By Jeffries Wyman, M.D., Harvard College. 20 pp. 8vo.

Practical Hints to the Medical Student. By William Allen Miller, M.D., LL.D., F.R.S. 32 pp. 8vo. *Longmans & Co.*

New Facts and Old Records: a Plea for Genesis. By S. R. Pattison, F.G.S. 30 pp. 8vo. *Jackson, Walford, & Hodder.*

An Investigation of the Distance of the Sun, and of the Elements which depend upon it, from the Observation of Mars, made during the Opposition of 1862; and from other Sources. By Simon Newcomb, U.S. Navy. 30 pp. 4to.

On State Medicine in Great Britain and Ireland. By Henry W. Rumsey, M.D., F.R.C.S. 58 p.p. 8vo. *From the Author.*

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THE QUARTERLY

JOURNAL OF SCIENCE.

APRIL, 1868.

I. HOW SCIENCE TEACHING IS FOSTERED BY THE STATE.

It is rather more than three years since there appeared in these pages an article upon that department of our executive which supports, or at least professes to support Science tuition in this country.* We there briefly reviewed the history of the movement, pointed out the defects in its management, and expressed an opinion as to its future, which it will now be found was not arrived at without proper consideration.

As a Committee of the House of Commons is about to be nominated to inquire into the whole system of scientific and industrial training for the artizan classes in England, and as the subject has of late absorbed a large share of public attention, it may be instructive for us to return for a moment to the earlier phases of the movement, and compare them with its present aspect.

As we stated in our former article, the scheme of Science teaching was originally set on foot by the Conservatives, Lord Salisbury being President of the Committee of Council on Education. The Government enlisted the services of men of Science as teachers, by offering them small annual payments upon their obtaining certificates of competency at South Kensington (varying from 10*l.* to 20*l.* according to the grade of the certificate for each subject in which they gave instruction); and it further sought and readily obtained the honorary aid of persons throughout the country, who from disinterested motives were willing to act as members of committees to see the Government grants fairly applied.

There were other inducements, such as prize-fees, held out to teachers to raise up intelligent men of Science from amongst the artizans of the country; and as to the latter, that is to say the students, they received handsomely bound books called Queen's Prizes, and were invited to compete for gold, silver, and bronze national medals.

* "The Science and Art Department," 'Quarterly Journal of Science,' No. V. (vol. ii.), July, 1865.

Those liberal measures had the effect of calling into existence a large number of Science schools and classes, which were well attended by intelligent artizans, and were, as a rule, ably presided over by teachers of no mean scientific attainments.

A change of Government, however, initiated a new, if not a wiser policy, and when Mr. Lowe took the direction of affairs he extended the system of "payments on results," with which he was, and still appears to be, so well pleased, to the Science teachers of the country; and whilst he effected a considerable reduction in the payments made to those gentlemen who were already engaged in the work, he, or the department under him, made great efforts to establish new classes, and to swell the list of pupils and teachers which is published in each new 'Directory.'

It is not very difficult to anticipate what would be the result of such a change. Teachers who had been receiving 100*l.* or 150*l.* from the State, soon found their incomes dwindling away to one-half or a fourth of that sum, and when the Government issued a "recommendation," as they did soon afterwards, that the fees of students should be increased to meet the deficit, accompanied by the gentle hint that State aid was liable to be withdrawn altogether, the School Committees had no alternative but to follow their instructions, and to drive away a considerable number of those persons, both pupils and teachers, who had been attracted by the bounty of the State. Between the years 1860 and 1864, with a rapidly-increasing list of teachers, entailing an amount of work *which rendered it necessary to double the sum expended in the management at South Kensington,* there was hardly any increase in the estimates for the payment of teachers, so that practically the Government was "robbing Peter to pay Paul;" and it was at this stage of the movement that the article appeared in which we pointed out the injustice and impolicy of such a proceeding, and predicted that it would have a most injurious effect upon the scientific education of the people. Our remarks concluded with an explanation of the reason why the Science teachers had not protested against the breach of faith on the part of the State, and it simply amounted to this: they had been decoyed into a profession, for which they were willing to make great sacrifices; they were comparatively few in numbers; and any resistance to the heads of the department would only have made its initiators marked men, and might have subjected them to great annoyance.

They suffered as long as they could, and many of them were compelled for a time to live upon a pittance which we should consider it an insult to offer to a skilled labourer. One gentleman (one of the best teachers in the three kingdoms), who was at first in receipt of a fair income from the State and from his pupils, many of whom were distinguished by the possession of valuable medals, retired from the profession and now occupies a humble, but at least an honourable appointment in connection with one of the learned societies. Another (a Doctor of Science of London University), recently deceased, who was the ablest teacher the department could boast, and whose certificates were high and numerous, received about 100*l.* for teaching one large class at the commencement of his career, and by extraordinary industry raised his income to twice or three times that amount, whilst at his death he was giving instruction in three different towns, and as far as our memory serves, his whole remuneration from the State amounted to about 30*l.* or 40*l.* He, too, was seeking gradually to free himself from the connection with South Kensington by practising as an analytical chemist, and, had he survived, would not long have remained a servant of the State. These are by no means isolated examples, not only of what has happened, but, as we shall see presently, of what is still taking place amongst our best teachers and institutions.

Then as to the Committees. Finding the support of the State gradually withdrawn, and the number of students rapidly diminishing in consequence of increased fees, perceiving in fact that their vessels would be allowed to run ashore wherever it pleased the tide to drift them, the gentlemen who had acted as pilots either deserted them or became indifferent to their fate. The teachers were allowed to take matters under their own management; secretaries played into their hands; examination papers were opened before the authorized hour, and copies of them sent to the teachers who were waiting outside to put down the answers; these were sent back and surreptitiously delivered to the students, who came off with flying colours and carried away prizes and medals in triumph. Of course this oozed out at length, and then "My Lords" issued an indignant circular, informing committees of those practices, stating that they had cancelled the papers of such and such classes, and rendered the regulations still more stringent and distasteful to gentlemen of honour, who were giving their valuable time gratuitously to the service of the State. Teachers and students were alike disgusted. How did they know for what length of time these practices had been carried on, and how many medals they had lost in consequence? And how did they know whether these transactions might not still be taking place to their prejudice?

But it may be objected on the part of those who uphold the present system that the number of schools has largely increased during the last few years notwithstanding all these defects; and we may be told that whilst in 1865, the year following the appearance of our article already referred to, the 'Directory' only noted the existence of 121 Science schools in the three kingdoms, that of 1867 gives us a list of 213 such institutions.

Whether this is a fair test of the success of the system, or whether it is not rather the result of factitious means which have been employed to create a false appearance, we shall now proceed to consider, first from the printed statistics of the department, and secondly from those sources that have been laid open to us by the managers of the various institutions which have been affected by the system.

The following schools were in existence in 1865 with the number of students placed opposite their names; *those schools are now entirely closed*, at least their names do not appear in the 'Directory' of 1867:—

Name of Town.	Institution.	Number of Pupils. 1864.	1865.
Ancoats	Educational Institute	—	32
Brentford	New British School	—	40
Christchurch	Working Men's Institute	—	25
Dudley	Mechanics' Institute	52	30
Duckenfield	Village Library	—	16
Exton	Boys' School	—	11
Glossop	Working Men's Institute	—	16
Gulworthy	Duke of Bedford's School	20	12
Kidderminster	Mechanics' Institute	14	10
Loughborough	Town Hall	24	23
London	Farringdon Street British School	200	50
"	Shadwell Sailors' Institute	32	19
Macclesfield	Mechanics' Institute	44	26
Marsden	"	15	14
Netherton	"	24	21
Newcastle-on-Tyne	"	42	31
"	Iron and Alkali Works School	—	15
Rawtenstall	Holly Mount	17	20
Redditch	Literary Institute	38	40
Slaithwaite	Mechanics' Institute	12	14
"	Meek and Walkers	—	18
Staleybridge	Mechanics' Institute	—	30
St. Day	Girls' School	18	12
Stourbridge	Grammar School	9	25
Tintwistle	National School	14	11
Upton	St. Leonard's Schoolhouse	30	40
Wells	Mutual Improvement Society	—	9
Bandon	Town Hall	—	20
Dublin	Athenæum	—	28
"	Christian School	—	190
"	Christian Brothers' School	—	29

Thirty schools, therefore, including those at such important centres of industry as Dudley, Glossop, Macclesfield, Marsden, Newcastle-on-Tyne, Staleybridge, and Stourbridge, have already disappeared; and if it had not been for the devotion manifested by teachers, or the repeated appeals of committees to raise the necessary funds for paying those teachers even a small pittance to retain their services, the number of *important* schools which have been closed would have been largely augmented.

And now turning from the 'Directory' of 1865 to that of 1867, let us supplement the inquiry concerning the schools that have been closed by another, as to where they have never been opened. *There are no institutions for Science teaching at Sheffield or Rotherham, none at Bradford, Dewsbury, Rochdale, Newark, Stoke-upon-Trent, Coventry, Birkenhead, Sunderland, and a vast number of other towns constituting the centre of trade or manufacture, and whilst we find in the list such important localities as Alderly Edge with a diminishing class of 14, Breage with 12, Clitheroe also with a decreasing school of 12, Congleton with 21, Cottesmore with 22, [illegible]nton with 10, Guisborough with 7, Kettering and Kingsbridge with 21 and 12 respectively, and a number of other similar places of whose existence many of our readers are probably not aware, we are cheered by finding that *Leeds has one school with* 39 *students, and that* 12 *persons in all are receiving instruction in Science in the important town of Wolverhampton.*

These, then, are some of the towns in which the schools have either been closed, or have never been opened; now let us turn for a moment to the condition of some of the more important ones still in existence—but which cannot long continue open unless the present system of granting aid is changed—and for this purpose we shall pass beyond the printed reports of the department and avail ourselves also of those which we have ourselves received from various parts of the country.

The following are the statistics of the department which show how some of the most important schools have declined or are declining:—

Name of Town.	Institution.	Number of Pupils. 1864.	1865.	1866.	1867.
Bolton	Mechanics' Institute	50	55	95	79
Burnley	"	69	24	60	48*
Cardiff	Free Library	—	—	56	42
Halifax	Working Men's College	21	38	15	17
Huddersfield	Mechanics' Institution	20	33	26	16
Liverpool	School of Science	125	37	28	68†
Manchester	Mechanics' Institute	291	281	388	239
"	Corporation Street	52	52	42	36
Nottingham	Mechanics' Institute	17	82	75	35
Oldham	Parish Church Schools	149	85	—	19
Salford	Working Men's College	65	41	53	44
Slough		41	66	65	62
Torquay	School of Science	—	—	70	36
Wigan	Mining School	92	93	30	23‡
Yarmouth	Navigation School	146	163	139	112§
Aberdeen	Mechanics' Institute	48	34	91	69

Thus it will be seen that besides the fact of there being no schools at all in a considerable number of our most important

* This year this school has still further declined; the number of pupils being 45.

† Again falling off this year.

‡ This school was to have been closed this year, but a visit from an emissary of the department has revived it after a fashion.

§ Still further decreased this year; number of pupils 85.

manufacturing and seaport towns, either because none have ever been established, or because after endeavouring to struggle against their difficulties for a short period they were compelled to close, we find a large number of the old schools in still more important towns either about to close, or with little prospect of enjoying a long existence. But an objection will be raised to our choice of figures, that we have not made any mention of new schools being opened in *some* (for it is only in a few) of the towns where the old ones are on the decline; and that objection we shall meet by describing the kind of procedure by which the present system has been upheld.

A school would be established, we will say at the town of A. Probably some zealous teacher had enlisted the co-operation of a committee of gentlemen (or *vice versâ*), the department would then be communicated with, and the necessary forms filled up. For a time the school would prosper: when the system of "payment on results" was introduced, remonstrances would be sent from the Committee to the Department, which would meet with no attention, or would be met by the "*non possumus*," which is as much in vogue at South Kensington as at Rome; this would probably be repeated year by year, until at length teacher, committee, and every one else concerned being disgusted with the treatment they had experienced, it would be decided to close the school, and notify the same to the department. Then an emissary of the department would make his appearance in the town, and if it was a small one where it would be useless to attempt the formation of a second school, he would go to the authorities (as it happened recently at Wigan), and would induce them to call a town's meeting, and attempt to resuscitate the school, attributing the failure, of course. to every cause but the true one. If, however, there were more institutions in the town capable of having Science classes attached to them, they would be probably visited and induced to start classes; and in the following 'Directory' another, or perhaps two new schools would appear on the list for the town of A, with what likelihood of permanent success we leave our readers to surmise. But if on the one hand we have omitted to give the names of some new schools where the old ones are on the decline, we have also passed over the names of some very considerable schools which appear to have been closed, inasmuch as we can hardly credit the fact, and think perhaps the omission may be susceptible of explanation. For example, we find in the 'Directory' for 1865 a navigation school at Plymouth, which had in the years 1864–65, 240 and 243 pupils respectively; whilst in that of 1867, we find the school named it is true, but no return of pupils either for 1866 or 1867. What is the reason of this? And again, at Newcastle there were in 1864–5 *three* schools, two of them being Science

schools, and one a navigation school. None of these appear in the 'Directory' for 1867, two seem without doubt to have been closed; but what has become of the navigation school, which in 1863–4 had 139, and in 1864–5, 165 pupils?

That there is something here which needs explanation, our readers will not doubt, and whatever else Parliament may think fit to do, or to leave undone, we trust it will make a searching inquiry into the condition of our navigation schools; that there are good grounds for such an inquiry will be seen presently. And now, having expressed our own disapproval of the system upon which the State dispenses the public funds in aid of Science, it becomes necessary that we should support this view by the opinions of others better able, perhaps, than we are to judge in the matter; although we may be permitted to add that our conclusions have not been formed without long-continued personal observation of the proceedings of the department and their effect upon the country.

The Science teachers and committees have now so little to expect from the State, and so little to thank it for, that it has needed no persuasion to induce them to lay bare their grievances and expose the condition of the institutions over which they preside, and from the numerous special reports which we have received, we will now select a few and print them *verbatim*.

Great Yarmouth School of Navigation.—The school was established in 1857. The year preceding the system of payments on results there were two teachers whose remuneration was as follows:—

	£	s.	d.		£	s.	d.
From the State	180	0	0	Head Master	120	0	0
				Assistant ditto ..	60	0	0
" Students ..	53	12	5	Head Master	39	14	4
				Assistant ditto ..	14	8	1
	£233	12	5				

The school then had 138 pupils; since that time there were at one period 168. *Now* it has one master and 85 pupils. The remuneration of the former is 100*l.* in all, namely, 40*l.* 4*s.* 10*d.*, "payments on results," and the remainder school-fees. "For the past three years this school has been kept in action with difficulty, and a question arose in the autumn of last year whether it should be entirely closed. We decided to try another year, trusting to some amelioration either in the attendance or Government aid. A comparison of the figures under the two systems shows the hardship upon the teacher."

The following is from Mr. Shore, the "Organising Master of the East Lancashire Union of Mechanics and other Institutes":—

***Burnley*, established in 1858, had (the year preceding the**

system of payments on results) about 30 or 40 students and one teacher (no account kept of remuneration): has had 48, and has now 45, students. Total remuneration from the State, 17*l.*, and beyond some trifling charge made for chemicals "the Committee do not guarantee the teacher any remuneration."

"The classes are fluctuating: payment on results is not the best basis for a scheme for Science teaching to rest on, for it stimulates cramming and indirectly discountenances practical work. The examination questions vary from year to year in their difficulty so much that teachers are not only dependent on their pupils, but at the mercy of the whims of the examiner. The system can never become a total success, as no encouragement is offered by 'payments on results' for teachers to devote themselves specially to Science teaching."

Mr. Shore also sends us equally disheartening details of schools and classes at Padiham, Haslingden, aud Bacup—all struggling to keep afloat; at the place last named three teachers receive amongst them about 30*l.*!

Slough.—(The secretary, Mr. Chapman, sends us the following.) The school was established in 1853. The year following the introduction of the system of payment on results, it had 50 students, and one teacher who received remuneration as follows:—

	£	s.	d.
From the State	19	10	0
" Students		Nil.	
" Committee	4	0	0
	£23	10	0

Now the Master has 75 students, and receives as follows:—

	£	s.	d.
From the State	12	0	0
" Committee	4	0	0
	£16	0	0

Here we have an encouraging view of the system of "payment on results"—25 more students, and 7*l.* 10*s.* less for teaching them!

Concerning this school the Secretary writes. "The members" (students) "are chiefly composed of carpenters, bricklayers, painters, blacksmiths, and the usual trades and occupations belonging to a small agricultural town." "Eight of the class have obtained master's certificates in plane, practical, and solid geometry, and two in building construction, three of whom are now engaged at different places as Government Science teachers." "The course of instruction is plane geometry, isometric and orthographic projection, descriptive geometry, perspective, building construction, plan drawing, ornamental painting (for house-painters), free hand drawing from the "flat" and "round," modelling for stonemasons, wood-engraving, mensuration, and valuation of work. Thus you will perceive the subjects are generally useful, and our course is not confined to the simple Science and subject for which the master has gained his certificate." "Numbers of our men have gone away and taken situations of great importance and responsibility with perfect success." *

Here we have *results*, which the State rewards with the munificent sum of 12*l*. per annum!!

Nottingham.—School established in 1861. There were originally three teachers, now there is only one who receives—

	£	s.	d.
From the State	8	10	0
" Students	4	5	0
" Committee		Nil.	
	£12	15	0

for which he teaches inorganic chemistry to 21 students, geology to 8, physiology to 30.† "Our greatest difficulty has been that of obtaining teachers, in consequence of the insufficiency of the remuneration."

Two other circumstances have forced themselves upon our attention during the perusal of the various reports which we have received. One is that the 'Directory' presents a more favourable view of the action of the State from there being included in it the names of schools (some of the largest by the way) which were in existence, and where all the subjects which are now mentioned were already taught before the system of State aid commenced. This is the case at the Manchester Mechanics' Institution, where "Science has been systematically taught since 1857 before the Government Science system was devised;" and to show how much has been gained by the introduction of the system there, we need only refer to the preceding table extracted from the Directories, from which it will be seen that whilst in 1864 the number of students was 291, it was in 1867, 239.

Another circumstance is that the work of establishing good schools is done by persons unattached to the State department, often at great personal risk to themselves. The late Dr. Birkenhead not only kept the schools open at Liverpool and Wigan, in the face of the withdrawal of State aid, but started fresh classes at Preston. Mr. T. Jones, a gentleman connected with the Jermyn Street

* We are sorry to be compelled to condense Mr. Chapman's report, which shows that the school at Slough is truly a "technical" one.

† The falling off in the number of students in this school will be seen on reference to the table.

Museum; and simply a "Science teacher" and "student," has started classes at Bermondsey, Croydon, Greenwich, Lambeth, Marylebone, Paddington, and Woolwich, in all 30 classes, and "the teachers of these are not paid by the committees;" he pays all "expenses, in some cases a heavy rent," and fixes and receives the fees. Such gentlemen are able (no doubt from their superior education) to establish Science schools in places where they are really needed, and they are entitled to the thanks of the community.

The limited space at our disposal prevents us from giving any further information as to the condition of other schools, but when we add that at Liverpool and Wigan they have had a career precisely resembling the worst of those referred to, and have been kept open solely on account of the disinclination of teachers and committees to deprive the working-man of the means of self-improvement, we think our readers will agree with us, that the whole scheme is quite unworthy of such a country as this, and reflects little credit upon all who are concerned in its management.

That the heads of the department are alive to the fact that no persons ought to be employed in its direction except those who are initiated in Science is quite clear from the wording of that portion of the 'Directory' which gives the names of the various officials; for we find opposite several of the names of clerks and others, the expression "certificated in Science." It naturally occurred to us, as it no doubt would to our readers, to inquire what are the grades of the certificates of these gentlemen; but, unfortunately, the printed information on this subject is as scanty as it is unsatisfactory; for although the names and rank of the teachers were formerly published, we do not find them in the 'Directory' any longer.*

Amongst the "first-class clerks" there are two certificated in Science; of one we can find no mention in the list of certificated teachers in 1865, although he was then already a clerk in the department; the other has distinguished himself by taking a second-class in one section of physics only (out of twenty-three subjects in which the Committee of Council grants certificates). Of the "supplementary" clerks, three are noted as "certificated;" of two we have no means of ascertaining the grade, but a third has outstripped the "chief clerk" above referred to, for he possesses two certificates, one of the second and one of the third grade.

It would, however, be superfluous to inform our readers that the whole of this department of the State is and has been for a long time shockingly mismanaged. It has been repeated, and repeated *ad nauseam*, in the public prints, in private circles, amongst teachers and committees of schools of Science, if not of Art; but the officials

* This is no doubt owing to the fact that any one may now become a "Science teacher," who has taken a student's 1st or 2nd class prize.

have sheltered themselves behind the bales of red tape with which South Kensington is stored, and have produced each succeeding year an imposing pamphlet testifying to an increased industry in multiplying regulations for the management of a scheme which they have sought to embarrass rather than to promote.

It does not form part of our duty to point out how the system can be re-organized. That is, we presume, one of the objects for which the Parliamentary Committee is being nominated, but we hope its labours will be speedily followed by an extensive measure of reform before the best schools shall have succumbed; that a better educated class of men will be introduced into the management of the department, men fitted to make their appearance in those quarters where training-schools for Science are the most needed; that, in the name of justice and common sense, we may have a scientific man at the head of the Science department, and that if it be deemed one of the provinces of the State to encourage Science teaching, our certificated masters may be paid at least sufficient to find them in board and lodging whilst they are engaged in the public service.

II. NITRO-GLYCERINE: ITS CLAIMS AS A NEW INDUSTRIAL AGENT.

By John Mayer, F.C.S.

Notwithstanding the lamentable occurrence at Newcastle, in December last, resulting, as it did, in the death of seven persons, and notwithstanding the fact, likewise, that nitro-glycerine has in three or four instances, in America, proved itself to be a dangerous compound when not properly dealt with, its advantages as a blasting agent have been so extensively and so satisfactorily demonstrated, during the last three years or so, that it is high time that industry should more generally step in and claim it as a new handmaid which science has placed within her reach. Already on the continent of Europe, and in America, this remarkable compound has established its claim to rank in the first place as an explosive agent; and it is the object of the present article to examine in a scientific and dispassionate manner its title to be regarded in that light, in such a manner, indeed, as shall, we hope, form a marked contrast to the wild panic-stricken editorials which were so numerous in the daily and weekly newspapers during the latter half of the month of December last. There would have been less need for this present "corrective," if certain scientific journals had not also run riot immediately after the Newcastle explosion, instead of showing that their guiding minds were possessed of the spirit of true scientific acumen and a desire to aid industrial progress in the fullest sense of that term.

It is not undesirable to refer, although very briefly, to the history and manufacture of nitro-glycerine, so as to carry our readers along with us intelligibly to the conclusion of our remarks.

Nitro-glycerine has been known as a blasting material in the operations of mining, quarrying, and railway-cutting, for about three years; but it is fully twenty years since it was discovered by a young Italian, M. Ascagne Sobrero, while he was a student in the laboratory of the well-known French chemist, Pelouze. Briefly, it may be stated that Sobrero obtained it as a result of the action of a mixture of strong nitric and sulphuric acids on glycerine. He examined it somewhat minutely, as also did several other chemists, continental and British. Amongst them Dr. J. H. Gladstone is not unworthy of mention. He reported at considerable length regarding it to the Chemical Section at the Cheltenham Meeting of the British Association.*

In course of time many facts were noted with reference to its true chemical nature and its chemical and physical properties, the chief of which, of course, was its great explosiveness, or rather its great power as an explosive compound. The practical utilization of this property was left for Mr. Alfred Nobel, a Swedish mining engineer. He was quick enough to observe that it might possibly be used in mining operations, and scientific enough to discover how it could be manufactured on the large scale, chemically pure, and always of the same quality in every respect. Former observers had been much troubled with it, owing to its instability, its tendency to decompose spontaneously, and generally with explosive violence. All chemists who know anything of the early history of gun-cotton will remember that chemical instability and spontaneous decomposition were almost invariably associated with it. Some French chemists still regard it as a very unstable, and, therefore, unsafe substance; but Von Lenk and Professor Abel have amply demonstrated that, if thoroughly cleansed raw cotton be used and every trace of acid be removed from the manufactured product, the tendency of gun-cotton to spontaneous decomposition is completely overcome. Nobel did exactly the same for nitro-glycerine, and its manufacture soon became in his hands one of the practical arts. He secured patent rights for his process of manufacture in most European states, and himself settled down on the Elbe, in the vicinity of the city of Hamburg, as a manufacturer of the new explosive, or "blasting oil," as he chose to call it.

There are now five establishments in existence—collectively aged eleven years—where nitro-glycerine is manufactured on the

* 'British Association Reports,' 1856.

large scale. They are at Lauenburg (Prussia), the one just referred to as outside the city of Hamburg, at Stockholm, Christiania, Helsingfors, and New York. In order to reduce to a minimum the danger which is alleged to attend the manufacturing operations, the establishment first mentioned is wholly built in an artificial excavation in and beneath the level of the earth; and thus any explosion which may possibly result in the works will be confined to the works themselves, and will exert no damage in a lateral direction. This plan might well be adopted in building gunpowder mills. As an indication that the manufacture of nitro-glycerine is conducted on an exact system, on rigidly scientific principles, it may be mentioned that in only one instance has there been an explosion in any of the five works mentioned, and even that was but a very slight one. The manufacture has not yet been introduced into England, although we carry on mining operations, quarrying, railway-tunnelling, &c., on such a stupendous scale as is not excelled in any country of similar extent. Why English capitalists have not taken to it we know not; but of this we feel assured, from what we know of the extent to which nitro-glycerine is already in use amongst us, that the manufacture of this substance is yet destined to become a profitable undertaking in this country, when its use will doubtless be very greatly extended.

As might almost be inferred from the name, and, indeed, as has already been mentioned, nitro-glycerine results from the action of nitric acid on glycerine; at all events, the chemistry of the operation is essentially limited to the reaction of those two substances on each other. In practice, it is found necessary to use sulphuric acid in conjunction with the nitric acid, as in the production of gun-cotton. The essential details of the chemical transformation are the following, according to M. Kopp and various other chemists:—Fuming nitric acid (sp. gr. about 1·52) is mixed with twice its weight of the strongest sulphuric acid, in a vessel which is kept cool by being surrounded with cold water. When this acid mixture is properly cooled, there is slowly poured into it rather more than one-sixth of its weight of syrupy glycerine; constant stirring is kept up during the addition of the glycerine, and the vessel containing the mixture is maintained at as low a temperature as possible by means of a surrounding of cold water, ice, or some freezing mixture. It is necessary to avoid any sensible heating of the mixture, otherwise the glycerine is to a large extent transformed into oxalic acid. When the action ceases, nitro-glycerine is produced. It forms on the surface as an oily-looking fluid, the undecomposed sulphuric acid forming the subjacent layer, owing to its greater specific gravity. The whole mixture is then poured, with constant stirring, into a large quantity of cold water, when the relative specific gravities become so altered that the nitro-glycerine subsides and the diluted acid rises to the surface. After the separation in this manner into two layers is effected, the upper layer may be removed by the process of decantation or by means of a siphon, and the remaining nitro-glycerine is washed and re-washed with fresh water till not a trace of acid reaction is indicated by blue litmus paper. The final purifying process pursued by Mr. Nobel,* is to crystallize the nitro-glycerine from its solution in wood naphtha. Every chemist knows that by this means the substance will be chemically pure and of uniform composition and quality.

Before enlarging on the properties of nitro-glycerine and its applications, we may just glance at its chemical nature for a moment or two. Glycerine is a ternary compound, a sort of oxidized hydrocarbon, its formula in the ordinary notation being $C_6\ H_8\ O_6$. The combined action of the strong sulphuric and nitric acids is to transform it into a quaternary compound, a substitution product, in which three equivalents of peroxide of nitrogen ($3\ NO_4$) are substituted for three equivalents of hydrogen, which are removed during the reaction. The chemical constitution of nitro-glycerine may therefore be indicated in the following manner:—

$$C_6 \left\{ \begin{matrix} H_5 \\ (NO_4)_3 \end{matrix} \right\} O_6, \text{ or } C_6\ H_5\ (NO_4)_3\ O_6.\dagger$$

As a substitution-product, or *nitro-compound,* nitro-glycerine very much resembles gun-cotton, the *nitro-cellulose* of the chemist; indeed, it may almost be regarded as liquid gun-cotton; and certainly it has a great amount of interest for the scientific chemist, as much even as for the practical man who employs it as an industrial agent.

As prepared in the manner already mentioned, nitro-glycerine is an oily-looking liquid, of a faint yellow colour, perfectly inodorous, and possessed of a sweet, aromatic, and somewhat piquant taste. It is poisonous, small doses of it producing headache, which may also be produced if the substance is absorbed into the blood through the skin, and hence it is not desirable to allow it to remain long in contact with the skin, but rather to wash it off as soon as possible with soap and water. Glycerine has a specific gravity of about 1·25–1·26, but the nitro-glycerine has a specific gravity of almost 1·6, so that it is a heavy liquid. It is practically insoluble in water, but it readily dissolves in ether, in ordinary vinic alcohol, and in methylic alcohol or wood spirit. If it be simply exposed to contact with fire it does not explode, although it is so powerful as an

* Letter in 'The Times,' 27th December, 1867.

† Mr. Nobel regards nitro-glycerine as having the following composition (ordinary notation):—$C_6\ H_5\ O_3\ (NO_5)_3$, and alleges, as a reason, that a solution of caustic potash will decompose the nitro-glycerine, resolving it into glycerine and nitric acid, and, with the latter, forming nitrate of potash.

explosive. A burning match may be introduced into it without producing any explosion; the match may be made to ignite the liquid, but combustion will cease as soon as the match ceases to burn. Nitro-glycerine may even be burned by means of a cotton-wick or a strip of bibulous paper, as oil from a lamp, and as harmlessly. It remains fixed and perfectly unchanged at 212° Fah.; if heated to about 360°, however, it explodes. Kopp says that it may be volatilized by a regulated heat without decomposition, but if it boils, detonation becomes imminent, and hence, when it is dropped on a metal plate which is hot enough to cause it to boil it will decompose with a somewhat violent detonation. A plate not actually red-hot will cause this change; if, however, the plate be red-hot, a drop of nitro-glycerine falling on it will immediately take fire and burn like a grain of gunpowder. At temperatures below from 43° to 45° Fah., it becomes a glassy crystalline mass, but is otherwise unchanged. It was crystallized nitro-glycerine which exploded on the Town Moor of Newcastle. Notwithstanding the great quantity of oxygen which is contained in this substance, and the powerful affinity which phosphorus and potassium have for that element, they have no effect on nitro-glycerine. If prepared perfectly pure it is totally devoid of any tendency to volatilize, and it may be kept for an indefinite period of time without showing any proneness to spontaneous decomposition.

Nitro-glycerine may be decomposed with the greatest of ease by treatment with caustic potash, which resolves it into glycerine and nitric acid. This is certainly the most effectual means of rendering it permanently harmless, although there are other substances which will bring about its decomposition without any explosion. The extraordinary power exerted by nitro-glycerine during its explosion is undoubtedly the most interesting property which this substance possesses. The practical utilization of this explosive power was at first thought impossible, because it was observed that a spark would not produce any explosion at all, and that a blow from a hammer or some similar instrument would only produce a detonation that was limited exclusively to the part struck. In using all other ordinary explosives, such as gunpowder and gun-cotton, it is practically necessary to employ fire, either as a spark or a flame, and as this would be of no use in the case of nitro-glycerine, some other mode of exploding it had to be resorted to. Mr. Nobel, who was the first person to demonstrate the possibility of using nitro-glycerine as a new industrial agent, hit upon the method now universally adopted, namely, percussion, or rather concussion. When a quantity of nitro-glycerine is spread in a thin layer over the surface of a hard stone, an anvil, or other metallic mass, and then *percussed*, or sharply struck with a hammer, only that portion actually struck explodes or detonates, so that percussion pure and simple is practically useless. The whole mass of explosive liquid must be violently *concussed*, and to produce the required concussion the nitro-glycerine must be in a confined space, while, immersed in the liquid, there must be a small bag of gunpowder, or a percussion cap of extra strength, firmly fixed on the end of a gunpowder fuse. Thus it will be seen that nitro-glycerine almost requires to be coaxed into an explosive mood; and if people could only be brought to look on the explosions at Newcastle, San Francisco, Aspinwall, and one or two other places, without prejudice, it would universally be admitted that nitro-glycerine is not only not that frightfully dangerous material which many people in their ignorance believe it to be, and which some of them in a panic-stricken mood propose to "stamp out," but that it is even less dangerous than gun-cotton and gunpowder, and more completely under control than they are. We know that this is a very heretical and unorthodox utterance, still it is one that can be most indisputably supported and established by a great accumulation of facts resulting from the observations and experience of many persons whose minds are perfectly unbiassed.

Taking advantage of the circumstance that nitro-glycerine is soluble in wood spirit or methyl-alcohol, Mr. Nobel, nearly two years ago, made the happy discovery that it could almost instantaneously be rendered inexplosive, and that its explosiveness could be restored to it with equal readiness. The method of making it inexplosive is at once simple and effective. It is to mix with it from five to ten per cent. of wood spirit, when all attempts at exploding it are rendered utterly futile. Five per cent. of methyl-alcohol is said to be amply sufficient to transform the nitro-glycerine into the inexplosive or protected state, but Mr. Nobel now always adds ten per cent. before sending any of his blasting liquid into the market. A commission, appointed by the Hamburg Association for the Promotion of Arts and Useful Professions, made an extensive series of experiments on nitro-glycerine protected by the addition of five per cent. of methyl-alcohol, in October, 1866. One of the experiments was an attempt to explode the liquid in the ordinary way with fuse and percussion cap. The experiment was twice repeated, but in neither case did the detonation of the cap affect the liquid. In another instance the protected liquid, in a tin bottle, was fired at with a bullet, but it was found impossible to produce an explosion. "In the opinion of the commissioners," the official report concludes, the protected blasting liquid "is perfectly inexplosive." When this protected liquid is exposed to heat in a proper vessel, the volatile solvent escapes, and in course of time, under the influence of a high temperature, the nitro-glycerine explodes, but not with the usual amount of violence because, probably, the explosion occurs before all the methyl-alcohol volatilizes. If protected nitro-glycerine be spread over the surface of an anvil, and then struck with a hammer in the usual way it will not explode; after the lapse of some time, however, the explosive state is induced, owing to the evaporation of the solvent liquid.

Many interesting observations were also made on nitro-glycerine, both in the protected and explosive states, by a Royal Commission, appointed from the Engineer Corps of the Prussian army. They were made in the year 1866, at Glogau, in Silesia. One or two of the experiments may be mentioned. Protected nitro-glycerine was poured into a tin vessel, seven inches square and twelve inches high, and fired at with a breech-loading musket, from a distance of seventy feet, or thereabouts. At the first trial common, and at the second explosive, cartridges were used. When the ball struck there was no explosion in either case. "In order to ascertain its character of safety during transport, two conveyances of inexplosive nitro-glycerine were undertaken. The distance of the first tour, *viâ* Bauschwitz and Gurken, was about one German mile. The carts passed over macadamized roads, good and bad, and returned in about one hour. A tin bottle, containing 3½ ounces of protected nitro-glycerine, was put into an old powder-box, and secured in such a manner as to admit of its moving backwards and forwards without falling down; nor was it entirely filled. The powder-box was attached to the hind axle-tree of a waggon with racks. Every pace of the horses was tried without any explosion taking place. At the second trial four horses were put to an Austrian ammunition waggon. One pound of inexplosive nitro-glycerine was put into this waggon, in a tin bottle, one-third empty, and the latter secured so as to allow it to move to and fro without falling down. This trip was somewhat longer, the cart going over about two German miles of ground. The cart was driven intentionally over the very worst parts of the road, and at the most rapid pace. On the road the bottle was inspected and was found to leak at the mouth. By this means some blasting liquid had accumulated at the bottom of the waggon, which by evaporation must have become explosive. But, as even explosive nitro-glycerine does not explode on wood, when struck ever so hard with a hammer, the trial was continued. In order to ascertain finally whether a prolonged uniform movement leads to a result different to that of violent shocks, the cart was driven from Bauschwitz to the scene of the experiments, about half a German mile, half of the road stone pavement, in a sharp but regular trot. No explosion took place."*

The transformation of protected into ordinary nitro-glycerine is effected by thoroughly agitating it with water, and allowing the mixture to settle for a short while. By this means the water dissolves out the methyl-alcohol, and the mixture of spirit and water readily rises to the surface, in virtue of its low specific gravity,

* Royal Prussian Commissioners' 'Report.'

and can be removed by means of a siphon, or, by simply pouring it off. The blasting liquid is now ready for use. It would seem that the methyl-alcohol is by this means separated very readily from the nitro-glycerine held in solution by it. If protected blasting liquid be kept in a closed vessel, it will remain in that state for an indefinite period of time, and ready at any moment to be reduced or rendered fit for action; if, however, it be exposed in an open vessel it will regain its explosiveness, in periods of time proportionate to the amount or degree of exposure. In the experiments, for instance, which were instituted by the Prussian Military Commission, it was observed that protected nitro-glycerine, exposed to the air in an open glass, only acquired explosiveness on the twenty-first day, although it was tried every second or third day; and such protected liquid, after being exposed in an open bottle with a narrow neck for twenty-one days, exhibited no tendency to explosion even then,—thus showing that comparative confinement of the liquid very greatly retards the evaporation of the solvent and protecting wood-spirit.

As an explosive capable of being practically used, nitro-glycerine is quite an exceptional substance, from the circumstance of its being a *liquid* compound. There are other liquid explosives,—as the so-called chloride of nitrogen, for instance,—but nobody has ever yet succeeded in practically applying them, or even ventured to prepare any of them in large quantity. The force exerted by nitro-glycerine, during an explosion, is truly marvellous; indeed, no correct conception can be formed of it by any person who has not himself experimented with it, or has, at all events, seen the experiments performed. Weight for weight the new explosive is ten times more powerful than gunpowder. The extraordinary mechanical or eruptive power which it exerts is partly owing to the fact that there is no solid residue attending the explosion, and that the enormous pressure exerted by the resulting gases is due to the great rapidity of the explosion. The rocks being blasted have not time enough permitted them to effect any sensible cooling and condensing of the vapours. In fissured rocks this rapidity of explosion is of immense consequence; it is so very great that the tamping employed in blasting operations, is in many cases not ejected from the bore-holes, although—by preference—it is almost invariably quite loose, consisting of sand, slate-dust, or other finely-divided solid matter, or even ordinary water.

Hard tamping is of comparatively little use, owing to another very curious property possessed by nitro-glycerine, namely, that of "striking down," as it has been called, or of exerting its explosive force—unlike gunpowder—almost entirely in a downward direction. This circumstance is intimately connected with the explosion on board, and ultimate destruction of, the steamship 'European' at Aspinwall. The nitro-glycerine taken by that vessel from Liverpool was placed in the very bottom of the hold, owing to its being shipped as a liquid. There is not room here to discuss all the *pros* and *cons* of that catastrophe; but one or two facts may be mentioned, as they have great scientific and practical interest, and some of them, although brought out at the Liverpool trial last summer and made public, have been misinterpreted. It is known that, besides the seventy-two 28lb. cases of nitro-glycerine, there were some 20,000 percussion caps and other combustible substances on board. It is also known that there were three explosions, the first being very loud and occurring about twenty minutes before the second, which was not nearly so loud, and the third and last occurring *after the vessel had taken fire* and had been for some time out at sea, where she had been towed by another steamer, and where she continued to burn, and eventually went down. The nitro-glycerine confined in the hold of a large iron steamer in such a warm climate would necessarily be in a somewhat sensitive state. The spontaneous combustion theory set up at the Liverpool trial, and supported by Professors Abel and Roscoe, is not necessary to account for the results. The first explosion was certainly due to nitro-glycerine, a case of which was being hoisted up by a steam-crane, and with such rapidity that when near the deck it struck against a beam and immediately exploded, when it was observed that two iron plates were blown off the top of the vessel on the port side and near the stern. There seems to be no room for doubting that the last explosion was also caused by nitro-glycerine, when the loudness of that explosion—it was louder than the second—is borne in mind, as also the intense heat of the burning ship, the position occupied by the remaining seventy-one cases of the liquid, the "striking down" character of an explosion of nitro-glycerine, and the fact that the said explosion caused the ship to go down. That it did not seem so loud as the first explosion is accounted for by the circumstance that the ship was not then lying at the wharf, but was some distance out at sea, and by the fact, also, that the nitro-glycerine was at the very bottom of the hold, at least ten or fifteen feet below the surface of the water.

Had we space at command it would be profitable to discuss the facts and suppositions connected with the Newcastle explosion, as that occurrence is invested with a great amount of interest. The evidence at the coroner's inquest—as at the Liverpool trial—brought forth the usual theory of spontaneous decomposition, supported by the stock arguments. As we happen to know something of the history of the Newcastle nitro-glycerine, we may oppose a few facts to the fiction which the Newcastle Coroner was compelled to listen to. To do so may possibly disabuse the minds of some persons of the prejudices acquired by the untoward event of December last. The nitro-glycerine in question was manufactured at Hamburg in the usual way, mixed with methyl-alcohol, and shipped as inexplosive blasting liquid, at the commencement of the winter 1866–7, on board a vessel which, on account of an accident, had to put into Harwich, where the cargo was received into two lighters, and remained about two months exposed to the severest weather of the season. One of the cases was opened at Harwich, in order to get a sample, but that was found to be an impossibility, as the contained nitro-glycerine was a perfectly solid ice-like mass. The weather had apparently destroyed the effect of the methyl-alcohol. When the substance was conveyed to Carnarvon, part of it was washed with water in the usual way, to remove the alcohol, as if it were still protected. But that was found to be unnecessary. The slate-quarrymen fired it with gunpowder without any difficulty, and it was evident that the effect of the alcohol, if not entirely destroyed, was nearly so. Twenty-four of the cases—6 cwt.—were sent into the Newcastle district in July last. A large portion of it, as is now well known, was stored in the town of Newcastle, in contravention of the provisions of the "Carriage and Deposit of Dangerous Goods Act, 1866." At the fatal Town Moor three of the tin cases, the tops of which were strongly soldered down, were forcibly opened by means of a spade, and found to contain a quantity of solid nitro-glycerine. In this state practical men know it to be more difficult to explode than when in the liquid state; but that it resisted such violent treatment is almost inconceivable, and that Sub-Inspector Wallace is still living is little short of a miracle. Is it possible that any sane person can believe that the crystallized nitro-glycerine after such a rough career and such violent usage could explode spontaneously? that it was so sensitive that the simple slipping or friction of one piece upon another brought about the fatal explosion? We sincerely hope not.

That nitro-glycerine has properties of peculiar value in blasting operations may be inferred from the following facts:—

The first and most successful company formed for the manufacture of the substance is one formed at Stockholm towards the end of the year 1864, and the shareholders in which are *all Swedish miners*, with the exception of one who is the director of the Stockholm Private Bank. The shares are much in request, but they are not in the market, and cannot be had, and the dividends are greater than the directors care to tell. The rapidity with which the Swedish miners took to the use of the new blasting agent is most extraordinary. The great tunnel of the Central Railway through Stockholm was blasted throughout with nitro-glycerine made by that company. A stupid accident occurred—not an explosion of the blasting liquid—which frightened the authorities so much that a royal order was issued that no more than two pounds of nitro-glycerine should be stored in one place within the city; but the workmen declared, one and all, that they would resign rather than work again with gunpowder for the same pay. For a few days the royal order remained in force, but it was then cancelled by dint of necessity, and the work of the tunnel proceeded to completion—the greatest underground work executed by the new blasting agent. Mr. Eric Unge, the chief engineer and managing director, speaks very highly of the advantages of using nitro-glycerine, including amongst them the saving of 23 per cent. on the cost of blasting, and 87 per cent. greater speed than with the use of gunpowder.

In the largest slate quarries of North Wales—some of them of immense extent—a larger amount of money is spent yearly on nitro-glycerine than on gunpowder for blasting purposes; and in many cases the men make their bargains dependent on the quarry proprietors undertaking to guarantee a supply of nitro-glycerine. Tons of this substance are used annually in the Welsh slate quarries, and yet accidents from its use, or rather its abuse, are almost never heard of. At the Penrhyn and Dinorwic quarries one quarter of a ton per month is used. Mr. Parry, the manager of the Dinorwic quarries, was recently asked about the danger of using nitro-glycerine as a blasting agent. He said they had never had an accident with it, while the accidents from gunpowder were so numerous during the past year, that he really could not tell how many there had been.

These are only samples of scores of facts which might be quoted in respect of the safety, the remarkable properties, and extensive use now attained by nitro-glycerine. In concluding, we may use the language of one of our correspondents who favours us with his experience as a practical man. He says:—"Miners may have dreamed of a blasting material ten times as strong as gunpowder, exploding with such velocity as to need no tamping, unaffected by water, blasting seamy as well as the hardest and most solid rock, and leaving no smoke; but surely in this substance the very properties most needed are realized to such an extent as to appear utopian or extravagant to all those who have not tried it for themselves. Whatever its drawbacks may be, nitro-glycerine certainly deserves a fair and liberal investigation. Nature and science have placed at our command one of the most powerful agents ever sent forth from their united laboratory; neighbouring nations have learned to tame its somewhat rebellious nature, and why should not we follow the example which they have set us?"

III. RANSOME'S PATENT CONCRETE STONE.

By Fred. Chas. Danvers, A.I.C.E., M.S.E.

Amongst the numerous inventions of the present age, we find but few aiming at an imitation of the works of Nature in so early an era as that which bears date long prior to the creation of man. With the advancement of scientific research, the aid of chemistry is now more generally sought than formerly, with a view to the creation or production of articles of general use, or to assist in the preparation and manufacture of some of our leading staple productions. Who, fifty years ago, would have thought of attempting the manufacture of stone? although many alchemists have in earlier days worn out their existence in the attempt to manufacture diamonds and gold. Yet now we see the art of man rivalling in its productions some of the supposed earliest strata of our globe, and the manufactured sandstone of the present day has been found by experiment to be superior to that obtainable in the best known quarries. Manufactured by the aid of chemistry, that agency has also itself been used to test its endurance, and the results show that, so far as can be ascertained by such means, the patent concrete stone is likely to endure far longer, when used in buildings or for other purposes to which it may be applied, than any of our natural sandstones; and we cannot but feel a conviction that not only will the invention of Mr. Frederick Ransome shortly lead to a considerable convulsion in the building trades, but that it will prove also a stepping-stone to other inventions of scarcely less importance and usefulness.

Mr. Ransome formerly belonged to the well-known engineering firm of that name at Ipswich, and it was whilst connected with them, and so long back as the year 1844, that his attention was first drawn to the subject of artificial stone. During the manufacture of some flour-mills for one of the colonies, Mr. Ransome's attention was directed to the unequal hardness of certain portions of a burr-stone when overlooking a workman renewing its worn-out ridges. It occurred to him that much time might be saved, and greater economy of working secured, if a stone of uniform grit could be obtained which would wear away evenly upon its surface. Collecting in his hand some of the surrounding chips, the idea suddenly suggested itself to his mind that some suitable means of cementing them together only was required in order to produce a stone of uniform hardness throughout. The first agency employed for this purpose was plaster of Paris, but this failing to give the desired results, he subsequently employed every other known material likely to act as a cement, during which experiments, though unsuccessful, he succeeded in obtaining a vast amount of excessively useful information regarding the properties of those several material in their varied conditions.

Notwithstanding his repeated failures, Mr. Ransome took out a patent for a process of making artificial stone, being confident that in the six months, at the end of which he would have to file a complete specification, he would be able to discover some means of attaining his desired object.

The next experiments were with the use of pulverized glass which he mixed with the sand. The mixture was first subjected to hydraulic pressure in iron moulds, and then by the application of heat the glass was fused and the particles were consequently mixed together. This plan, however, also failed, owing to the stone either breaking or running into vitrified masses when subjected to the high temperature of the kiln. The idea of obtaining liquid glass and mixing it with the sand next occurred to his mind, and this was within three weeks of the time when the final specification had to be lodged at the Patent Office.

Mr. Ransome's attention having been drawn to the solution called silicate of soda, determined to make further experiments, with a view of testing its applicability to furnish the sort of cement he so much desired. "Flint, although apparently a most inert substance, is, in its chemical constitution, as much an acid as sulphuric acid is. In the one case we have one atom of silica combined with three atoms of oxygen, and the other, also, one atom of the base—sulphur—combined with the same number of atoms of oxygen. Using the ordinary chemical symbols, flint is, $Si\text{-}O^3$; sulphuric acid, $S\,O^3$. Now it is found that just as sulphuric acid combines with potash or soda to form a salt, so does silicic acid combine with either of these alkalies. The difference between the reactions is, that in the case of sulphuric acid, the affinity for the alkalies is more energetic, and the union takes place more rapidly and at a lower temperature. There are two methods of combining potash or soda with flint. The first, called the dry process, is to take a quantity of fine sand, which is nearly pure silex, and to mix it in a crucible with an excess of the alkali, and then to bring the whole mass to a high temperature, when a combination readily takes place. If the quantity of alkali used is just sufficient to saturate the silicic acid—that is, if there is only one particle of the alkali to one particle of the acid, as represented in the formula $K\,O,\ Si\,O^3$, the glass so formed is less soluble in water than when there is an excess of alkali, as in the formula $^3K\,O,\ Si\,O^3$. This process is necessarily an expensive one, for two reasons—the large quantity of alkali which is required, and the high temperature rendered necessary to effect the combination.

"The other, or moist process, although not liable to the last objection, is, nevertheless, more open to the first. In the moist process calcined flints were ground to a fine powder, and then mingled with a large excess of alkali, either potash or soda; and this mixture boiled for a considerable length of time, when a thin, rather sweetish fluid formed, which was a solution of silicate of soda, when that alkali was used. As already stated, the disadvantages attending this process are the large excess of alkali which it requires, the tediousness of the operation, thinness of the solution, and lastly, the expense of calcining and pulverizing the flints."*

The great desideratum now was to devise some method whereby a solution of silicate of soda might be obtained of sufficient consistency for his purpose, and at such a price as to render it available for general use. Whilst lying in bed one night, the idea suddenly flashed across his mind that if he subjected flint-stones in a solution of caustic alkali to heat in a boiler under high pressure, he might be able to reduce them to the desired state. Forcibly impressed with the idea that he had at last hit upon the right means to his end, he jumped out of bed, and having called his laboratory boy to his assistance, he took an old boiler belonging to a model steam-engine, and having fitted on to it a safety valve and a small cock whereby to draw off the liquid at intervals to test it, he filled the boiler with flints and a small quantity of caustic soda and water. He now urged the fire, and from time to time drew off small quantities of the liquid, which, in spite of all endeavours, continued as thin as at first. The pressure, perhaps, was not sufficient, so he tied down the safety valve, and continued to urge the fire until, to his dismay, the boiler began to get red-hot. Thinking now that his experiment was at an end—that all the liquid in the boiler had evaporated, and probably nothing remained within it but the hard flint-stones as they had at first been placed there—he began to yield to despair, for but a short time yet remained before he must file his complete specification. Taking hold of the boiler with a long pair of tongs, he threw it into a cistern of water which stood close by, and, as might have been expected, the boiler at once flew to pieces. Desirous now of obtaining some rest after the toil and excitement of the preceding hours, he was going into the house to retire again to bed, when, on passing the cistern, he looked in upon the fragments of the boiler, which, to his astonishment, were coated internally with a white waxy substance, and at the bottom of the cistern lay a glassy syrupy mass. On trying to separate this hard substance from the shell of the boiler he found that the part of it in immediate contact with the iron was hard as the natural flint from which it had been made. Thus then, when on the brink of despair at the supposed failure of his endeavours, Mr. Ransome discovered that, not only could he reduce his flints to an almost liquid consistency,

* 'The Engineer,' December 5, 1856.

but that the means also existed of restoring those disintegrated particles to their former consistency and hardness. Thus far Mr. Ransome had succeeded in dissolving his flints, but he found, on mixing his silicate of soda with sand in moulds, that the application of heat for the purpose of reindurating the silica failed to give satisfactory results, for the surface first naturally became hard and was cracked by the escape of the moisture from within.

The desired end was therefore not yet attained, but Mr. Ransome persevered in his experiments, and seemed gradually approaching towards more satisfactory results, when, about the year 1852, the discovery that the stones with which the Houses of Parliament at Westminster had been built, were beginning to show signs of decay, caused his attention to be directed to the discovery of some means whereby his solution of silicate of soda could be applied, so as to give an indestructible surface to the stonework. "He had not proceeded far in the application of soluble silicates to this purpose before he found that, although the theory with which he started was alike pretty and plausible, in practice the results were imperfect, inasmuch as the substance applied as a preservative being in itself soluble, the ordinary humidity of the atmosphere, apart even from the more powerful action of showers of rain, would, at least partially, dissolve and wash it away. Mr. Ransome's numerous experiments at this juncture, about 1856, were directed to the discovery of means for converting the soluble into an insoluble silicate, so as to render the effect perfectly independent of extraneous action and conditions. It occurred to him that if a compound silicate of lime—the substance which has given such enduring properties to the old mortars of the ancients, which have remained unchanged for thousands of years—could be formed in the structure of the stone, that agent would not only possess the property of perfect insolubility, but it would also most effectually envelop and bind firmly together, by an indissoluble bond, the several particles of which the stone is composed. After numerous experiments, designed to reduce this principle to practice, he found that the application of a solution of chloride of calcium (or lime dissolved in muriatic acid) formed, almost instantaneously, with the silicate of soda previously used, by double decomposition, an insoluble silicate of lime, and a soluble salt of chloride of sodium, or common salt, which latter substance is easily removed by subsequent washings."* Subsequent experiments having proved the readiness with which this principle might be applied to the preservation of natural stones from decay, Mr. Ransome next turned his attention to the manufacture of stone by the same process. The results proved as satisfactory as could be desired, and in 1863 a joint stock company was formed with a view to carry out operations on a large scale.

* 'Engineering,' December 7, 1866.

Works have now been erected at East Greenwich, having a frontage on the river, and although not yet to the extent contemplated, they even now cover a large area, and will repay a journey from town in order to inspect them. The process of the manufacture of this artificial stone is exceedingly simple; the sand, chalk, or other mineral substance, is mixed with its proper proportion of a solution of silicate of soda in an ordinary pug-mill, and the mixture, which very much resembles in substance fresh putty rolled in sand, and is of a very plastic consistence, is either pressed into blocks or moulds, or can be rolled into slabs or forms as may be desired, and is afterwards either saturated with, or immersed in, a solution of chloride of calcium, when a double decomposition of the two solutions employed immediately takes place. The silica combines with the calcium, and at once forms an insoluble silicate of lime, firmly binding together all the particles of which the stone is composed, whilst at the same time the chlorine combines with the soda and forms chloride of sodium, or common salt, which is easily removed, as has been already explained. The materials used by the Patent Concrete Stone Company at their works at East Greenwich are principally sand, gravel, flints, chalk, limestone, caustic soda, chloride of calcium, and water. Any quantity of the finest sand is obtainable from the neighbourhood of Maidstone; gravel is to be had at a nominal price from the bed of the Thames; chalk and flints are abundant in the numerous pits near by; the chemicals are brought by water carriage from the North of England, and a plentiful supply of water is furnished by a large well which has been sunk in the yard, this supply being supplemented, as required, by the North Kent Water Company.

The digesters, in which the silicate of soda is produced, are supplied with steam from a high-pressure boiler. In the lower part of each digester is a coil of steam-pipe, and above this is an iron grating upon which the flints are placed. The digester is then nearly filled with a solution of caustic soda, of a specific gravity of about 1·120, and the steam is admitted into the coil pipe raising the liquid to boiling point. When this operation has been continued long enough the liquid solution is sent into a reservoir, whence it is drawn off, from time to time, into pans, in which it is evaporated down to a specific gravity of about 1·700; this gives the necessary degree of viscidity for the use to which it is to be applied.

The best stones are made from finely sifted dry sand. A small quantity of pulverized stone, or carbonate of lime, is added to the sand to give the silicate of lime, produced in the manufacture, the necessary closeness of surface for its cementing action. To each bushel of this mixture, one gallon of the silicate of soda, prepared in the manner stated above, is added; they are then thoroughly incorporated together in a mill, which operation takes only about four minutes. The plastic mass is then put into moulds, and rammed firmly into the corners and interstices by means of wooden instruments designed for the purpose. When turned out of the moulds the edges all present a very sharp rigid appearance, and in the further process to which they are subjected, the mouldings retain their precise form and size without either shrinking or cracking. After being turned out of the moulds, they are played upon with a solution of chloride of calcium in a cold state, which speedily solidifies the mass The castings are next immersed into a bath containing a solution of chloride of calcium, having a specific gravity of about 1·400, and a temperature of about 212°. After this operation it only remains to wash away the chloride of sodium, which is readily effected by placing the stone under a dripping shower-bath. This done, the stone is ready for any purpose for which it may be designed.

The following is an extract from a report by Dr. Edward Frankland, F.R.S., &c., Professor of Chemistry at the Royal Institution, London, dated December 21st, 1861 :—

"I have submitted to experimental investigation the samples of stone forwarded to this laboratory, and have now to report as follows:—The experiments were made in the following manner. The samples were cut as nearly as possible of the same size and shape, and were well brushed with a hard brush. Each sample was then thoroughly dried at 212°, weighed, partially immersed in water until saturated, and again weighed; the porosity or absorptive power of the stone was thus determined. It was then suspended for forty-eight hours in a very large volume of each of the following acid solutions, the alteration in weight after each immersion being separately estimated. The sample was then boiled with water until all acid was removed and again weighed. Finally it was dried at 212°, brushed with a hard brush, and the total degradation or loss since the first brushing was ascertained. The following numbers were obtained:—

Name of Stone.	Porosity: Percentage of water absorbed by dry stone.	Percentage alteration in weight by immersion in dilute acid.						Total Percentage loss by action of acid and subsequent boiling in water.	Further loss by brushing.	Total degradation from all causes.
		Of 1 per cent. Acid.		Of 2 per cent. Acid.		Of 4 per cent. Acid.				
		Loss.	Gain.	Loss.	Gain.	Loss.	Gain.			
Bath	11 57	1·28	—	2·82	—	2·05	—	5·91	·26	6·17
Caen	9·86	2·13	—	4·80	—	·67	—	11·73	1 60	13 33
Aubigny	4·15	1·18	—	4 00	—	—	1·04	3 56	·29	3·85
Portland	8·86	1·60	—	1·10	—	1·35	—	3·94	·24	4·18
Anston	6·09	3·52	—	3 39	—	3·11	—	11·11	·27	11·38
Whitby	8·41	1·07	—	—	·53	None.	None.	1·25	·18	1·43
Hare Hill	4·31	·75	—	—	·60	None.	None.	·98	·15	1·13
Park Spring	4·15	·71	—	—	·10	·15	—	·81	None.	·81
Ransome's Patent	6·53	—	·95	None.	None.	None.	None.	·63	·31	·94

The numbers in the above table speak for themselves, and it is scarcely necessary for me to add that whilst they point out the Portland, Whitby, Hare. Hill, and Park Spring, as the natural stones best adapted to withstand the influences of town atmospheres, they also indicate that Ransome's Patent Concrete will be found equal to the best of these, and if the newness of Ransome's stone (the specimen experimented upon not having been made a fortnight) be taken into consideration, together with the well-known fact that its binding material, silicate of lime, becomes harder, and more crystalline by age, I am induced to believe that Mr. Ransome has invented a material which, with the exception of the primary rocks, is better capable of giving permanency to external architectural decorations than any stone hitherto used."

A very interesting set of experiments was made so recently as January last, with a view to test the transverse strength of the patent stone. For this purpose bars of selected samples were obtained of Bath Stone, Park Spring, Bramley Fall, and Portland, which were set in competition with Ransome's Patent Stone. The bars were each four inches square in sectional area, and two feet long; they were supported upon iron bearings, each of one inch in width, and placed seventeen inches apart in the clear. The bars were then weighted in the centre by weights suspended in an iron strap, having a bearing on the samples of one inch in width. The Bath Stone broke immediately with a weight of 942 lbs., Park Spring with 1,495 lbs., Bramley Fall with 2,091 lbs., and Portland with 2,132 lbs., whilst Ransome's Patent Stone sustained a permanent weight of 2,153 lbs. without fracture.

Besides stone for ordinary building purposes, Mr. Ransome also manufactures grindstones from the same materials. One great advantage of these artificial grindstones is that they can be made with any degree of fineness and sharpness of grit, whilst their cost is not greater than that of natural stones. At some experiments recently made by Messrs. Donkin and Co. of Bermondsey, the following remarkable results were obtained:—A Newcastle stone, and one of Ransome's manufacture, were both set up and driven by a belt from a driving shaft, whilst a bar of steel was fixed and pressed against each revolving stone by means of a spiral spring. The time taken to grind away one ounce of steel was, by Ransome's artificial grindstone, sixteen minutes, and by the Newcastle stone, eleven hours, and that notwithstanding the surface speed of the latter was more than 20 per cent. greater than of the former.

By omitting to mix the pulverized stone or carbonate of lime with the sand for manufacturing stone for ordinary uses, as has been already described, a porous stone is obtained suited for filtering purposes.

It is impossible to state to what new applications this process of manufacturing artificial stone may, with certain modifications, be found capable of being adapted. It is now used extensively in England and all over the Continent, as well as in America, where amongst other buildings it has been extensively used in the decorative portions of Cranston's Hotel in New York. It is being employed in the construction of a glass roof over the beautiful Indian Court at the new India Offices in London, and a great quantity of ornamental work has been sent out by the Patent Concrete Stone Company for public buildings under construction in Calcutta. They have received orders also from China; and large quantities of the silicate of soda and chloride of calcium have from time to time been shipped for different parts of India, with the view of manufacturing artificial stone on the spot where it was required to be employed.

IV. AMBER; ITS ORIGIN AND HISTORY, AS ILLUSTRATED BY THE GEOLOGY OF SAMLAND.

By Dr. G. Zaddach, Professor in the University of Königsberg, and Director of the University Museum.

The Natural History of Amber still presents its many problems, although for the last century numerous investigators have endeavoured to solve them. One of the few places at which some of these questions may be elucidated is Samland, which has for ages been celebrated for its richness in Amber, and which even now possesses in deep-seated deposits an inexhaustible store of this valuable fossil. I therefore undertook, some years ago, the geological examination of this district in the employment of the 'Physikalisch-ökonomische Gesellschaft' of Königsberg, and I have lately published the results of my survey in a detailed essay, accompanied by several maps, in the 'Schriften' of that body. A short summary of these results will, I hope, be of some interest to the readers of this Journal.

By the name Samland is distinguished that part of the Province of Prussia which is bounded on the west by the Baltic; on the north by the same sea, the Kurische Nehrung, and the Kurische Haff; on the east, by an arm of the Pregel (the Deime); and on the south, by the Pregel itself and the Frische Haff. The north-west part of this region, which constitutes the promontory of Brüsterort, is hilly, from 100 to 150 feet in height on the average, but reaching in many places to the height of 200 feet, and in some even to 300 feet. On the other hand it becomes flat towards the north-east and east, and gradually sinks down towards the south-eastern angle, where, upon a peninsula lying between the sea and the Frische Haff, are situated the seaport and the fortress of Pillau. This surface-contour of the country corresponds also with the form of the coast, the eastern portion of the north coast and the southern portion of the west coast being for the most part flat, and exhibiting only Quaternary formations: Diluvium, and Alluvium. The coast of the elevated north-western portion of the country, on the contrary, forms steep cliffs both on the north and on the west, and exhibits a section from 100 to 190 feet in height. In this manner an excellent insight into the geological structure is afforded, showing that in many places, under a proportionally slight thickness of Diluvium, Tertiary beds are conspicuous at a height of from 80 to 125 feet above the sea-level. They are not continuous, but are interrupted at several places, the gaps being filled up with newer formations, such as marl and sand. Sometimes also dislocations are seen in the older deposits, while the Tertiary beds are broken through and displaced by the pressure of the overlying masses.

Fig. I. in the accompanying quarto plate shows the north-western part of the coast of Samland on a scale of 1 : 100,000. Below it is drawn a view of the profile of the same part of the coast, where the vertical scale is 36 times that of the horizontal. The notches reaching from the surface to the sea-level signify ravines, which at various places intersect the coast, and down which streams flowed to the sea. The heights are given in Prussian duodecimal feet. The places where the Tertiary formation is preserved are shaded both upon the map and section: the white portions are therefore those where only Postpliocene or Diluvial masses exist. Of the formations which belong to the recent period, there occurs on this coast only blown sand, or Dunes, and these in so slight a degree as to require no attention.

Where the Tertiary formation crops out it always comprises two different deposits; the underlying consisting of thick beds of Glauconitic Sand, which sometimes attains a height of 65 feet above the sea-level (Figs. II., III., *A*), and upon which are the beds of the Brown-coal formation, from 60 to 100 feet thick (*B*).

The Glauconitic Sand is not everywhere similarly composed. It is necessary to distinguish a northern deposit, which occurs on the whole of the north coast, and on the northern part of the west coast, as far as the village of Kreislacken; and a southern deposit, which extends from Kreislacken to the village of Kraxtepellen, so far as the formations can generally be followed on the coast.

The northern deposit (Fig. III., 1, 2, 3, *A*) is very simply constituted. The upper part, from 40 to 60 feet thick, presents a bright-green sand (*c*), which is composed of rather large quartz-grains and bright-green knob-like granules of Glauconite. In the north-western corner of Samland, namely, near the villages of Grosskuhren, Kleinkuhren, and Rosenort, the lower beds of this

"Green Sand" are cemented by hydrated oxide of iron into a coarse sandstone, which is important on account of its containing remains of numerous animals, which have not been preserved in the loose sand. Under the "Green Sand" lies a deposit, consisting of finer quartz-grains and a larger quantity of Glauconite, besides containing clay and Mica, which increase in quantity the deeper the deposit is penetrated. The Glauconite gives it, in the dry state, a greyish-green colour, which becomes nearly black when the rock is moist. Generally, also, the following beds can be distinguished in this deposit. The uppermost, from 5 to 8 feet thick, is called a "Quicksand" (Fig. III. *b*), because it contains a large quantity of water, which has been arrested in its descent by the underlying clayey stratum; next follows the so-called "Blue Earth," or "Amber-earth," which is from 3 to 4 feet thick, and more firm, dry, fine-grained, and argillaceous than the "Quicksand." The still more deeply seated deposit is called the "Wilde Erde," because it contains no Amber. It has been explored only here and there to the depth of from 10 to 18 feet; and generally there has been no inducement to penetrate farther. It is also unknown how deep this formation continues and what underlies it.

The Amber occupies only a narrow zone in the whole formation; in this, indeed, it occurs abundantly, but is not equally distributed. For each square foot of the surface of the bed, that is, one cubic foot of sand, from ½ lb. to 1 lb. of Amber may be reckoned as about the average. The pieces are of various sizes, those weighing as much as half-a-pound being seldom found; and larger lumps of one or more pounds weight are extremely rare. Their surfaces are dull and worn, and their edges and angles are also somewhat rounded, but not to a sufficient extent to obliterate the various forms which they originally received as the liquid resin of a tree, such as pins, drops, and plates, which were formed between the bark and the wood, or between the yearly rings of growth of the stem. Frequently, also, fine impressions of the parts of the plants which produced them can be distinguished on their surfaces. It follows, therefore, that the pieces of Amber were for some time, but not for very long, rolled about by the water previous to their deposition.

With the Amber also occurs fossil wood, but generally only in small pieces, which were probably half-decayed when they were deposited. The complete stem of a tree has never yet been found in the Amber-earth, and solid pieces of a foot or more in length are very rare. Such pieces of wood as still have Amber attached to them are of especial interest; and there are even some so completely penetrated with Amber-resin that they appear to consist not so much of wood-fibres as of Amber-filaments. In the "Amber-earth" and in the lower part of the "Quicksand," there also occur pieces of compact clay and marl, which contain numerous fossils, the same as those which are found in the overlying ferruginous sandstone. Mr. C. Mayer, of Zurich, determined thirty-five species of these fossils in the year 1860.* Among them the most abundant are an oyster (*Ostrea ventilabrum*, Goldf.), a small cockle (*Cardium vulgatissimum*, Mayer), *Pectunculus polyodontus*, Phil., *Natica Nysti*, D'Orb., *Morchia Nysti*, Gal, besides two species of *Spatangus* (*S. Sambiensis*, Beyr., and *S. bigibbus*, Beyr.), a small *Echinus* and a *Scutella* (*S. Germanica*, Beyr.); as well as a Crab related to the living *Carcinus moenas;* finally, there occurred in the greatest abundance species of *Eschara* and *Cellepora.*

The conclusion which Mr. Mayer has drawn from his examination is that the "Glauconitic Sand" of Samland is of the same age as the Glauconitic Sand of Egeln near Magdeburg, and of Lethen in Belgium, and therefore belongs to the Eocene or Lower Oligocene division of the Tertiary formation.

From the circumstances previously mentioned it follows that the Amber in the "Amber-earth" by no means lies in its original bed, that is, not in the soil of the old forest in which the Amber-pines grew; but that the whole deposit of the "Glauconitic Sand," so far as we have hitherto considered it, is a marine formation; and that the Amber was washed into it by the sea in which the crabs, sea-urchins, and oysters lived. From the habits of these animals, and from the form of the pieces of Amber, it may be inferred that the deposition of the latter occurred not very far from the shore; and from the condition of the Amber, that its deposition took place in a proportionately short time, and that considerable stores of it must have been collected in neighbouring localities. In the beds above and below the "Amber-earth" only a few isolated pieces of Amber occur.

The southern deposit of the "Glauconitic Sand," which commences near the village of Kreislacken on the west coast (Fig. III., 4, 5, 6*A*), behaves somewhat differently. Here the distance between the base of the "Amber-earth" and the upper margin of the "Green Sand" is less than anywhere else, namely, scarcely 30 feet, notwithstanding that the "Amber-earth" is 8 feet thick. Towards the south, however, the latter not only descends lower, but also increases in thickness, so that in a distance of half a German mile, near the village of Kraxtepellen, the thickness of the formation has increased to more than 50 feet, and that of the "Amber-earth" to more than 20 feet. This is caused by the coming in here of five different beds above one another from south to north. The Amber-earth is here composed of two different layers (Fig. III., 6, a^1, a^2), each of which is covered with a bed of quicksand, and the lower of which is dis-

* 'Die Faunula des marinen Sandsteines in Kleinkuhren bei Königsberg.' Vierteljahresschrift der naturforchenden Gesellschaft in Zurich. Jahrg. 1861, p. 109.

tinguished by its very coarse quartz grains. Above them lies a bed of "Green Sand" (*c*), then follows a bed composed of a very fine micaceous sand, from 10 to 25 feet thick, containing quite as small granules of glauconite, and much clay, being near the latter rich in sulphate of iron. This bed bears amongst the Amber-diggers the name of the "White Wall" (*d*), because when it is dry it soon becomes covered with a sheet of sulphate of iron. Upon it, finally, there reposes (still in the southern part) a bed of coarse quartz sand, 3 feet thick, which is particularly rich in large granules of Glauconite (*e*). Of all these beds only the upper "Amber-earth" and the "Green Sand" can be compared with the corresponding beds of the northern deposit, the remainder being peculiar to this southern formation. The latter is also further distinguished by containing no fossils with the exception of shark's teeth, which occur everywhere in the "Amber-earth," and by the greater abundance of pieces of Amber in the beds overlying the Amber-earth, namely, in the so-called "White Wall," than in the "Green Sand" of the northern deposit. We have evidently here, therefore, the northern margin of a deposit, which filled up a basin of its own,—immediately connected, it is true, with the great sea-bed in which the northern deposit was accumulated,—but which was formed by the action of particular currents. All this is clearly and sufficiently explained if we assume that these southern deposits have been formed at the mouth of a stream. The following observations will confirm this hypothesis.

In order to advance the solution of the various disputed questions relating to the birth-place of Amber, I directed my attention particularly to those minerals which are found in the beds of the "Glauconitic Sand" in the form of pebbles; and it has been my good fortune to obtain such a series of these pebbles as throws considerable light on the problems in question. In the "Amber-earth" of the northern deposit are found somewhat abundantly pieces of a compact stone, from the size of a hazel-nut to that of a walnut, which is evidently the parent-rock of the "Green Sand," as it is composed of exactly similar granules of Quartz and Glauconite bound together by a marly cement. These fragments, however, vary amongst themselves, in the quartz grains being sometimes larger and at others smaller, and the cementing marl being sometimes more and sometimes less abundant. With them also are associated small portions of marl which contain only granules of Glauconite.

In the "Amber-earth" of the southern deposit, however, occur fragments of that Cretaceous rock which is so abundant as pebbles in the Diluvial deposits of Northern Germany, and which is known sometimes as hard chalk, or as chalk-marl, or again as earthy ("*todter*") limestone. It is characterized by its richness in such fossils as *Belemnitella mucronata* (Schl.) d'Orb., *Ostrea vesicularis*, Lam., and *Terebratula carnea*, von Buch.; and it is composed of very small granules of Quartz, minute flakes of Mica, and little grains of Glauconite, cemented together by a matrix of marl. It has therefore exactly the same constituents as the above-mentioned pebbles, and corresponds to them so precisely that both of them are evidently only variations of one and the same rock. This marly sandstone, however, is still found upon the neighbouring Island of Bornholm,* and belongs to the Greensand of the Cretaceous formation, which also includes in its lower beds coarser glauconitic sand and glauconitic marl. It is therefore proved that the Tertiary "Glauconitic Sand" of Samland has been formed out of the Greensand of the Cretaceous formation, the younger beds of which constitute a part of the Danish Island. The marly sandstone is evidently the parent-rock of the deposit which I have already distinguished by the name of the "White Wall," and which is particularly characteristic of the southern deposit of the Samland formation.

We can determine, however, still more exactly the route over which the materials of the northern deposit were brought there, because in the "Amber-earth" small pebbles of Silurian limestone occur in some abundance. This fact is itself sufficient to prove that the "Green Sand" came from a region where the Cretaceous formation reposed on old Silurian rocks. Moreover, two large stones, which were once found in the "Green Sand" near Warnicken, contained fossils, namely, *Beyrichia Buchiana*, Jones, *Chonetes striatella*, Dalm., and *Rhynchonella nucula*, Murch., and resembled partly rocks of the Island of Gothland and partly those of the Island of Oesel, so that it is in the highest degree probable that they were derived from the land which connected these two islands during the Tertiary period. And as the Silurian pebbles and the "Green Sand" came together to Samland, so it follows that, at that period, the Greensand of the Cretaceous formation extended from Bornholm towards the north, through Gothland to Oesel, and occupied a great part of the area which is now filled by the southern half of the Baltic Sea. The Cretaceous rocks then formed, evidently, a broad coast-land round the old continent of Northern Europe, which consisted of the crystalline rocks of Scandinavia and Finland, and of Silurian and Devonian strata. They also extended from Scandinavia over the area which is now occupied by the northern part of the Baltic and its bays, as also so far as Courland and Esthonia far away towards the east. The northern and north-eastern part of that coast-land which lay north of the existing Samland must have been formed out of the oldest beds of the Cretaceous formation,—the loose Greensand and glauconitic Marl;

* For a recent account of the Geology of this Island see K. v. Seebach's 'Beiträge zur Geologie der Insel Bornholm.' Zeitschr. deutsch. Geol. Gesell. vol. xvii., p. 338.—Trans.

because upon the Danish Islands the deposits of that formation still form zones which follow one another in the order of their age from the north-east to the south-west. Add to all this that Cretaceous beds now crop out in the East of Prussia on the banks of the Niemen near Grodno, and that in the south Cretaceous beds to the thickness of 300 feet were bored through, in sinking a well near Thorn on the Vistula, and scarcely a doubt can then remain that the Tertiary deposits were accumulated in a sea-bed, which was formed by a great depression of the strata belonging to the Cretaceous formation.

The discovery of the parentage of the "Glauconitic Sand" also furnishes us with that of the Amber of Samland. The trees which yielded the Amber-resin must have grown upon the Greensand beds of the Cretaceous formation. Even as in North America at the present day the *Taxodium distichum* especially delights in the low and frequently inundated marsh-lands lying along the lower portion of the Mississippi, so during the Tertiary period may the Amber-trees have flourished best on the boggy coast which then surrounded the great continent of Northern Europe.

We can still more exactly draw the boundaries which then existed between sea and land, and with the assistance of a few hypotheses we can picture to ourselves the conditions under which the Amber was deposited.

We know not, indeed, how far in Prussia the beds of the "Glauconitic Sand" extend, as they are exposed only on the coast of Samland; but as we know that the beds of the Brown-coal formation were deposited immediately upon them, we can conclude, from the expansion which these beds possess in Prussia, what were the general boundaries of the old Tertiary sea, namely, that the whole of West Prussia, a neighbouring portion of Pomerania, and the western half of East Prussia, extending to about the thirty-ninth degree of longitude (from Ferro), formed the bed of a bay connected in the south-west with the great Tertiary sea, which covered the larger part of Northern Germany. The northern boundary of this bay left Samland at some distance, and was continued westward with some irregularity to Rückshöft, which lies at the foot of the peninsula of Hela, and where thick Brown-coal beds crop out on the coast of the Baltic. The bay was, as we have seen, a basin in the Cretaceous formation, and was bordered by widely expanded flat coasts, which mark the last upheaval of the district. Numberless rivulets with small discharge emptied themselves into the bay, and carried solid matter into it; but a larger stream from the north-west, which flowed through the southern portion of the Cretaceous land, also discharged itself here.

We have no knowledge of the oldest deposits which were formed in the bay; we can only conclude from the corresponding formations in Belgium, where the Tertiary strata likewise repose on the Cretaceous beds, that the "Glauconitic Sand," which contains the Amber, may have been preceded by other deposits. In the meantime the coasts continued covered with luxuriant plant-growths—with that flora, in fact, the most delicate structures of which are still preserved to us in the clear Amber. If we consider that the temperature was then much higher than it is now, that the land descended from the highest North towards the South, and was there washed by a Middle-European sea, the temperature of which was, perhaps, elevated by a warm current, we shall then find it explained how this flora contains certain northern forms associated with plants of a temperate climate, and with others whose nearest allies now live in much more southern regions. Thus, Camphor-trees (*Cinnamomum polymorphum*, Heer) occur with Willows, Birches, Beeches, and numerous Oaks; amongst the Conifers the most abundant tree was a *Thuja*, very similar to the *Thuja occidentalis* now living in America, next to which abounded *Widdringtonia*, Pines, and Firs in great variety, and amongst them the Amber-pine. Many thousands of the last might already have perished, and while the wood decayed, the resin, with which the stem and branches were stored, might have accumulated in large quantities in bogs and lakes in the soil of the forest. In order to explain, however, that this accumulation of Amber could be suddenly broken up, floated away, and scattered, I assume that the coast of the district was at that time on the point of sinking. This supposition will appear less arbitrary when we see, as we shall presently, that alternate upheavals and depressions of the country may be positively proved to have occurred in the immediately succeeding period. If at that time the coast sank but slowly, nevertheless in the lapse of a few centuries, or even in a shorter time, a great portion of the flat coast-terraces might have been covered by the sea. The forest-earth was washed up by the waves, and the Amber carried into the sea. The greater portion being probably still attached to the wood, it could float about in the water for some time before it sank. The forest of the inundated coast was also destroyed; but the stems of the trees which floated out into the open sea were scattered about, only those pieces of wood which lay in the earth with the Amber sinking with it to the bottom. Thus perished the greater portion of the Amber forests; but it is not necessary to assume that they were all destroyed, as it is much more probable that in the higher districts of the country there still remained many forests which also were rich in Amber-trees.

The deposition of the "Green Sand" lasted for a long time afterwards, and pieces of Amber still continued to be washed into the sea; but it was only in the neighbourhood of the streams that it was now deposited in greater quantity, probably because they flowed through either uninjured forests, or soil rich in Amber, in the higher parts of the country. What finally put an end to the deposition of the "Green Sand" it is difficult even to conjecture. Probably the land was so deeply depressed that the lowest beds of the Cretaceous formation,—the looser Greensand and sandstone,—were covered by the sea, and consequently protected from the action of rain.

Immediately upon the "Glauconitic Sand" lie the beds of the true Browncoal-formation. They very clearly form three deposits or stages (Fig. III., *B* 1, *B* 2, *B* 3), of which the two lower are certainly the most closely connected. The lower stage (distinguished by 1 in Fig. III.) is principally formed of "Quartz-sand," which generally contains no admixture. It is everywhere much more coarse-grained than the other varieties of sand belonging to the Browncoal-formation, but it is nevertheless found composed of particularly large grains in certain layers in the southern portion of Samland. At some places it alone (Fig. III., 1, *B* 1) constitutes the lower stage of the formation, which is everywhere of the same thickness, namely, from 24 to 25 feet; at other places the lower stage includes also a bed of clay (Fig. III., 2, 3, *B* 1). In order, however, to be able to explain the expansion of this clay, we must glance at the stratification of certain older beds which we have not yet discussed.

The beds of which we have hitherto spoken,—both the "Glauconitic Sand" and the "Quartz-sand,"—do not lie horizontally; but in proceeding from east to west along the north coast, they may easily be observed to sink gradually from the village of Sassau, then to proceed horizontally near Georgswalde, and to rise again from Warnicken towards Grosskuhren. They form therefore a trough-shaped synclinal, which is, however, very flat, as it possesses only a depth of from 40 to 50 feet in a length of nearly two miles. This trough is also seen again on the west coast; and numerous observations and measurements prove that it stretches from north-east to south-west through the western part of Samland, and in this direction becomes considerably widened and deepened. While its north-western margin is turned from the village of Grosskuhren on the north coast towards the west-south-west as far as the estate called Gross Dirschkeim, the eastern border appears to be extended from the village of Sassau in a southerly direction; but the site of the latter is not known exactly, as it passes through the midst of the country. The deepest point of the trough is near the village of Rothenen on the west coast, for while its base is 42 feet above the sea-level near Georgswalde, at the former locality it lies 10 feet below it. According to this the "Amber-earth" would occur near Rothenen at a depth of from 60 to 80 feet below the sea, but hitherto it has been proved here quite as little as at other localities on the north coast, where it exists at a considerable depth.

The trough has evidently been formed by the upheaval of its two sides, and it can easily be shown when this commenced, and that it continued slowly. This is taught us by the clay-bed (Fig. III., 2, 3.—2), already mentioned as occurring in the "Quartzsand" of the lower deposit, and as possessing a thickness of from 8 to 10 feet. It has exactly the same extension as the trough; it does not, however, belong to its infilling, but lies under it, forming a part of its base. Together with the "Quartzsand" it possesses the same thickness as the latter assumes, where it alone forms the lower division of the formation. It therefore follows that the upheaval of the sides began at a time when from 15 to 17 feet of "Quartzsand" had been deposited, and that while it continued, "Quartzsand" was thenceforward deposited only in the upheaved area; the resulting trough, however, was immediately covered with the mud, which is now hardened into a clay-bed. Where the clay is mixed with sand, it is not the "Quartzsand," but the fine Micaceous sand, which, as we shall see, forms the principal constituent of the infilling of the trough. This clay-bed, which I shall call the lower, because two others follow above it, belongs therefore, according to its situation, to the lower stage of the formation; according to its origin, however, it belongs to the middle stage, and thus it connects in the most intimate manner the two divisions, one with the other.

The materials which fill the trough (Figs. II., III., *B* 2) are of three kinds; namely—Clay, Sand, and Browncoal; but the first and the last occur only here and there, and the Sand (Fig. III.—4) must be considered the most important deposit in this series. It is composed of fine quartz-grains with an admixture of numerous small flakes of Mica and small bright-green granules of Glauconite. At the same time it contains many pieces of coal, partly as powder or small particles, and partly as large tree-stems. The first form the layers and nests, which give to a section of the sand a brownish striped appearance. I have, therefore, called this deposit the "Striped Sand," and it is absolutely peculiar to the Prussian Browncoal-formation as a glauconitic Micaceous sand. It is, however, on that account particularly remarkable, because it contains Amber, which occurs, not indeed so abundantly, nor yet in one precise layer, as in the Amber-earth, but still in tolerable richness as nests in the brown stripes, and with small pieces of coal. As this Amber comes from a much dryer stratum than the blue "Amber-earth," it may be distinguished both by its external appearance and its greater solidity; and it is on that account more highly valued than that from the latter deposit, which, if it dries in the open air, becomes cracked and shivered.

Under the "Striped Sand" lies, here and there, a clay-bed (Fig. III., 2, 6–3), which I call the Middle; it contains the remains of an extinct Flora, changed into coal,—some large portions of stems, flattened branches and stalks in greater abundance, and many leaves. As at other places, here also it may be observed that the last belong in great part to deciduous plants, while the wood is almost entirely that of conifers. This Browncoal-flora differs from the older Amber-flora; either the latter had perished as a shore-flora, and we have in the former the plant-growths of more northern and more elevated districts, or — what is more probable — the climate and flora of northern Europe had already altered. This flora, indeed, contained many species of plants which at the present day are quite foreign to the region; but it was, nevertheless, very similar to the existing Flora. Poplars, Alders (*Alnus*), Buckthorn (*Rhamnus*), Ash (*Fraxinus*), and, among the Conifers, *Taxodium dubium* and *Sequoia Langsdorfii* formed the principal components of the forests of that period; with them, however, occurred also a *Gardenia* with pea-like fruit, a Fig, and species of the genera *Sapindus*, *Diospyros*, and *Banksia*. The clay in which these plant-remains lie sometimes passes immediately into Brown-coal (Fig. III., 6. 5); generally, however, the latter occurs higher, above the "Striped Sand," and forms the uppermost member of the whole series (Fig. III., 2. 5, 9).

It is very remarkable that exactly in the same area which the southern deposit of the "Glauconitic Sand" occupies, the lower division of the Browncoal-formation appears to be differently composed. Instead of the simple clay-bed which lies above or in the "Quartzsand" on the north shore, we find here three deposits of clay and argillaceous sand (Fig. III., 4 and 6—2′, 2″, 2‴), so that the "Quartzsand" forms only thin layers between them. No one can doubt that these clayey deposits owe their origin to the same source as the older argillaceous sand which we have previously distinguished by the name of the "White Wall." More than this, we can even determine exactly the area over which the current of the river made itself perceptible in the Tertiary sea. For on the portion of the coast belonging to the village of Gross Hubnicken occurs a district, 2,700 paces broad, which contains generally the same beds as the districts lying to the north and the south, with this difference, that the argillaceous portions are absent (Fig. III., 5). Instead of the three clayey beds of the lower stage we find striped sand deposited in the "Quartzsand" of this area (Fig. III., 4); and we cannot explain this otherwise than by the supposition that the current was here so strong that it carried on the argillaceous ingredients, and sorted out, as it were, the striped sand. At the same time this furnishes us with the proof that all the clayey beds of the lower stage belong to the "Striped Sand," and that, therefore, not only it, but all the infilling of the trough, with the Amber which it contains, was also brought there by the same river which during an earlier period had floated similar materials from the land into the sea. Thus the deposit of the "Glauconitic Sand," which appears to be connected with the Green Sand, is bound up in a wonderful manner with the overlying Browncoal-formation.

The deposits of the middle division of the Browncoal-formation have no important relations, for altogether they attain a thickness of only 22 feet, and even thus are unrepresented in one-half of the trough. The beds of the third division of the formation (Figs. II., III., *B* 3) are thicker and more wide-spread; they extend over the whole area of the Lower Stage, and repose partly upon the "Quartzsand" of that division, and partly upon the beds of the second stage. The succession of its various strata is also nearly the same as in the Middle Stage. At the base lies a clay-bed (Fig. III.—6), which passes upward into a clayey "Micaceous Sand" (7). Both contain plant-remains: pieces of wood and leaves of Conifers. As the clay and coal diminish in quantity, the "Micaceous Sand" becomes brighter, and at last white. It does not, however, contain Glauconite, and is thus distinguished from the "Striped Sand." Its upper layer is in great part composed of a Quartzsand, the grains being more equal and smaller than in the "Quartzsand" of the Lower Stage; but it can nevertheless only be looked upon as an alteration of the same. It is coloured grey or black by a great quantity of coal-dust, and is therefore appropriately called "Coal-sand" (Fig. III.—8). In it or in the uppermost layer of the "Micaceous Sand" sometimes occur, finally, true beds of Brown-coal (Fig. III.—9), from ·6 to 8 feet thick, which are sometimes sandy, but at others consist of bituminized wood, and then contain a great quantity of gigantic trunks of trees. These upper Browncoals are those which are found also in other remote districts of the Province of Prussia covered by newer formations, for instance, near Braunsberg on the Passarje, near Schwetz on the Vistula, near Rückshöft on the Baltic, &c.

From what has now been stated it will be easy to carry on the history of Samland through the Tertiary period. When in the place of the "Glauconitic Sand," the deposition of the "Quartzsand" commenced, the relations of sea and land were not changed. As the "Quartzsand" in the southern districts is much coarser than in the northern, and as it forms in the latter area numerous intercalated beds between other strata, which do not occur in the former, we can infer that it was carried into the Bay from the great sea in the south-west. After the deposition of this Sand, and of the clayey ingredients which the river washed into the Bay, had continued undisturbed for some time, began the gradual upheaval of the country lying east and north-west of the Bay. And the Bay itself, which had been so extended by an earlier depression, was now confined to the small flat trough whose most northerly portion we have now learnt to know. As it arose, however, it was filled up with the mud which the river carried into it, for the barriers which had formerly stopped its deposits were now destroyed by the upheaval of the coast. With the sand, which it derived from a variety of the Cretaceous Sandstone, poor in Glauconite, it took up also, out of the lakes and marshes through which it flowed, the Amber which was deposited there, and carried it into the trough, as well as numerous fragments of such plants as a river would bear away from an old forest. That the wood occupies as Browncoal chiefly the uppermost place in the series of deposits can perhaps be explained only by supposing that it floated about on the surface of the water until the trough under it was filled up, and it was pressed downward into the Sand.

About this time the coarse Quartzsand on both margins of the trough lay dry; but, as it is covered by the beds of the uppermost division of the Browncoal-formation, it is clear that a depression again followed the upheaval of the country, during which the deposits of the argillaceous "Micaceous Sand," of the "Coal-sand," and of the Browncoal, were accumulated. The "Micaceous Sand" of the upper division contains, however, no Glauconite, and as we are unacquainted with its origin, the influence of the river on these beds is also unknown, and the mode of their formation cannot be pursued any farther with certainty. No doubt the forests of an extensive shore-line again perished, and furnished the wood to the Browncoal-beds. Finally, the Prussian Bay of the North-German Tertiary sea was filled up, and while numerous deposits were formed in other parts of this sea, Prussia was laid dry by an upheaval of the rocks, and thus ended for a time the history of the country, but only to commence again after many centuries, when a harsher period of destruction succeeded to the clemency of the Tertiary Epoch.

This new period in the history of Samland began with the depression of the continent of Northern Europe. This region, which had endured since the oldest period of the earth's formation, was depressed first of all in the north-east, then in the south; and the Polar sea was enlarged as gradually, the valleys and deeper portions of the land being overflowed towards the south. The climate and all the conditions of the country were thus completely changed. The mountains projecting out of the sea were covered with glaciers, which extended down to the water. Icebergs and ice-flakes laden with the *débris* of rocks and with blocks of stone were detached from these glaciers and drifted towards the south; here they stranded upon the overflowed land, which was formed of Silurian and Cretaceous strata. The latter, with its many soft and marly beds, offered the least resistance to the water and the ice, and was therefore the most deeply eroded and destroyed. The clayey material, being more easily suspended in the water, was carried away by the sea and deposited as mud. The harder portions were mixed with the crushed components of the northern rocks, and were also widely distributed as sand by the water and the ice.

Without doubt there remained also at this period considerable deposits of Amber upon the Greensand beds of the Cretaceous formation, where the remains of the old forest soils existed, or the marshes and lakes which long ago had dried up or been filled with earth. With the soil, these also were now broken up, and with them the Amber was scattered in every direction. It can thus be explained why Amber-nests are found in the Diluvial deposits over all the German Plain, and why Amber also occurs in many other countries in Northern Europe, for instance, in Sweden, on the coast of the North Sea, &c. After the partial destruction of the Cretaceous beds, however, the Tertiary formation of Samland was laid bare to the fury of the waves and the pressure of the icebergs; it was destroyed in many places, and at last overflowed and covered with mud and sand.

The high coast of Samland presents an excellent opportunity for observing the nature and mode of the erosion of the Tertiary rocks by the Diluvial sea; and even the small coast-section (Fig. II.) enables us to perceive how here and there the upper beds only have been denuded, while at other places all the strata have been eroded down to the present sea-level, and even deeper. The narrow limits which have been assigned to this article, render it impossible for me to discuss very closely these relations, and I must therefore confine myself to the following remarks.

Of the deposits which were thrown down by the Diluvial sea, two divisions, having clear boundary lines, are usually distinguished, namely, the Older Diluvium and the Newer. The Older Diluvium (Figs. III., IV., α to δ) is deposited on the Tertiary strata to the thickness of from 10 to 40 feet; but where the latter have been denuded down to the sea-level, it may be seen reaching a height of 150 feet. Marl (which was deposited by the sea as mud), sand, large pebbles, and boulders are the principal components of the Older Diluvium. The sand, which has numerous varieties, distinguishable partly by colour and partly by the size of the grains, is characterized throughout Samland by always being rich in Glauconite, which was no doubt derived from the Greensand beds of the Cretaceous formation. The Newer Diluvium (Figs. III., IV., ε) consists of yellow sand and yellow loam; it is but slightly developed in north-western Samland, and forms a covering of from 5 to 20 feet in thickness, spread regularly over all older deposits.

The destruction of the Tertiary strata had commenced before they were overflowed, no doubt by means of the masses of ice which were driven against the deeper beds. On thawing, the ice deposited the débris and stones with which it was laden. This explains the great gravel-bed which often lies imbedded in marl, near the remains of the Tertiary strata (as in Fig. IV., near A and E α). Often, however, surrounded by Diluvial masses, occur large blocks derived from the uppermost beds of the Browncoal-formation; they fell down by the destruction of the middle beds, and remain lying in the mud. Thus were large blocks of the older rocks washed away. In Fig. II. we see such removals, both in the east near Neukuhren and Wangen, as also westward near Georgswalde and Warnicken,—isolated remnants of the older beds being still seen projecting from their foundations. In Fig. IV., also, is exhibited on a larger scale the last-named coast district, where near A is seen one such remnant, and near E the step-like fractured margin of the Tertiary beds. These denudations, however, were also sometimes accompanied by dislocations, which were caused by the pressure of the masses of mud and sand which were thrown on the older beds. One such dislocation is shown in Fig. II. in the district of Rauschen; and near Rosenort on the west coast we have the remarkable case of the older Glauconitic beds being upheaved, and not only covered by Diluvial masses, but having also the same beneath them,—where they appear to have been thrust by lateral pressure.

In the deeper erosions occur marl and sand, not in a regular succession of beds, but thrust without order into each other, or heaped up against one another. Such a mode of arrangement cannot be explained in deposits from water; but they may nevertheless have arisen in two ways. At one time the ice-islands of the diluvial sea abundantly destroyed again the deposits which they had themselves formed, and the gaps which thus arose were filled up with other material. Still more generally it happened that the half-floating mud was forced upwards, by the weight of the sand which was heaped up on it, to such points where this pressure was accidentally slighter; by these means the mud penetrated into the overlying sand, as may be seen in Fig. IV. near B; or the sand beds were heaved up and thus fractured, as the sand beds D have been heaved up through the marl. All these changes took place slowly and in slightly agitated water. The proof of that is found in the circumstance that the broken and transported masses of the older beds are often found very near the places where they were detached; and great deposits of Tertiary sand are found with the ordinary Diluvial sand in the Diluvium, having been derived from the denuded portions of the Browncoal-formation.

After the deposition of the Older Diluvium the land was raised up above the water, and lay dry for a long time. At that time, probably, numerous hills were formed as Dunes, for they can be proved in some cases; and thus by means of wind and water the land probably obtained its present features; but it was once more overflowed. The depression this time seems to have progressed faster and to a greater depth than before, so that the ice-islands drifting towards the south but slightly eroded the surface; and, on their melting, only the blocks which they had transported were deposited; and these are imbedded abundantly in the associated sand and loam.

After this the land once again emerged out of the water; and thus it is that through alternate upheavals and depressions it has gradually risen to the height which it now possesses; but the waves of the sea still continue the work of destruction which they commenced thousands of years ago, and yearly lessen the area of the country. If, however, other countries can only complain of the damage which the sea has inflicted on their coasts, it here amply repairs the loss it has caused. When lashed by storms, it tears up the Amber out of the deep-lying beds of Amber-earth; by the help of sea-weeds torn up at the same time from the bed of the sea the Amber is heaved upwards, and carried on the surface of the water; and when the storm abates and the sea becomes calm, it carries the Amber, together with pieces of older Browncoal and fresh marine plants, on to the beach, where a hundred hands are waiting to intercept it with nets. That is the "Amber-drawing," a trying occupation, which demands a strong and hardy frame, for the cold winter storms yield the richest booty. But many pieces of Amber, nevertheless, do not reach the shore, for the largest and heaviest pieces have already sunk to the bottom, and lie between the large boulders which cover the sea-bed. Therefore, in calm weather and with clear water, the inhabitants of the coast go in boats, and turning the stones with hooks fastened on long poles, endeavour to discover the Amber in the interspaces, and to draw it up with small nets. This is called "Striking for Amber."* For a long time people were contented with what Amber they could recover by these means from the sea; and these modes of acquisition still furnish the greatest quantity of the Amber which is obtained from Samland for commerce. For the last ten years, however, on all points of the coast where the Amber-earth does not lie too deep beneath the sea-level, endeavours have been made to lay it bare and to obtain the Amber immediately from it. The circumstance that it is overlain by a bed of very loose sand, which contains a large quantity of water, has hitherto impeded the attempts to open out the Amber-earth by subterranean mining-works. And to make this possible,

* "Bernstein stechen."

and therefore to render accessible the stores of Amber which lie hidden in the interior of the country, will be the next progress in the acquisition of these, in so many respects, remarkable fossils.

For the benefit of such students as desire to inform themselves more fully concerning the natural history of Amber, we append a list of the principal books and papers which have at various times been published on the subject; and we also venture to illustrate the paper of our contributor with a plate, which will convey some idea of the organic remains usually found in this fossil resin. For the accuracy of the list of works, therefore, as well as for the second plate, the Editors of this Journal are responsible. The specimens figured in that plate belong to the National Collection in the British Museum; and for the facts relating to the Insects embodied in the annexed explanation of it, we are indebted to the kind and able assistance of Mr. Frederick Smith, of the Entomological Department of that Museum.—Editors.

EXPLANATION OF THE QUARTO PLATE.

Fig. I. shows the north-western part of the coast of Samland.

Fig. II is a section of the same line of coast.

In both figures the tinted portions distinguish those places where the Tertiary beds crop out above the sea-level The white portions are those where Quaternary or Postpliocene deposits only are visible. The principal divisions of the Tertiary rocks are distinguished by different lines. *A* signifies the deposit of the "Glauconitic Sand"; *B* 1 the Lower Stage, *B* 2 the Middle Stage, and *B* 3 the Upper Stage, of the Browncoal-formation. The boundaries of the Synclinal Trough, which the Second Stage fills up, are shown by dotted lines.

Fig. III. exhibits vertical sections on a larger scale through three points on the north coast and three on the west. Here *A* distinguishes the deposit of the "Glauconitic Sand"; *a*, the "Amber-earth"; *b*, the associated "Quicksand"; *c*, the "Green Sand"; *d*, the so-called "White Wall"; *e*, the "Green Wall." *B* is the true Brown-coal formation; also 1, the "Quartz-sand"; 2, the intercalated clay-beds, which are represented on the west coast by three members, 2′, 2″, 2‴; 3, the Middle Clay-bed; 4, the "Striped Sand"; 5, the Lower Brown-coal; 6, the Upper Clay-bed; 7, "Micaceous Sand"; 8, "Coal Sand"; and 9, the Upper Brown-coal. *C*, Diluvial deposits:—*α*, coarse sand, gravel, and large boulders; *β*, Marl; *γ*, ordinary sand; *δ*, redeposited Tertiary sand;—all these (*α* to *δ*) belong to the Older Diluvium; *ε* is the Younger Diluvium.

Fig. IV. shows on a much larger scale than Fig. II. a small part of the coast near Warnicken, where the Tertiary beds are in great part denuded and replaced by Diluvium, exhibiting also the position of the Diluvial masses. The letters and numbers upon it have the same signification as in Fig. III.

EXPLANATION OF THE PLATE OF ORGANIC REMAINS FOUND IN AMBER.

Fig. 1.—A Dipterous Insect belonging to the European genus *Leptis*. Three times the Natural Size.

Fig. 2.—A Dipterous Insect belonging to the European genus *Echinomyia*. Enlarged one-half.

Fig. 3.—A species of the Blind Travelling Ants (*Formicidæ*) of Africa, being either *Anomma rubella* or a closely-allied species. Twice the Natural Size.

Fig. 4.—A species of the spined *Formicidæ* belonging to the South American and African genus *Polyrhachis.* Twice the Natural Size.

Fig. 5.—A Dipterous Insect belonging to a new genus of *Muscidæ,* allied to the European genus *Tachinus.* Twice the Natural Size.

Fig. 6.—A Clicking Beetle belonging to the European genus *Cardiophorus.* Twice the Natural Size.

Fig. 7.—A species of Heteromerous Beetle belonging to the family *Cistelidæ,* and allied to the genus *Statira,* in which, as in the fossil, the eyes coalesce. Three times the Natural Size.

Fig. 8.—A species of the tropical family of Beetles, termed *Eumolpidæ,* and probably belonging to the genus *Calasposoma.* Twice the Natural Size.

Fig. 9.—A species of *Termes* (White Ants). Twice the Natural Size.

Fig. 10.—Front view of a Spider belonging to the family *Attidæ.* Magnified four diameters.

Fig. 11.—An oblique Dicotyledonous Leaf. Natural Size.

In the above Explanation, the term "European genus" is not used as signifying that the genus is now *confined* to Europe, but only to show that it is still represented on the Continent.

LIST OF THE PRINCIPAL WORKS ON AMBER AND THE ORGANIC REMAINS PRESERVED IN IT.

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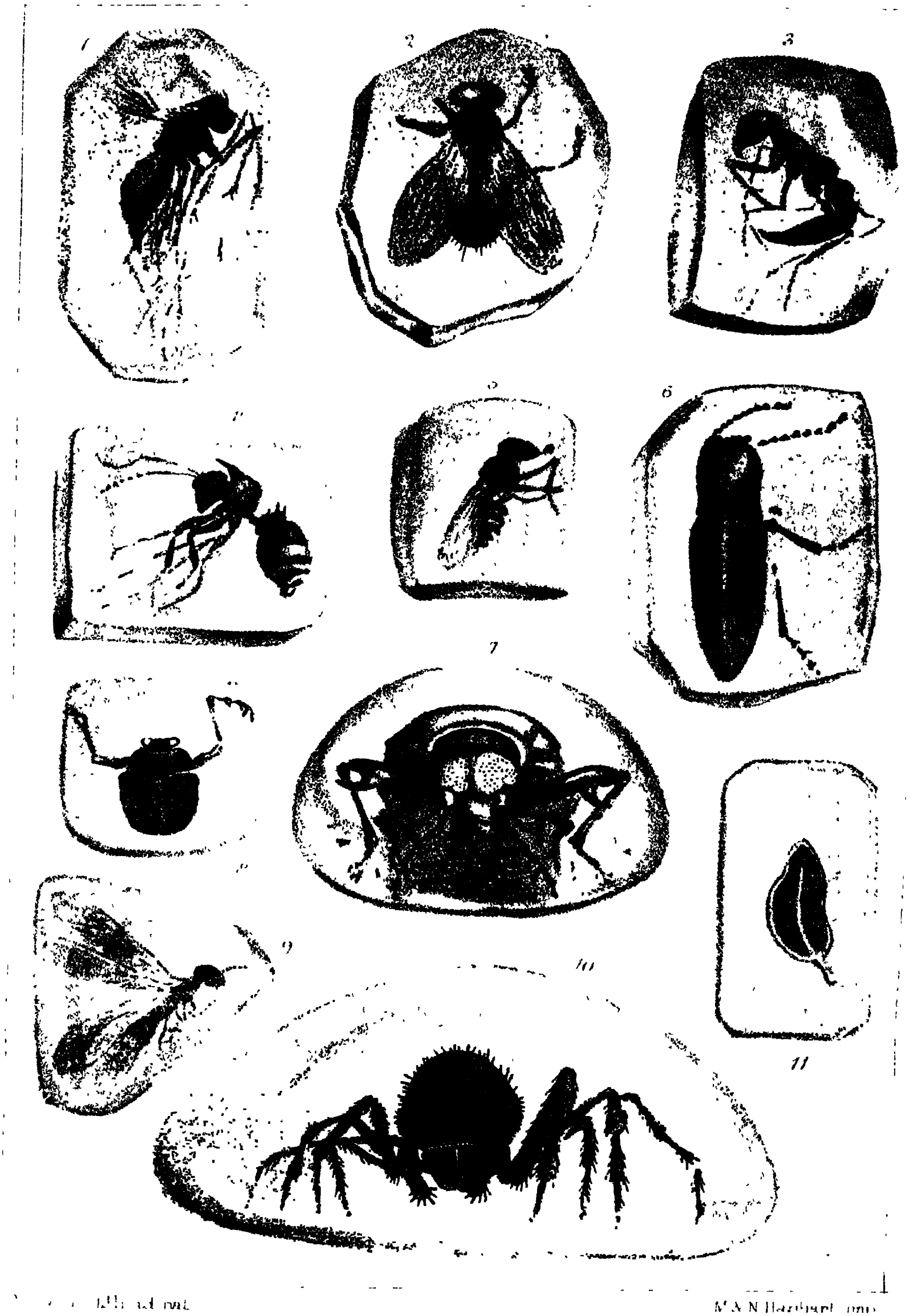

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V. SIR JOHN HERSCHEL AND MODERN ASTRONOMY.

Astronomy is remarkable, as the solitary example of a science, for which exactness has been secured by the elucidation of the laws regulating a power which is associated with every form of matter. The laws ruling the influences of that power or principle, as exerted through space, have been developed with a clearness which removes every shadow of doubt.

When Newton determined by the most careful examination of facts, and by the penetrating power of his mental analysis, that every body circulating in space, was compelled to move in obedience to the force of Gravitation, acting according to the law of the inverse square, he furnished the key by which all astronomical problems connected with "the stars in their courses" could be solved.—The stone flung into the air by the playing child—the ball projected at high velocity from a piece of artillery—the planet rolling with majestic regularity across the celestial vault—the twin and triple stars circulating mysteriously about each other in the remoteness of the heavens—the yet inscrutable nebulæ—and the space-exploring comets,—are, each and all, equally bound to move in obedience to a force, of which we know only the *law* of action. But the knowledge of this law has placed a wand in the grasp of the astronomer, by which he feels out worlds, ere yet they are visible to human sense.

Every reflecting mind will naturally inquire, What is this all-pervading power which we call Gravitation, binding the Moon to the Earth, the Planets to the Sun, and the Solar System itself, to some immeasurably-distant star; which, though it be the centre of motion to our small group of planets, may be itself but the satellite of some yet grander luminary—distributing its energies from depths of space to which no telescope has ever penetrated? And such a mind—while impressed with the immensity of power displayed—will ever feel its littleness when compelled to own, that of the cause of that power it is deeply ignorant.

"The law of Gravitation," says Sir John Herschel, "the most universal truth at which human reason has yet arrived—expresses not merely the general fact of the mutual attraction of all matter; not merely the vague statement that its influence decreases as the distance increases, but the exact numerical rate at which that decrease takes place; so that when its amount is known at any one distance, it may be calculated exactly for any other."*

* 'A Preliminary Discourse on the Study of Natural Philosophy.'

Yet, the author of that paragraph was heard by the writer of this article to declare, on this point, the weakness of his knowledge —and, at the same time, with something like prophetic inspiration, to express a feeling, amounting to conviction, that Gravitation was the effect of vastly superior causes, ascending in grandeur of action, one above the other, until we reach the Great First Cause of All.

May it not be, that while we are groping our way amongst the interstices of matter, and learning a little of "molecular forces,"—to which we h ve given many names—we are slowly obtaining dim glimpses of modified forms of this force, at once so powerful and universal in heavenly space, and so subtle when confined in the labyrinths of earthly matter? However this may be, all "celestial weighings and measurings" (as Sir John Herschel phrased it, in one of those popular articles which he can write so well) are carried out entirely by our knowledge of the law of Gravitation, and thus is Astronomy made an exact science.

As we improve our instruments we shall see yet deeper into the heavens, and by long-continued and well-directed observations, we shall make new discoveries among the stars, and learn yet more of the arcana of space. But these discoveries, though they will enlarge our knowledge, will not disturb that which we know; and of no other science than Astronomy can this be said.

If we intended a review of modern Astronomy, it would be necessary to notice the labours of many men who have, in this country, in Europe, and in America, by their powers of observation, their unwearying industry, and their skilful analysis, largely increased the sum of human knowledge. Between the time when William Herschel discovered Uranus, and Adams pointed to the spot where a planet must exist, and where Neptune was found, many eminent men have yoked their names with astronomical researches of the highest value. Of none of these is it our purpose to speak; our only intention is to set forth, in brief, the labours of one man who has proved that he combines in his own person the assiduous astronomical observer, the acute mathematician, the deep-thinking philosopher, and the graceful poet,—that man being Sir John Herschel. It is not to many men that intellectual powers of so high an order have been given—it is not in many men that we find such perfect balancing of those varied powers—it is in few men that we discover such profound humility, and such a deep sense of reverence for the Creator of those works, the study of which has been a life-labour of love. When we have examples before us of superior intellects wandering away into error, deluded by the meteor-gleam of their own great, but irregularly-trained, and therefore, now uncontrolled, powers, it is of the utmost importance that the example of the brighter star, moving in brilliancy around the Centre of all good, should be contrasted with their meteor-flights—"a moment bright, then gone for ever."

Sir John Frederick William Herschel, Bart., was born in 1790 at Slough, near Windsor. He is the only son of Sir Frederick William Herschel, whose name is for ever associated with astronomical discovery. From the father the son derived his passion for the study of the stars,—and it may be incidentally noted here that in this family we have the rare example of the father, the son, and the grandson (Alexander Herschel) pursuing with great success the study of the exactest of the sciences. There is a pleasure and a purpose in tracing the progress of an individual mind, especially when that mind has made itself a place in the history of science. We have not the information necessary for treating inductively our examination of the development of the mental powers of the young John Herschel. We have heard numerous anecdotes of an absent, a retiring, a star-gazing boy, but, although there may be traces of truth in some of these, we believe they generally resolve themselves into the every-day expression of those who do not understand the condition of a meditative youth, loving solitude, because in solitude alone could he hold communion with nature's works and view her charms unrolled. John Herschel was a student of St. John's College, Cambridge, where he achieved the honourable position of Senior Wrangler, and became Smith's Prizeman in 1813. He appears from this time to have devoted himself seriously to those pursuits with which his father's name was already associated.

In 1816 we find him giving a large amount of time to observations on the multiple stars; these observations were continued, sometimes alone, and sometimes in conjunction with Sir James South, until, as the result of ten thousand observations, we find in the 'Philosophical Transactions for 1825' "a series of micrometric measures of 380 double stars, executed in conjunction with Sir J. South in 1821–2–3."

Previously to this we have the subject of this notice producing, with Dr. Peacock, the well-known Dean of Ely, a reconstruction of Lacroix's treatise 'On the Differential Calculus,' and he was at the same time a zealous student of chemistry and of the physical sciences. The 'Philosophical Transactions for 1826' contain an important paper, entitled "An account of a Series of Observations made in the Summer of 1825, for the purpose of determining the difference of the Meridians of the Royal Observatories of Greenwich and Paris." For several years, especially in 1825, 6, and 7, Mr. Herschel was occupied at Slough with the 20-feet reflector making observations on the multiple stars. The labour of these investigations may be judged of by the titles of the several series which were published in the 'Memoirs of the Astronomical Society,' and which we copy so far as to show the work performed :—

Series 1, including	381 new double stars.
„ 2, „	295 more new double stars.
„ 3, „	384 more new double stars.
„ 4, „	1,236 double stars, the greater part not previously described.

These observations were continued with the most untiring industry, and in 1832, Mr Herschel published, as a fifth series, a catalogue of 2,007 double stars, of which 1,304 were new, and a sixth series was produced in the following year. In the 'Philosophical Transactions for 1833' there is a valuable communication, "Observations of Nebulæ and Clusters of Stars," with a 20-foot reflector. In this memoir we have a most careful examination of all the conditions observed in star-clusters and nebulous masses. Some two thousand of these mysterious classes of bodies were examined, and their physical construction, as far as possible, is described. The result of all this labour may be examined with much advantage in the 'Outlines of Astronomy.' In the paragraphs of that work which are devoted to this subject, the speculations of Sir William Herschel are cautiously reviewed. The "*nebular hypothesis*," as it has been termed, supposes the existence of an elementary form of luminous siderial matter, and its gradual subsidence and condensation by the effect of its own gravity, into more or less regular spherical or spheroidal forms. "Assuming that in the progress of this subsidence local centres of condensation, subordinate to the general tendency would not be wanting, he (Sir W. Herschel) conceived that in this way solid nuclei might arise, whose local gravitation still further condensing, and so absorbing the nebulous matter, each in its immediate neighbourhood, might ultimately become stars, and the whole nebulæ finally take on the state of a cluster of stars." Sir John Herschel's leaning towards this view will be evident from the following remarks:—"Among the multitude of nebulæ revealed by Sir W. Herschel's telescopes, every stage of this process might be considered as displayed to our eyes, and in every modification of form to which the general principle might be conceived to apply. The more or less advanced state of a nebula, towards its segregation into discrete stars, and of those stars themselves towards a denser state of segregation round a central nucleus, would thus be, in some sort, an indication of age. Neither is there any variety of aspect which nebulæ offer which stands at all in contradiction to this view."*

Another contribution to astronomical science was his 'Observations on the Satellites of Uranus,' published by the Astronomical Society; and this was followed by two series of micrometrical measurements of double stars, made at Slough with a seven-foot Equatorial.

* 'Outlines of Astronomy,' pp. 598, 599.

Whilst this indefatigable astronomer was thus busy with the most distant stars, and examining with philosophic acumen those conditions of matter which appear to indicate something which may well be taken for world-formation, he found time not merely to study several branches of physical science, but to write treatises, which are, even now, referred to as authorities upon every point of importance treated in them. The treatises on Sound, and on Light, published in the 'Encyclopædia Metropolitana,' are striking examples of that exactness which should ever belong to inductive science—of clear deductions, ever displaying the powers of the most philosophic mind, and a perspicuity of style which other writers on science would have been wise to imitate. These labours may not be regarded as belonging to astronomical science; but the theory by which the phenomena of light is explained, based as it is, by analogy, on the laws of sound, is intimately connected with the perfect understanding of the instruments employed in celestial surveys. Incidentally, too, we must notice in passing the 'Preliminary Discourse on the Study of Natural Philosophy,' which formed a volume of 'Lardner's Encyclopædia,' as a work singularly fitted to prepare the student for his labours. We cannot refrain from making one quotation from this charming little volume, to the study of which we have returned with advantage again and again. Discussing the question of the benefits to be derived from the pursuits of science which Sir John Herschel contends has peculiar tendencies to improve and purify the mind, he concludes :—"There is something in the contemplation of general laws which powerfully persuades us to merge individual feeling, and to commit ourselves unreservedly to their disposal; while the observation of the calm, energetic regularity of Nature, the immense scale of her operations, and the certainty with which her ends are attained, tends irresistibly to tranquillize and reassure the mind and render it less accessible to repining, selfish, and turbulent emotions. And this it does, not by debasing our nature into weak compliances and abject submission to circumstances, but by filling us, as from an inward spring, with a sense of nobleness and power which enables us to rise superior to them, by showing us our strength and innate dignity, and by calling upon us for the exercise of those powers and faculties by which we are susceptible of the comprehension of so much greatness, and which form, as it were, a link between ourselves and the best and noblest benefactors of our species, with whom we hold communion in thoughts, and participate in discoveries which have raised them above their fellow mortals and brought them nearer to their Creator."*

An article from the same pen on Physical Astronomy appeared

* 'Discourse on the Study of Natural Philosophy,' pp. 16, 17.

in 1823 in the 'Encyclopædia Metropolitana.' In 1832, 'A Treatise on Astronomy' was published as one of the volumes of the 'Cabinet Cyclopædia,' which was subsequently enlarged into the 'Outlines of Astronomy,' of which work the eighth edition was published in 1867. The extensive popularity of this treatise will be judged of from the fact of its having been translated into Russian, Chinese, and Arabic. In 1831 this eminent astronomer was created a Knight of the Royal Hanoverian Guelphic Order (K.H.), and he became a baronet in 1838. In the interval Sir John Herschel visited the Cape of Good Hope for the purpose of carrying out a similar system of celestial observations to those pursued at home. It has been often stated that this expedition was undertaken at the cost of the Government: this was not the case. A passage in a king's ship was offered to Sir John Herschel, but he declined to avail himself even of this, and the whole cost of the voyage and the expenses consequent on the removal of all his instruments were defrayed by himself. Four years were spent at Feldhuysen near the Cape of Good Hope. His labours in the Southern Hemisphere were published under the title of 'Results of Observations made during the years 1834–8, at the Cape of Good Hope,' completing the Telescopic Survey of the visible Heavens, commenced at Slough in 1825. This work was published at the expense of His Grace the Duke of Northumberland. The great object of Sir John Herschel was to discover whether the distribution of the stars in the Southern Hemisphere corresponded with the results of Sir William Herschel's similar labours, prosecuted mainly on the opposite side of the Galactic circle. In order that the observations made at the Cape might admit of comparison with those made at Slough, they were made with a telescope of the same optical power and according to the same method. These observations embraced a region of the celestial sphere, extending from the south pole of the Milky Way to a distance of 150° measured upon a great circle passing through it. The whole number of stars counted in the telescope amounted to 68,948, which were included within 2,299 fields of view. It appeared from these observations that the Southern Hemisphere is somewhat richer in stars than the Northern, and this is thought to indicate that the solar system is not situate exactly in the plane of the Galactic circle, but is displaced a little towards the North. M. Struve * remarks that the apparent position of the Milky Way presents an interesting accordance with this conclusion, for it has been found that its mean course does not coincide exactly with the great circle of a sphere, but with a parallel distant about 92° from the Galactic North Pole. By a computation, based on the star gauges in both hemispheres relative to the Milky Way, Sir John

* 'Etudes d'Astronomie Stellaire.'

Herschel found the stars visible in a reflecting telescope of eighteen inches aperture to amount to 5,331,572. He concludes, however, that the number really visible in the telescope is much greater than this, as in many parts of the Milky Way the stars appear so crowded as to defy counting.

Not only were all the observations, during his sojourn at the Cape, made by Sir John Herschel himself, but all the reductions of every sort which are found in the published volume were executed by himself. While at the Cape, Sir John Herschel observed, with his usual care, all the phases of Halley's comet, and noticed,—what had indeed been previously observed with regard to comets,—an enlargement of volume taking place simultaneously with the recess of the comet from the sun. During the interval between the 25th January, 1836, and the 1st of the following February, the volume of the comet was found by him to have increased in the proportion of 1 to 41·605. Sir John Herschel argues, that as the comet approaches the perihelion, the action of the solar heat will be constantly transforming the nebulous matter of which it is composed into the condition of a transparent invisible gas; and as this process necessarily commences at the exterior of the nebulosity, where the solar rays impinge, the immediate consequence will be a diminution of the volume of the comet. After the passage of the perihelion, the radiation of heat from the surface of the more condensed portion of the comet will not be sufficiently compensated by the solar heat, and the diminution of temperature hence arising, will occasion a precipitation on the surface of the nebulous matter suspended in a gaseous state in the atmosphere of the comet. This precipitation of nebulous matter will continue to go on, under the influence of the cooling process occasioned by the increasing distance of the comet from the sun, and the manifest result will be the rapid enlargement of the visible dimensions of the comet. According to the laws of equilibrium the lighter particles of the precipitated vapour will arrange themselves so as to form the superior stratum of the enveloping nebulosity of the comet. It is evident also that as this bounding stratum continues to diminish in density, it will attain a higher and higher elevation, while at the same time its increased tenuity will cause it to assume a more and more filmy aspect.*

It has been argued, from the slight retardation observed in Encke's comet, and from other phenomena connected with comets, that evidence has been obtained of the existence of an all-pervading "ether." While on the subject of comets, it will be advantageous —especially as showing the kind of reasoning which Sir John Hershel brings to bear on hypotheses of this class—to quote a

* 'Memoirs of the Astronomical Society,' vol. vi., p. 99.

few sentences from one of his popular Essays; he is writing of Donati's comet:—"It was not till the 14th August, or seventy-three days after its first discovery, that it began to throw out a tail, and to become a conspicuous object. Very soon after this, its first appearance, *a slight but perceptible curvature* was perceived in the tail, which on the 16th September had become unmistakable, and continued to increase in amount as the latter extended in apparent dimensions, till it assumed at length that superb aigrette-like form, like a tall plume wafted by the breeze, which has never probably formed so conspicuous a feature in any previous comet. To a certain extent, it is a common enough feature in the tails of comets, and is usually regarded as conveying the idea of their moving in a resisting medium, in a space, that is to say, not quite empty, as smoke is left behind a moving torch. But this is a very gross and inadequate conception of the peculiarity in question. The resistance of the 'ether,' such as the phenomena of Encke's comet, already noticed, may be supposed to indicate, is far too infinitesimally small to be competent to produce any perceptible deviation from straightness. Nor is it at all necessary to resort to any such explanation of the fact. Such an appearance would naturally arise from a combination of the motion the matter of the tail had (in participation with that of the nucleus) with the impulse given it by the sun, each particle of it describing—from the moment of quitting the head, an orbit quite different from that of the latter, being under the influence of a *repulsive force* directed *from* the sun—a curve of the form, called by geometers an hyperbola, nearly approaching to a straight line, and having its convexity turned towards the sun."

From time to time we hear of evidences of this repulsive force, existing as a power belonging to masses of matter. This must not be confounded with the repellant power manifested by an electrically excited body, or by that seen in the repulsion of the similar poles of magnetic bodies. With humility we venture to inquire, is not this repulsive force of the sun as pure an hypothesis as the resisting ether of stellar space?

In the 'Geological Transactions for 1832' there appeared a paper by Sir John Herschel "On Astronomical Causes which may influence Geological Phenomena."

The subject of this memoir is an example of much originality of thought.

With regard to the operation of astronomical causes upon climate, especially as elucidating former varieties of climate in geological history, Sir John Herschel refers to the influences of the sun and moon. The moon's mean distance is now on the decrease; also, the eccentricity of the lunar orbit is subject to fluctuations; both these causes would produce differences in the tides. If the mean distance of the moon were diminished by only one-tenth of its actual amount, the mean rise and fall of the tides would be increased by a full third of their present quantity, which would, of course, produce a great increase in their erosive action on the continents, as well as in the transporting powers of the waters of the ocean over the materials of the land. He shows, too, how the secular variation of the eccentricity of earth's orbit may have produced both warmer and colder periods than the present. This idea, after lying dormant for thirty years, has recently been revived and extended by Mr. Croll, in several papers written on this subject, which is now materially affecting the reasoning of geologists regarding the history of ancient formations and the measure of geological time.

It is not possible within the limits placed at our disposal to mention several papers of great value which have from time to time appeared in the 'Memoirs of the Astronomical Society,' 'The Transactions of the Royal Society,' and in journals devoted to scientific literature. Amongst the more remarkable of those contributions, to our knowledge may be mentioned a paper investigating orbits of double stars; and another, "Determination of the most probable Orbit of a Binary Star," which were published by the Astronomical Society. "A notice of an error of two days, left uncorrected in the Gregorian reformation of the calendar," appeared in the 'Athenæum.' A paper "On a new Projection of the Sphere" was read by Sir John Herschel before the Royal Geographical Society in 1859. The principle of this projection was included in some of Gauss's general formulæ, but this was unknown to Herschel, and it had never before been reduced to a chart. The article "Telescope" in the 'Encyclopædia Britannica' was from Sir John Herschel's pen. (This is the only place in which will be found an account of the method of polishing specula, adopted by Sir William Herschel.) A Catalogue of Nebulæ and Stars, 5,078 in number, in order of right ascension, brought up to 1860, with precession for 1880, and descriptions, was prepared for the Royal Society in 1863. 'The Quarterly Journal of Science' in 1864 has a paper "On the Solar Spots" from the pen of this astronomer, in which he considers the speculation on the gradual variation of density in the solar atmosphere "an aggregation of the luminous matter in masses of some considerable size, and some certain degree of consistency, suspended or floating *at a level determined by their specific gravity* in a non-luminous fluid—be it gas, vapour, liquid, or that intermediate state of gradual transition from liquid to vapour which the experiments of Caignard de la Tour have placed visibly before us." To this article we refer our readers for an examination of this original idea.

Sir John Herschel in 1839 received from Oxford an honorary D.C.L.; in 1842, he was elected Lord Rector of Mareschal College, Aberdeen; in 1845, Sir John was President of the British Association; in 1848, he became again President of the Astronomical Society, having filled that honourable office in the years 1828 and 29, 1840 and 41. In December, 1850, he was appointed Master of the Mint, which office he resigned in 1855.

The influence of the Herschels on modern astronomy has been considerable. Added to great mechanical skill, remarkable powers of observation, and unwearying industry, we find in them high philosophic powers. As they pursued their inductive researches, they were ever producing, as efforts of pure deduction, thoughts which advanced the science to which they were devoted. This has been most especially the case with Sir John Herschel. If any one doubts this, let him read his 'Preliminary Discourse on the Study of Natural Philosophy' or his 'Essays,'* containing his admirable addresses to the Astronomical Society.

While devoting the powers of his mind so zealously to astronomy, it must not be forgotten that Sir John Herschel found time for the most careful examination of several other branches of science. The chemical action of the sun's rays on both inorganic and organic matter forms the subjects of two memoirs printed in the 'Transactions' of the Royal Society, which are full of the most suggestive experiments and thoughts. By those researches he greatly advanced the art of photography, and led onward by his investigations to the production of those exquisitely sensitive tablets, by means of which the luminous elevations which appear on the edge of the solar disc during a total eclipse have been faithfully copied and preserved, and the moon has been mapped by a most unerring pencil, the rays reflected from her own mountains and valleys. Nor must it be forgotten that in 1819 Mr. Herschel communicated three papers to the 'Edinburgh Philosophical Journal' on the Hyposulphites. He then explained the peculiar action of the hyposulphites on chloride of silver, which placed, after long years, in the hands of the photographer the only agent, hyposulphite of soda, which can be employed efficiently to give permanence to his pictures. Without this agent the photographs of the solar clouds and the lunar mountains would be as transient as the rays by which they were at first delineated.

Sir John Herschel has ever maintained the serene dignity of a true philosopher; and his utterances of truths, which have inspired him with their divinity, have ever been received with delight by those who have listened to his subdued but impressive eloquence. How soul-elevating are the concluding passages of his address to the members of the British Association in 1845, with which we must close our notice of his labours:—

* 'Essays from the Edinburgh and Quarterly Reviews, with Addresses and other Pieces.' Longmans & Co. 1857.

"That astronomers should congregate to talk of stars and planets, chemists, of atoms; geologists, of strata, is natural enough; but what is there of *equal* mutual interest, *equally* connected with and *equally* pervading all they are engaged upon, which causes their hearts to burn within them for mutual communication and unbosoming? Surely, were each of us to give utterance to all he feels, we would hear the chemist, the astronomer, the physiologist, the electrician, the botanist, the geologist, all with one accord, and each in the language of his own science, declaring not only the wonderful works of God disclosed by it, but the delight which their disclosure affords him, and the privilege he feels it to be to have aided in it. This is indeed a magnificent induction, a consilience there is no refuting. It leads us to look onward, through the long vista of time, with chastened but confident assurance that science has still other and nobler work to do than any she has yet attempted; work which, before she is prepared to attempt, the minds of men must be prepared to *receive* the attempt—prepared, I mean, *by an entire conviction of the wisdom of her views, the purity of her objects, and the faithfulness of her disciples.*"

VI. SILURIA.*

Geology still advances with the rapidity which always characterized the science; and it needs considerable industry to keep oneself *au courant* with its progress. Sir Roderick Murchison, however, even in his old age, not only accomplishes this task, but still assists in no small degree to smooth the path and to hasten the march. More than this, he is ever foremost in the recognition of the improvements which the allied sciences constantly enable the geologist to make; and if he does not always join the ranks of the newer school of geologists in more doubtful and theoretical questions, who shall say that his opposition does not benefit the science by preserving his younger brethren from rushing into those speculative excesses which have too often proved so detrimental to the attainment of a true philosophy.

The most noticeable change in the present edition of 'Siluria' is the immense importance acquired of late years by the old gneissic rocks, described in the previous edition as the "Fundamental Gneiss" of Sutherland and Ross, which was there treated of as the

* 'Siluria: A History of the Oldest Rocks in the British Isles and other Countries; with Sketches of the Origin and Distribution of native Gold, the general Succession of Geological Formations, and Changes of the Earth's Surface.' By Sir Roderick Impey Murchison, Bart., K.C.B., D.C.L., LL.D., F.R.S., &c. Fourth Edition (including the Silurian System). London: John Murray, 1867.

oldest of the British stratified deposits; the reality of this, the latest of Sir Roderick's discoveries, being then still *sub judice*. In this edition we find a record of the correlation of this Fundamental Gneiss with the Eozoon containing Laurentian rocks of Canada, discovered by Sir William Logan, and about which, as the sepulchre of the most ancient of all known fossils, we have lately heard so much.

It speaks well for the breadth and catholicity of Sir Roderick's mind that he should have been able at once to acknowledge the reality of this discovery, and to grasp its important bearing on the geology of our own islands. He was also the first to recognize the high probability of his "Fundamental Gneiss" being of the same age as the Laurentian rocks, and to abandon the name he had himself given to the Scotch series, adopting that applied by Sir William Logan to the far more extensive development of them in Canada. Were anything still wanting to show the nature of our author's exalted opinion of Sir William Logan's discovery, it would be found in the graceful dedication of this edition to the eminent Canadian geologist.

Another most important alteration has been made by the author with reference to the reptiliferous sandstones of Elgin and Ross-shire. The strata conformably overlie and apparently pass into deposits undoubtedly belonging to the Old Red Sandstone; but they long ago yielded remains of reptiles allied to those found in Triassic rocks of other localities. Sir Roderick Murchison, reasoning upon the stratigraphical evidence, had hitherto classified these upper sandstones with the Old Red deposits, while palæontologists considered that if reptiles of Triassic affinities existed in the Devonian or Old Red period "'twas passing strange." Fortunately, however, a specimen from the undoubted Triassic deposits of Warwickshire has lately been identified by Professor Huxley with the *Hyperodapedon*,—a reptile which had previously been obtained from the sandstones of Elgin,—and thus this vexed question has been decided in favour of Palæontology, and Sir Roderick Murchison has yielded to the stubborn fact, and excluded the portion of his former editions which treated of these strata as belonging to the Old Red Sandstone.

Our knowledge of the geology of other portions of Great Britain is also more complete than at the date of the publication of the last edition; and Sir Roderick has taken especial care to bring his work up to the present state of the science, so far, at least, as he can admit the views of other investigators. He has personally been concerned with Professor Harkness in the determination of the Permian age of large tracts in Westmoreland, which had previously been mapped as Triassic; and Mr. Geikie has shown that the red sandstones overlying the Ayrshire coal-measures are of the same age. These facts have an important bearing on the question of our future coal-supply, and are, therefore, more especially worthy of record.

More than twenty years ago Sir Roderick Murchison made a great stride in advance of other geologists by showing that in certain cases the mineral riches of distant lands may be predicted by means of geological data. In the year 1844, having recently returned from the auriferous Ural Mountains, he examined a collection of rocks from Australia, and from their similarity with those occurring in the Russian range he expressed his surprise that "no gold had yet been detected" in the Australian "Cordillera." The fact that gold *had* been detected (the discovery being then unknown in Europe), is the strongest possible proof of Sir Roderick's induction being, in a scientific sense, a real discovery; while the memoirs which he published on the subject in the years 1844–6 testify that his comparison of the two regions was not a mere haphazard surmise, but the result of a scientific comparison of the rocks, and the earnest belief of a geologist in the method and principles of his science. The principles as to the distribution of gold in the earth's crust, upon which Sir Roderick then relied, have since undergone some alteration, but only to show that gold is somewhat more widely distributed than was at that time supposed. In place of the Lower Silurian deposits being the *only* matrix in which gold is found *in situ*, which was Sir Roderick's original induction, we now know that they are but the chief depositories of the precious metal. No one, however, acknowledges this extension of our knowledge of the possible sources of gold more freely than the author of 'Siluria;' and as the subject is one of great economic importance, we quote, *in extenso*, his most recent conclusions (p. 472):—

1. That looking to the world at large, the auriferous veinstones in the Lower Silurian rocks contain the greatest quantity of gold.

2. That where certain igneous eruptions penetrated the Secondary deposits, the latter have been rendered auriferous for a limited distance only beyond the junction of the two rocks.

3. That the general axiom before insisted upon remains, that all Secondary and Tertiary deposits (except the auriferous detritus in the latter) not so specially affected never contain gold.

4. That as no unaltered purely aqueous sediment ever contains gold, the argument in favour of the igneous origin of that metal is prodigiously strengthened; or, in other words, that the granites and diorites have been the chief gold-producers, and that the auriferous quartz-bands in the Palæozoic rocks are also the result of heat and chemical agency.

Some other additions to our knowledge of the geological structure of the British Isles have a purely scientific value. Such, for instance, are the determination of the Lower Llandeilo age of the oldest rocks in the Lake-district of Cumberland by Professor Harkness, and the reference of the Devonian, or Old Red, rocks of the south-west of Ireland to the upper member of that formation.

In some respects the author of 'Siluria' holds aloof from proposed alterations in the interpretation of the relations of Palæozoic rocks of Britain. He does not accept Mr. Jukes's views on the Devonian rocks—a course in which he is supported by most of his contemporaries; nor does he yield to Mr. Salter's attempt to separate the Lingula flags from the Silurian System. We also perceive, with some surprise, that he does not completely agree with Dr. Holl's interpretation of the structure of the Malvern Hills, on the ground that the crystalline rocks have a strike parallel with that of the flanking Silurian rocks, Dr. Holl's statement being, that the former strike obliquely across the range. This, however, is a question of fact which will be easily decided by future observers.

In the last chapter of his work Sir Roderick Murchison gives a general view of ancient life from its earliest traces, and attempts to sketch the progress of creation from the commencement of geological time. He describes, first, a long period, characterized only by Invertebrata, and ending with the first appearance of Fishes in the uppermost Silurian deposits; this period of Fishes was followed by the appearance of Reptiles, and afterwards of Mammals, in subsequent formations.

Progression has long been a favourite hobby with our author, and if by it he simply means that Invertebrates appeared before Fishes, Fishes before Reptiles, and so on, who will quarrel with him. It is, then, simply a statement of a broad fact, and means very little. We suspect, however, that Sir Roderick has not sufficiently considered the fact that Fishes, Amphibia, Reptiles, Birds, and Mammals are merely *classes* of animals, whereas the great group of Invertebrata comprises about a dozen such subdivisions. No naturalist is yet in a position to show even the probability of all the classes of animals having appeared in the order of their organization, beginning with the most simple and ending with the most complex. And if the theory of progression is really the explanation of the order of creation, it should hold good for each and every of the orders, families, &c., into which classes are subdivided by naturalists.

The author then describes the former changes of the earth's surface, and illustrates their magnitude by striking examples of fractures, dislocations, and reversals of strata, coming to the conclusion that such great movements are inexplicable by reference to modern causes, so far at least as regards their intensity. At the same time he admits that "the former physical agencies were of the same nature as those which now prevail." Although we cannot bring ourselves to agree with Sir Roderick's views on this subject, we freely acknowledge the desirability of so eminent a member of the "old school" recording his best arguments in favour of its principles; and we feel sure that, whatever can be said—for it has been stated by him at least as well as, probably much better than, it could be done by anyone else. One consideration we will venture to suggest to the readers of this review, and of his book:—If modern causes have operated for a certain definite time on the crust of the earth, their effect may be conventionally represented by a certain symbol; if for twice that period, then by a symbol of twice the value; and so on. Now the Silurian deposits are very many times more ancient than (say) the Eocene; and if the intensity of modern causes acting since the Eocene period has been sufficient to metamorphose Eocene strata into gneiss, to upheave them, and even to overturn them, how very much greater must be the effect of the *same* causes, continuously acting for such an immense period upon the Silurian deposits, which are so many times older than the Eocene.

These general considerations, however, form merely the author's peroration, and in no way affect the general value of the book, which is a perfect storehouse of facts carefully observed, and garnered for the use of the present and future generations of geologists.

CHRONICLES OF SCIENCE.

1. AGRICULTURE.

THE need of extending the benefits of education to the children of agricultural labourers—the importance of defined relations between landlord and tenant—the necessity of continued legislation about the home and foreign cattle traffic—the limits put by the nature of the living things which the farmer cultivates to the enterprise of the agriculturist—the theory of land drainage—the relative values of our leading breeds of cattle—the cultivation of the sugar beet—the extension of the co-operative system—the improvement of the Irish butter manufacture — the activity of Farmers' Clubs and Chambers of Agriculture:—these are some of the subjects which have occupied the attention of agriculturists and agricultural readers during the past quarter. If we take the last subject first, it is that we may point out with what promptitude, activity, and force all these topics are now brought under the notice of the farmer as soon as their importance is established or even suggested.

With all that lack of union and organization which distinguishes agriculturists, when on any political question their voice or influence is desired, there is yet no occupation or profession in the country like theirs for such a frank and constant discussion by its members of the principles and methods of their business, as one witnesses at the meetings of Farmers' Clubs all over the country. Of this a few examples will suffice. The paper lately read by Mr. Bone, of Ringwood, before a Hampshire Agricultural Society, may be named as one. He discussed what he called the staple improvements of land: meaning thereby the permanent improvements of which the soil itself, apart from the mere current management of it, is capable. Among them is the improved texture which is conferred by the application of marls to sands, the processes of burning and draining clays, and the use of lime and chalk on both sands and clays. A very able and exhaustive treatise on what may be considered rather the landlord's than the tenant's interest in the soil was thus laid before a meeting of farmers, who were told a great deal of useful information for which they have to thank the geologist and chemist. Several of the tenant-farmers present related facts within their own experience, which not only proved the value of the processes Mr. Bone had recommended, but illustrated the cost of them, and therefore the need of a certain tenancy for a term of years, which alone would justify a tenant in incurring the expenditure involved. The relations of landlord and tenant, on which so much of the fertility of the soil is thus shown to depend, are the subject of constant discussion before similar societies in all parts of the country. At the Hexham Farmers' Club—which has just lost its founder by the death of Mr. John Grey, who perhaps more than any other man in the country was trusted by all parties as the best exponent of these relations—the subject has been lately re-discussed under the guidance of Mr. C. G. Grey, who has succeeded his father in the management of the large estates of the Greenwich Hospital in the North of England. An elaborate lease was laid before the club for its approval, in which the style of cultivation was limited rather than defined; and among other particulars, a list of unexhausted manures was specified, for which at certain rates the tenant was to receive repayment on giving up the land. For lime applied during the last year of the lease, the outgoing tenant was to receive the full price paid at the kiln—for bonedust one-half the bill—for guano one-third. The faults appear to us twofold:—There is too much detailed instruction as to what, under penalty, the tenant shall and shall not do; and there is not a sufficiently detailed account of the repayments which are due to him provided he maintains good and energetic management till the close of the term. Many, at least, of those improvements to which Mr. Bone referred appear to have no place in Mr. Grey's schedule of repayments.

We may, however, find some explanation of this in another Farmers' Club discussion. At Maidstone, some weeks ago, a very interesting paper was read by Mr. Robertson, "On The Agricultural Differences between the North and South of England," in which it was pointed out that in the former it was the almost invariable practice of the landlord himself to undertake the expenditure involved in permanent improvements of the land. Thus the late Duke of Northumberland laid out more than half-a-million of pounds during his lifetime in the improvement of his Northumberland estate; and of this 200,000*l.* was spent on drainage, 5 per cent. being charged upon the tenant for the outlay. Other differences in management are of course explained on the ground of climate; and here we come upon those limits to agricultural enterprise resident in the very nature of the plants and animals which are its object, which some reckless innovators disregard,—to their loss. The cultivation of mangold-wurzel in the South is one of those specialities of management which are explained in this way; and the superiority of the turnip crop in the North is another; and both of these differences were commented on by Mr. Robertson, who urged on the attention of the Kentish farmers the compensating opportunities and possibilities which a southern climate places within his reach. The farmers' clubs of Ireland are in no respect behind those of England. At Athy, Ballymahon, and other places, many very excellent agricultural essays are read every year, on subjects whose discussion cannot fail to be of service to the Irish farmer.

Mr. W. Davison lately read a paper on the "Waste Lands of Ireland" at the former club, wherein land-drainage, for which Government aid is offered, was described and recommended, along with the subsequent cultivation of rape and other green crops; and the granting of long leases, for the encouragement of tenants with capital, was urged upon the landlord. As to the ultimate advantage of the process to all concerned, he quoted an instance where land, the property of Mr. La Touche, worth 5*s.* an acre, had been let, after ,800*l.* had been spent on 140 acres of it, at 22*s.* an acre to a tenant, who was shortly afterwards offered 400*l.* for his interest in t. It is the relation of landlord and tenant, after all, which is at the bottom of all agricultural energy and enterprise.

The Morayshire Farmers' Club, which has heretofore taken the ead in introducing many agricultural improvements, was lately addressed by Mr. Geddes, of Orbliston, on the vexatious cropping clauses in leases, which often hinder the full use by the tenant of both his capital and his intelligence. He stated it as matter, not merely of opinion but of fact, which had arisen within his own experience, that land, however well cleaned and manured, tires of the same continued round of crops which the lease prescribes; that those who have most liberty of action in regard to the cultivation of the land, obtain the most produce and maintain the highest fertility, and are thus most serviceable to the country, the landowner, and themselves. He pointed out the Lothians as an example of the profits arising to everybody from liberal cropping clauses in agricultural leases. Elsewhere there is as good a climate and soil, originally as fertile, and where freedom and scope in the management of the land is given to the intelligence and enterprise of the tenantry, a larger capital will be attracted to the work of cultivation of it, larger produce will be obtained from it, and larger rents will be given for it.

At Cirencester, the other day, a very interesting lecture was given by Professor Wrightson, of the Royal Agricultural College here, before the Chamber of Agriculture, on the use to be made of books by practical farmers. He declared, from personal experience, that much time is lost in agricultural education from the student resident on a farm receiving no such preliminary instruction as books would give him, but being suffered to wander from field to field to gather such information as unassisted observation might give him. At the Central London Farmers' Club, steam cultivation, the risks of the foreign cattle trade, the policy or impolicy of compulsory system for the education of country children, the advantages of the American cheese factory over ordinary English dairy management, the influences of railways upon agriculture, and the undeveloped power of British agriculture are among the subjects named for discussion during the year. The Chambers of Agriculture are engaged with the impolicy of the turnpike system and the impending legislation on that, on the foreign cattle traffic, and on rural education. It is plain, we think, that the agricultural world is in this country alive to the many interests involved in its failure or prosperity.

Among the more important agricultural events of the past quarter must be named the proposal to re-establish the beet-root sugar manufacture among us. Twenty years ago this was attempted in Ireland, but failed, in some measure, perhaps, owing to the insufficient sweetness of the Irish-grown beet-root; but mainly, it is asserted, because of a faulty and imperfect manufacturing process.

Mr. Duncan, a sugar-refiner, dealing with no less than 300 tons of sugar weekly, is about to start the beet-root sugar manufacture in this country, and has advertised his willingness to contract for the purchase of 6,000 tons of beet-root next autumn, at 18*s*. a ton. His principal condition is that no farmyard manure shall have been put this year upon the land where they are grown. Over-luxuriance of growth is fatal to the development of much sugar in the juice. Purchasing these in October, he would grind them to a pulp, and thereafter press the juice out; boil it with lime, thus coagulating all albuminous matters; throw down the lime in solution, by passing carbonic acid through the liquid; and reduce the residual liquor by evaporation, till 50 per cent. of it was sugar, when it would be conveyed to the sugar refinery for further manufacture. The main difficulty in the way of the profitable growth of the sugar beet in this country is the small weight of root which must not be exceeded. Fifteen tons per acre are a full crop under ordinary circumstances, for the plants should not be more than two and a half pounds in weight, or the percentage of sugar will suffer.

An attempt to re-introduce the crop will, however, be made this year; and we understand that contracts have been already made with Suffolk farmers for a quantity of roots sufficient to justify Mr. Duncan in the erection of his manufactory.

Agriculture, in so far as it, too, is a trade, has shared in the recent excitement on the subject of co-operation. An association exists which professes to supply its members with agricultural implements and manures at manufacturers' and importers' prices. And even in the direct work of farm management, it has been attempted to make the workmen and the master fellow-labourers, both of them directly interested in the profits of the year. Mr. Lawson, of Blennerhasset, near Carlisle, has tried the principle of co-operation in this latter particular; but it appears that hitherto there have been no profits to divide. And it seems plain that these depend much more directly upon the skill and energy of the master than upon the mere co-operation of his men; which, after all, is better secured by adopting the principle of piece-work payment, so that industry at once meets with its reward, than by offering as its stimulant a share in doubtful profits twelve months hence. The association for supplying cheap implements stands, perhaps, upon a sounder basis, for no doubt the charges made by agents and allowed by manufacturers are an excessive fine on customers; but we suspect that the competition of individual dealers is likely in the long run to make them the cheapest and most efficient agency for distributing these as well as all other kinds of goods to purchasers.

A paper by Mr. Maw on "Potatoe Culture," in a recent number of the 'English Agricultural Society's Journal,' deserves mention here as an example of an elaborate experimental agricultural research. Mr. Maw's experience proves that, the cultivation and manuring being alike, the weight of the crop is proportioned very accurately to the weight of the sets. Full-sized potatoes, from 4 to 8 oz. in weight, planted 10 inches or a foot apart, in rows 2 feet or 26 inches from each other, yield the maximum return. And where the sets were made to average 6, 4, and 2 ounces in place of 8, the crop per acre was found to drop from 26 tons per acre to 15, 14, and 11 tons respectively. Although the plots on which the experiments were tried were small, and the crops recorded almost incredibly large, yet the trials themselves were so numerous and the results so uniform, that the rule seems sufficiently established; and we may consider it as certain that the crop will generally vary as the weight of the sets; and as these are best planted at a certain distance apart, the larger sets are to be preferred.

The theory of land drainage has been under discussion recently owing to the assertion that the opening of a shaft to the surface of the land from the upper end of an ordinary drain, giving a direct connection with the air, facilitates the escape of water. This is of course an assertion which can be properly tested only by experiment; but it appears to us obvious that the broad surface and the whole substance of the soil are already entirely under the influence of atmospheric pressure, and that the operating cause in land drainage is plainly the mere weight of water which the land contains pressing downwards everywhere—into any channels, therefore, which may be provided for its escape. The provision of one opening more through which air can find a direct passage, if it will, from the sunlight to the underground channel, seems to us incapable of any power or influence at all on the process of land drainage which may be going on through that channel.

The agricultural statistics of the past year have just been published. They are interesting on a comparison with previous publications of the kind, as showing the unexpected changes which have gradually and unnoticed taken place in English and Irish agriculture during recent years. Thus it appears, that during the past ten years the growth of wheat in Ireland has dropped from 544,348 acres to 280,549 acres, and in Scotland from 243,240 acres to 110,609 acres. No such comparison is possible in the case of England, for we have not a ten years' record in her case; but it is plain that such a record is very desirable, as pointing out how agricultural practice is drifting from the old lines without anybody otherwise having the chance of knowing it: so that national risks are gradually being incurred of which no suspicion had otherwise existed. Mr. Caird read a most elaborate and instructive paper the other day on this subject before the Statistical Society, pointing out the many ways in which the annual publication of our agricultural produce must tend to regulate trade, and correct the evils inflicted by misjudgment here upon agricultural as well as other national interests. We place the leading facts of 1866 and 1867 on record here for annual reference hereafter.

POPULATION, AREA, ABSTRACT OF ACREAGE UNDER CROPS, &c., AND NUMBER OF LIVE STOCK IN EACH DIVISION OF THE UNITED KINGDOM.

	Years.	England.	Wales.	Scotland.	Total for Great Britain.	Ireland.
Total Population	1866	20,276,494	1,187,103	3,136,057	24,599,654	5,571,971
Total Area (in Statute Acres)	..	32,590,397	4,734,486	19,639,377	56,964,260	20,322,641
Abstract of Acreage:—						
Under all kinds of Crops, Bare Fallow, and Grass	1866	22,236,737	2,284,674	4,158,360	28,679,771	15,550,231*
	1867	22,932,356	2,519,170	4,379,552	29,831,078	15,542,208*
Under Corn Crops	1866	7,365,170	521,074	1,366,540	9,252,784	2,174,033
	1867	7,399,317	521,404	1,364,029	9,284,780	2,115,137
„ Green Crops	1866	2,759,912	139,265	663,257	3,562,434	1,481,605
	1867	2,691,734	138,387	668,042	3,498,163	1,432,252
„ Bare Fallow	1866	760,979	109,878	94,080	964,937	25,419
	1867	753,210	86,257	83,091	922,558	26,191
„ Grass:—Clover, &c., under Rotation	1866	2,296,087	256,722	1,141,415	3,694,224	1,601,423
	1867	2,478,117	300,756	1,211,101	3,989,974	1,658,451
Permanent Pasture, not broken up in Rotation *	1866	8,998,027	1,257,721	893,066	11,148,814	10,004,244
	1867	9,515,675	1,472,359	1,053,285	12,071,319	10,057,072
Abstract of Live Stock returned:—						
Total Number of Cattle	1866	3,307,034	541,401	937,401	4,785,836	3,746,157
	1867	3,469,026	544,538	979,470	4,993,034	3,702,378
„ of Sheep	1866	15,124,541	1,668,663	5,255,077	22,048,281	4,274,282
	1867	19,798,337	2,227,161	6,893,603	28,919,101	4,826,015
„ of Pigs	1866	2,066,299	191,604	219,716	2,477,619	1,497,274
	1867	2,548,755	229,917	188,307	2,966,979	1,233,893
Number of Persons from whom Returns were obtained:—						
Occupiers of Land owning Live Stock, and Occupiers of Land only	1867	338,588	52,072	78,792	469,452	About 600,000
Owners of Live Stock only	1867	7,457	572	4,629	12,658	

* Exclusive of heath or mountain-land.

2. ARCHÆOLOGY AND ETHNOLOGY.

M. Paul Gervais has recently published an important work, entitled "Recherches sur l'Ancienneté de l'Homme et la Période Quaternaire," illustrated by nineteen quarto plates of figures of implements, ornaments, human bones and skulls, and mammalian remains, from various caves and stratified deposits of the Quaternary period. The scope of this work is very comprehensive, as the author treats the subject from several points of view. After certain preliminary observations, designed to show that the Quaternary period is really entitled to a separation from the Tertiary, M. Gervais enumerates the various kinds of proof which are commonly invoked in favour of the pre-historic existence of man in Europe, and then proceeds to subdivide the Quaternary period into four epochs, as follows:—(1.) The epoch of *Elephas meridionalis*, which can no longer be contested, since M. l'Abbé Bourgeois has discovered worked flints at Saint Prest, but which is difficult to separate palæontologically from the succeeding epoch. (2.) The epoch of *Elephas primigenius*, characterized by that species, and by *Ursus spelæus*, *Hyæna spelæa*, *Felis spelæa*, &c. (3.) The epoch of the Reindeer, characterized by the fractured remains of that animal. During this period, the animals which were especially characteristic of the preceding epoch appear to have become extinct, and in certain places their bones are found associated with the fragmentary remains of the Reindeer, as well as with the worked horns of that animal. (4.) The epoch of the pile-dwellings, of which the fauna appears to be the same as that of the present day, except that wild oxen and deer, though still existing, then roamed over districts where they are now unknown. This period is posterior to the extinction of the great mammals, and to the retreat of the Reindeer into more northern regions.

Our space will not allow us to discuss the author's valuable descriptions of the numerous caverns in France which he has explored, and several of which contain human skulls, nor his original observations on the species of mammalia contained in them; we must pass at once to a consideration of the manner in which the ancient people to whom these skulls belong have been so far modified as to have yielded the French population of the present day. M. Gervais states that the original inhabitants were Celtic; that after the Glacial period, during the long interval which preceded the invasion of Gaul by the Romans, the country was peopled successively by races from the East, chiefly from Asia, of which the tribes appear to have possessed distinguishing characteristics, similar to those spoken of by the ancient historians as characterizing the populations of the several provinces of France at the time of the

Roman conquest. From the fusion of these several tribes with the original Celtic inhabitants arose the numerous varieties of people which existed at the latter period. And where the influence of the Roman invasion was least felt the aboriginal races have been preserved in the purest condition,—for instance, the Basques.

M. Gervais's book contains the discussion of too many large subjects to be thoroughly reviewed in a Chronicle; we therefore refer our readers to the work itself,—a most complete exposition of the subject in all its bearings, as connected with the history of France and of the French people.

In the numbers of the 'Intellectual Observer' for December and January, Mr. Llewellyn Jewitt continues his description of the Grave-mounds of Derbyshire, and their contents. As we stated in our last Chronicle, the greater number belong to the Celtic period, the smallest number to the Romano-British period, and an intermediate number to the Anglo-Saxon. The mounds of the Celtic period were described in the papers which we then noticed; in those now before us, the author describes the few Romano-British tumuli, and those of the Anglo-Saxon period. Mr. Jewitt states in explanation of the fact that so few Roman monuments occur in Derbyshire, that the Romans did not make regular settlements in that county, that they "seldom raised tumuli over their dead, or, in this country, placed any ostentatious monuments over their remains." The interments which have been discovered include examples of burial both by inhumation and by cremation. The articles found in the graves, of course, are not numerous; but they include pottery and glass, coins, fibulæ, armillæ, and other ornaments (of bronze and iron), knives, spear-heads, combs, &c.

The Anglo-Saxon period is remarkably well represented, the graves being generally rectangular cists, or pits cut in the ground, to the depth of from two or three to seven or eight feet. Mr. Jewitt gives an interesting account of the burial by inhumation; but it seems that cremation was the dominant practice. With the urns "but few articles, either of personal ornament or otherwise, are found;" but where the body had been placed entire in the grave the objects are numerous, and frequently elaborate, including "swords, knives, scaxes, spear-heads, umbones of shields, buckles, helmets, querns, drinking-cups, enamels, gold, silver, and bronze articles, baskets, buckets, draughtsmen, combs, beads and necklaces, rings, earrings, caskets, armlets, fibulæ, articles for the chatelaine, pottery," &c., examples of which are described by the author.

"Pfahlbauten in Meklenburg" is the title under which several reports by Dr. G. C. F. Lisch are being published in a collected form. These reports were originally published in the 'Jahrbuch' of the Society of History and Antiquities of Meklenburg, and two instalments of the collection have now been republished—namely, one in 1865 and one in 1867. They contain, chiefly, descriptions of the "Pfahlbau" of Wismar, and of the bones and the objects of human workmanship which have been found in it. As some discussion arose in Germany concerning the authentic nature of this pile-dwelling, these collected reports by Dr. Lisch will, no doubt, be welcomed by students of Pre-historic Archæology.

M. Husson has published a collection of his pamphlets on the Antiquity of Man under the title, "Origine de l'Espèce Humaine dans les Environs de Toul par rapport au Diluvium Alpin." Most of these papers have appeared previously in the 'Comptes Rendus,' and the chief conclusion which the author endeavours to establish is, that man did not exist during the epoch of the Alpine Diluvium.

The antiquities found in the tumulus known as the Butte-Ronde have been splendidly illustrated in a memoir by the Duc de Luynes, entitled, "Notice sur des fouilles exécutées à Butte-Ronde près Dampierre (Seine-et-Oise)." They consist of Roman coins, bronze ornaments, iron tools, numerous ornamented jars, and other objects in pottery, and a few broken glass vases, with flint and stone implements, and some bones of an herbivorous animal, at least one of which had been submitted to the action of fire.

The second volume of M. Dupont's collected papers on the Belgian caverns, published under the title 'Notices préliminaires sur les fouilles exécutées dans les cavernes de la Belgique,' has recently appeared. It contains three pamphlets, two of which are descriptions of addition caverns, and the third, to which we shall confine our attention, is on the "Ethnography of the People of the Reindeer-age in the valley of the Lesse." M. Dupont infers from the pyramidal architecture of the skulls, and the lozenge-like form of the face, that the reindeer-folk belonged to the Turanian branch of the Uralo-Altaic family. They rarely attained the middle height, and generally speaking it may be said that individuals of small stature are abundant, while those above the middle height are exceptional. The characters of the pelvis and of the bones of the extremities are indicative of great muscular power and of considerable agility. The mortality of the infants and youths appears to have been very great; while the preponderance of the remains of females seems to show that large numbers of the men died from injuries which prevented their regaining their own homes. Several of the bones which have been obtained also exhibit evidences of disease. Amongst other noticeable points we may mention that M. Dupont credits these people with having been endowed with considerable curiosity and a love of investigation, as they made collections of fossil shells, pyrites, fluorspar, &c.; and with a love of decoration, as witnessed by the numbers of ornaments which have been found in the caves. Possibly to the latter cause should also be assigned the collection of shells, &c., most of which have been perforated by them. M. Dupont speculates on their carelessness, their industry, their superstition, and their respect for the dead, all of which he ingeniously infers from circumstances connected with either the position or the material of the objects obtained from the various caves.

In the recently published volume of the 'Transactions of the Historic Society of Lancashire and Cheshire for 1866–67,' Mr. Henry Ecroyd Smyth gives his annual paper on the "Archæology of the Mersey District," this one being for 1866. It is perhaps rather more interesting than usual on account of its containing a record of the discovery of an early stone Celt in Parliament Fields, Liverpool; and an "omnium gatherum" thrown up on the sea-beach near Wirral, including objects of Primæval, Romano-British, Saxon, Early English, and Later English dates. The author prefaces his list of these remains by supporting in the main Dr. Hume's views on the latest submergence of the country near Liverpool against the opposition of Mr. Joseph Boult, although at the same time he differs from the former gentleman in some matters of detail.

Professor Schaaffhausen, of Bonn, delivered an address last September before the forty-first 'Versammlung deutscher Naturforscher und Aerzte' of Frankfort-on-the-Main, entitled "Ueber die anthropologischen Fragen der Gegenwart," which is published in their last 'Tageblatt.' This review of Anthropology, which is really an eloquent advocacy of it, is chiefly remarkable from being based on a view of the subject which is mainly conspicuous in Germany by its absence. It is directly opposed to the blasphemies of Buchner, and we strongly commend it to the notice of the Anthropological Society of London.

The new scientific magazine, entitled 'The American Naturalist,'—to which we have occasion to refer at length in our Zoological Chronicle—for January, contains an interesting "Account of some Kjoekken-moeddings, or shell-heaps, in Maine and Massachusetts," by the eminent naturalist, Dr. Jeffries Wyman. In it the author describes several such accumulations which he visited last year; but they have yielded nothing which indicates so high an antiquity as the similar accumulations of the Old World, although certain circumstances indicate the lapse of a considerable period of time, *e.g.*, the friable condition of the shells in the lower layers, the occurrence of a layer of earth between the two principal strata of which they consist, and that of the remains of animals not now known in the district. We may cite, in illustration of the last-named condition, the elk, which at present is not known to exist east of the Alleghany Mountains; the wild turkey, now virtually extinct in New England; and the great auk, which has receded almost, if not quite, to the arctic regions. All of these animals, however, have disappeared during the historic period of the continent. At Coluit Point, a metatarsal bone from the great toe of a human foot was discovered, otherwise these shell-heaps have been entirely unproductive of human bones. Remains of numerous animals, however, have been found in abundance associated with pottery, rude in its manufacture and its ornamentation; and implements of stone and bone, the latter being by far the more abundant, except in one locality.

The 'Anthropological Review' for January contains, besides several articles of interest, a report of Sir John Lubbock's paper on "The Early Condition of Man," which was read before the British Association at Dundee. In this paper the author examines the late Dr. Whately's theory that "man was from the commencement pretty much what he is at present; if possible, even more ignorant of the arts and sciences than he is now, but with mental qualities not much inferior to our own." Savages are considered by the supporters of this theory to be the degenerate descendants of far superior ancestors. Sir John Lubbock advocates the opposite view, that "man was at first a mere savage, and that our history has on the whole been a steady progress towards civilization, though at times, and at some times for centuries, the race has been stationary, or even has retrograded."

M. F. Garrigou has published, in the last volume of the 'Bulletin de la Société d'Histoire Naturelle de Toulouse,' a paper entitled, "Age de Renne dans la Grotte de la Vache, près de Tarascon (Ariége)," which has also been republished in the 'Annales des Sciences Naturelles.' The author finds evidence, over an area having at most a radius of 3 kilomètres, of the existence of man at four successive periods—namely, (1) the age of the *Ursus spelæus* and *Elephas primigenius*; (2) the age of the Reindeer; (5) the Polished Stone period; and (4) the age of Bronze and Iron.

In the 'Reliquary' for January is an account of the discovery of Pre-historic remains in the gravel-beds at Malton, Yorkshire, by Mr. Charles Monkman. This discovery has excited considerable discussion, and therefore, as this note is illustrated by views of the implement, and a rough section of the beds from which it is said to have been obtained, it will no doubt be welcome to those interested in the subject. The weapon is a polished greenstone axe, apparently belonging to the Neolithic or Polished Stone period, but it is said to have been found in the lower beds of the Malton gravel, and immediately beneath a thin bed of clay, said to have been in an undisturbed condition. The question is, How did a polished stone axe get into a position in which one would have expected to find only chipped flint implements? Unfortunately, the facts relating to the position of the axe depend entirely upon the testimony of a workman, who would be very likely to read the section of a gravel-pit altogether differently from an expert scientific investigator.

3. ASTRONOMY.

(Including the Proceedings of the Royal Astronomical Society.)

THE news which has been received from America since our last Chronicle was in type suffices to show that—as we ventured to surmise—astronomers had not been mistaken in anticipating a fine display of the November shooting-stars in longitudes west of the British Isles. Considering how recently we have obtained any exact knowledge respecting the position of the meteor-ring in space and the motions of its members, the agreement between the predictions of astronomers and what actually took place is remarkably close. We mentioned half-past seven on the morning of November 14th as the probable epoch of maximum display: it will be seen from what follows that the earth passed through the richest portion of the meteor-belt about two hours later.

Professor Daniel Kirkwood, LL.D., assisted by Professor Wylie and several students, kept watch for meteors from 9h. 15m. P.M. to 5h. 15m. A.M., November 13th and 14th, at the Indiana University, Bloomington, Indiana. Although the sky was obscured by so dense a haze that only stars of the first magnitude were visible, they obtained the following results:—

November	13	from	9h. 15m.	to	12h. 0m.	..	1 meteor
,,	14	,,	0h. 0m.	,,	3h. 15m.	..	75 meteors
,,	,,	,,	3h. 15m.	,,	4h. 15m.	..	351 ,,
,,	,,	,,	4h. 15m.	,,	5h. 15m.	..	98 ,,

The maximum occurred at about 3h. 45m. Cincinnati time, corresponding to 9h. 33m. Greenwich time. At this time the rate was 12 per minute.

Captain Stuart obtained a better view of the meteors at Nassau, Bahamas. There is a slight misprint in the tabulated results, and hence some difficulty in determining whether the maximum display took place at 4h. 15m. or at 4h. 20m. This is not very important, however. At the maximum the rate was 21 per minute, though 3-fifths of the sky only were clear. The corresponding Greenwich time is 9h. 25m. or 9h. 30m. Other observers who had a more extensive view of the heavens counted nearly half as many again as Captain Stuart.

Lastly, Commander W. Chimmo, H.M.S. 'Gannet,' records the fall of an immense number of sparks near his ship, followed shortly by the explosion of a brilliant meteor near the East, emitting sparks like those of a rocket. He called the attention of the First-Lieutenant and Master, "who were on the bridge at the time, to the meteoric shower then in view, falling rapidly and perpendicularly; every now and then a brilliant meteor bursting and lighting up the whole heavens." The hour of observation was from 5h. 20m. to 6h. 15m. A.M., local time, or 9h. 25m. to 10h. 20m. Greenwich time. A little consideration will show that the radiant point in Leo was near the zenith during the whole of this interval, so that all the shooting-stars would seem to be [illegible]

Commander Chimmo adds that at Trinidad, from 2 A.M. to daylight, 1,600 meteors were counted, only 693 of which fell before 5h. 30m. A.M. Some were reddish, others green, and one of a bright fiery purple, lasting many seconds.

Considering that during the whole time of the display the full moon obliterated all save the largest meteors, we are forced to conclude that the earth passed through a very rich stratum of meteors at about half-past nine on the morning of November 14th, 1867. Also it is very noteworthy that the accounts above referred to, are such as to leave no doubt that the real beginning and end of the shower were witnessed by the observers. This was not the case in England, in November, 1866. The shower in 1867 did not last more than five hours, whereas in 1866 it lasted at least six hours (counting from the earliest reported observation, made at Kishnagur, near Calcutta). The shower was heavy for but one hour. As the earth was traversing the thickness of the meteor-bed at the rate of 18,000 miles per hour, it follows that the total thickness was 90,000 miles, as against upwards of 108,000 miles in 1866; and that a stratum of about 20,000 miles in thickness was richly strewn with meteors. If we remember that the part traversed in 1866 was removed more than 500 millions of miles in November, 1867, and that there is every reason for supposing the meteor-band to be continuous, though varying in density (the variation being probably uniform, not abrupt), we shall be able to form a conception of the extent and importance of the November meteor-system.

Astronomers continue to be divided in opinion respecting the reputed change in the lunar crater Linné. Many hold that the apparent alterations are merely optical. On the other hand, Mr. Buckingham reports that the small crater which he was the first to notice, and which appeared as a small hill on the western border in December, 1866, and as a crater in January, 1867, has in every succeeding month approached nearer to the centre of Linné, increasing also in magnitude. As it is well known that the central cone of Vesuvius frequently shifts its position, Mr. Buckingham's observation seems to confirm the views of those who consider that Linné during the past seventeen months has been in a state of active eruption. Mr. Buckingham states that the change of place is at least a second and a half, corresponding to a distance of about a mile and a half.

M. Hoek remarks in the 'Astronomische Nachrichten' that

Comet III., 1867, in all probability belongs to the same system as Comets III. and V., 1859. The three planes in which these comets move intersect in the same line. M. Hoek had already suspected that the two comets of 1859 had a common origin, on account of the close resemblance between their elements, and the brief interval between their apparition.

The Gold Medal of the Astronomical Society has been presented to M. Leverrier for his elaborate investigation of the motions of Venus, Mercury, the Earth, and Mars.

Mr. Huggins has confirmed the discovery lately effected by the observers at Paris that bright lines appear in the spectra of three small stars.

The 95th asteroid was discovered by M. Luther at Bilk-Dusseldorf on November 23, 1867. It is of the 10th magnitude, or rather less.

Proceedings of the Royal Astronomical Society.

When astronomers first directed their attention to the determination of stellar distances, it was natural to expect that the brightest stars would exhibit more evidently than the rest that annual parallactic displacement on which the determination depends. This, however, was not found to be the case. Sirius, for instance, which shines four times as brightly as any other star visible in our latitudes, was found to exhibit a very minute parallax. Mr. Cleveland Abbe, of the Poulkova Observatory, has lately applied a careful and laborious process of calculation to a fine series of meridional observations of Sirius, made with the transit circle of the Cape of Good Hope Observatory. He deduces a parallax lying between 0″·37 and 0″·17—that is, it appears that the distance of Sirius lies between 563,000 and 1,224,000 times the diameter of the earth's orbit. It will be remembered that Henderson, who observed Sirius at the Cape, but with an inferior instrument, deduced a parallax of 0″·23.

The Astronomer Royal calls attention to the fact that the dark shadow in the great eclipse of August 17–18, 1868, coincides through a large portion of its length with the course of our mail-steamers between Aden and Bombay. A mail-steamer is to leave Aden on August 16, and will be due at Bombay on August 23, and a mail-steamer is to leave Bombay on August 11, and will be due at Aden on August 22. Both these steamers will pass through the dark shadow. Although a ship's motion renders it impossible to make many of the more important observations, yet several observations can be readily made on board ship. The red prominences could certainly be detected with a good opera-glass. The polarization of the corona could be readily examined by a polarizing test which acts by extinction, as the Nicol's prism. Perhaps even, with a hand-spectroscope and narrow chink, lines in the spectrum of the corona might be seen. Marine and meteorological phenomena never yet observed might also be noticed.

Mr. Stoney, F.R.S., supplies a paper on the subject of the same eclipse. Viewing the corona which is seen during a total eclipse as caused by the sun's enormous outer atmosphere projecting beyond the disc of the moon, he considers that the examination of this phenomenon through a spectroscope adapted to an equatorial telescope would be likely to yield results of extreme interest and importance. He points out that the shell of excessively faint cloud which seems to lie at a distance of 8″ or 10″ from the edge of the sun's disc should be observed both from a central station and from stations close to the northern and southern limits of totality, so that we may be enabled to determine whether it is continuous all round the disc. It is desirable also that the flame-like protuberances should be examined, in order to determine whether their spectra resemble the solar spectrum, or on the other hand consist (some of them, at least) of bright lines. We should thus learn whether these objects resemble mists or true vapours.

Mr. Stone applies a careful investigation to Professor Newcombe's determination of the solar parallax. Professor Newcombe deduces the solar parallax from the parallactic inequality in the earth's motion, a method already applied by Leverrier, and described by us in a recent chronicle. But the value deduced by Professor Newcombe differs considerably from Leverrier's. In place of a parallax of 8″·91, Newcombe obtains the value 8″·81. It will be remembered that the estimate of the moon's mass is a very important element in the inquiry. Newcombe makes the moon's mass $\frac{1}{81 \cdot 08}$ of the earth's; Leverrier's labours corrected by Stone gave the fraction $\frac{1}{81 \cdot 48}$. After a careful revision of the processes applied by Leverrier and Newcombe, Mr. Stone arrives at the conclusion that Newcombe should have obtained the value 8″·87 for the solar parallax, if his own estimate of the moon's mass were adopted, and the value 8″·89 if Leverrier's estimate were taken.

In a later paper Mr. Stone determines the moon's mass independently, retaining all terms of the third order in the Lunar Theory. He obtains the following relation :—

$$\frac{\text{Moon's mass}}{\text{Earth's mass}} = \frac{1}{81 \cdot 38}$$

This result depends on the adopted values of Luni-Solar Precession (50″·378), and Nutation (9″·223).

Mr. Stone deals also at length with Bessel's Mean Refractions. From the existence of several small but systematic discordances, he had been led to form the opinion that the refraction-corrections used at Greenwich for zenith distances less than 85° are too great.

He finds that the refraction of Bessel's 'Fundamenta' require to be diminished in the proportion of 0·99797 to 1, to be correct for Greenwich. He has examined also the Melbourne observations for 1863, 1864, and 1865, to test the accuracy of the proposed diminution of the Greenwich tabular refractions. A somewhat remarkable result has attended the inquiry. He finds evidence of a difference in mean refraction towards the south and north at Melbourne. He ascribes this to the position of Melbourne. The refractions towards the south are greater, because the ocean lies to the south, so that there is more moisture in the air-masses which lie in that direction. The refractions toward the north are less, because the effective strata of air have been to a considerable extent deprived of moisture.

Mr. Penrose has attempted to facilitate the prediction of occultations and eclipses by the application of geometrical constructions. Such methods are not, perhaps, likely to supersede the more rigorous processes adopted by the compilers of our ephemerides, but they are valuable in many respects. We believe that there is room for a great extension of geometrical processes to the illustration of many astronomical phenomena which at present are either dealt with by abstruse processes intelligible only to the advanced mathematician, or so roughly and imperfectly illustrated that the amateur astronomer is more likely to adopt incorrect impressions than to acquire any real information.

Mr. Browning has ascertained that the colours of stars are not nearly so intense in telescopes of large aperture as in small instruments.

The following summary of the results of the examination of three long periods for the determination of Mars' Rotation-period may prove interesting. Each period begins from Hooke's observation of Mars, on March 12, 1666, 12h. 20m. (astronomical time and new style), and the periods extend severally,—(i) to April 24, 1856, 10h. 50m., (ii) to November 26, 1864, 11h. 46m., and (iii) to February 23, 1867, 6h. 15m.:—

Int.	Int. in Secs.	Cor. for Geoc. Long.	Cor. for Phase.	Corrected Int. in Seconds.	No. of Rotations.	Resulting Rotation Period in Secs.
(i)	5999524200	— 0°	—12°	5999521246	67682	88642·737
(ii)	6270650760	—248°	0°	6270589696	70740	88642·734
(iii)	6341394300	—273°	+3°	6341326590	71538	88642·734

Mr. Proctor mentions that nothing is doubtful in this table except the correction for Geocentric longitude (which, however, may be depended on as being within 1° of the truth) and the correction for phase. The last correction depends only on the accuracy of the drawings of Mars by Hooke—at one end of the intervals, and by

Dawes and Browning at the other. Hooke took two closely according views separated by an interval of 10 minutes; Dawes' accuracy of delineation is beyond question; and though Browning has had less practice in observations of this sort, yet he has already acquired a high reputation for accuracy and care, and further his drawing gives results closely according with those deduced from Dawes' views. Hence we can scarcely doubt that the mean of the above rotation-periods, or 24h. 37m. 22·735s. is very near the true rotation-period of Mars. We notice, however, that an error of 1° in any of the corrections corresponds to an error of about $\frac{98}{76} \times \frac{1}{360}$ths (or very nearly $\frac{1}{280}$th) of a second, or ·0036s.; so that Mr. Proctor's result cannot be held to be trustworthy beyond the second place of decimals,—perhaps even not beyond the first. We may assume that Mars' rotation-period lies *certainly* between 24h. 37m. 22·75s. and 24h. 37m. 22·71s., and a corresponding error therefore exists in Kaiser's estimate—24h. 37m. 22·6s., and Mädler's—24h. 37m. 23·7s.

Mr. Harrison supplies an interesting paper on the moon's insolation. Assuming that the moon's substance has a capacity for heat, the mean maximum state of insolation of any hemisphere would evidently be attained when the largest surface has been continuously exposed to the sun's heat for the longest duration of time. Accordingly, the visible hemisphere would be heated to its greatest possible extent during the third, or last quarter, when the half-moon then illuminated has been subjected to the solar radiation for a mean period of 265·5 hours, and the remaining half, now in shade, has very recently received the sun's rays for a period of equal duration. Now, the heat thus assumed to be acquired by the moon, and radiated to the earth, is dark heat; and it has been shown by Professor Tyndall that the aqueous vapour in our atmosphere has a power of absorbing dark heat. Accordingly, instead of heating the earth, this heat would be employed in heating the air above the clouds, and causing increased evaporation from their surface. Clouds would thus be raised to a higher elevation, and, under favourable circumstances, would even be dispersed. Thus, there would be a diminished check upon the radiation of terrestrial heat, and a sensible fall in the temperature of the air near the ground would necessarily follow; and results of a precisely opposite character would occur at the period of minimum heat in the moon's visible hemisphere. The daily mean temperatures at the Oxford, Berlin, and Greenwich Observatories, when arranged in tables according to the age of the moon, show that the temperature of the air near the ground is sensibly affected. The maximum mean temperature occurs on the average on the sixth and seventh day of the lunation, and the minimum soon after full moon—results which confirm Mr. Harrison's views in a remarkable manner.

With reference to these speculations we must note that inquiries specially directed to the subject are required before an opinion can be formed. It must be remembered that the moon rises to the meridian at a different part of the day in each lunation; and meteorologists are familiar with the fact that the hygrometrical state of the air varies at different hours of the day. There is the epoch at which—on the average—clouds are most numerous; the epochs at which the absolute quantity of vapour in the air reaches its maximum and minimum; and the epochs (not necessarily the same as the preceding) at which the humidity of the air is least or greatest. Now we clearly cannot neglect the consideration that the moon's influence—which certainly exists—may vary in different parts of each lunation, *not* for the reasons assigned by Mr. Harrison, but because it is exerted at more or less favourable hours of the day. And, although we have not space here to explain the considerations on which our opinion is founded, there are reasons for anticipating that the first and third quarters, when the moon reaches the meridian in the evening and morning, should be marked by a greater apparent influence—one way or the other—than the second quarter when the moon reaches the meridian near midnight, a period of the day far less *critical* (as respects hygrometrical conditions) than the two former. We may be permitted to question the justice of Mr. Harrison's conclusions, when we find that a marked rise in the temperature occurs in the middle of that quarter which should exhibit (and does exhibit *on the average*) the lowest temperature. It is true Mr. Harrison finds a reason for this, in the supposition that *fresh cloud may have been found to arise a day or two before the third quarter*, to supply the increased demand for vapour at that period. But when opposite effects can thus be assigned to the operation of the dark heat assumed to be emitted from the moon, a little uncertainty is thrown over the whole subject.

As respect the heating of the moon's surface it may be remarked that although, undoubtedly, an enormous quantity of heat is poured upon a lunar hemisphere in the course of the long lunar day, yet we have no means of knowing how this heat is disposed of. Nearly all of it may be at once radiated into space, or a large portion may be consumed in effecting changes—as of solids into liquids or of liquids into vapours—imperceptible to us, and followed by a return to the original state during the long lunar night. It seems hardly conceivable that the heat emitted during the latter process of change should become in any way sensible to us. Far more probably the heat we actually receive from the moon is reflected towards us precisely as the moon's light is.

Messrs. De la Rue, Stewart, and Loewy communicate the results of Observations made on Sun-spots, in Kew and in Dessau, during the year 1867. Hofrath Schwabe reports that the uniform brightness of the sun's surface observable in the beginning of the year and the almost total absence of faculæ, both which phenomena were lately submitted to the attention of astronomers, have disappeared, and since October the luminosity has again diminished near the edge of the sun's disc.

Mr. Browning has invented an ingenious contrivance for reducing the angular velocity of meteors, so as to facilitate the observation of their spectra. The contrivance consists of "a direct-vision prism, having in front of it a deep concave cylindrical lens, and in front of that a double concave lens of the usual kind." With this apparatus he has found it easy to obtain the spectra of balls shot from a Roman candle, placed but a few yards from the instrument. The angular velocity of the projected balls (estimated from the instrument) is, of course, very great under such circumstances, yet the characteristic lines of baryta, strontia, &c., can be readily distinguished in their spectra.

4. BOTANY AND VEGETABLE PHYSIOLOGY.

ENGLAND.—*A new British Morel.*—In the 'Journal of Botany' we read of a new British fungus. It was first found in a hedgerow, near Kingskerwell, South Devon, by Miss Lott, of Barton Hall, at the end of last April. The first specimens were sent to Mr. W. G. Smith for identification, and it has since been found elsewhere. It is a very large form, and when well grown is one of the finest fungi of our flora; the spores are oval, yellow, and depressed, having a length of ·0007 inch. The substance of the flesh is not so firm as that of our common Morel (*Morchella esculenta*, Pers.), and is not so readily dried; it becomes moist, and is apt to decompose. It is, however, excellent for the table, and with a little pains may be readily dried for winter use.

Different kinds of India-rubber.—In the same journal is a most interesting article, by Mr. James Collins, on india-rubber. It appears that india-rubber first became known when Columbus discovered America, and was described by the earlier travellers as a great curiosity. The natives used it to make balls, with which they played a sort of game like tennis. The ordinary practice of coagulating the milky juice of the cow-tree on bottle-moulds held over a fire is well known: it appears that this is the method practised on the Amazons; but that in other districts and countries sheets are prepared, or the juice is dried in the sun. Some persons have supposed that the black colour of parts of india-rubber is due to the smoke of the fire over which it is dried. This is quite a mistake; freshly prepared india-rubber is, as the Indians make it, of a pale yellow colour; it becomes black by exposure to the air. Inferior kinds of india-rubber are blacker than others, and contain a sticky, resinous fluid, which can be squeezed out. Other sorts are white and hard when dry, resembling gutta-percha in that they become elastic when heated gently. The first person to advocate the use of india-rubber for erasing pencil-marks (whence has arisen its name) was the great Dr. Priestley, and at the end of the last century you might buy a square inch of india-rubber for 3*s.*! The vast variety of uses to which india-rubber has now been put has caused it to be searched for and discovered in every quarter of the globe; and though the principal supply is still from America, it has been found in use among the natives of Asia, Africa, and even Australia, and is now imported thence. Of the American india-rubber, the original and best is procured from *Heveà Guayanensis* (*Siphonia elastica*), and other species of the same Euphorbiaceous genus: it is known as Para-rubber. Pernambuco rubber is the product of *Hancornia*, an Apocynaceous genus, and is an excellent sort. *Couma*, another Apocynaceous plant, yields a hard, white, gutta-percha-like substance, which is sometimes sold as "rubber milk." The *Castilloa elastica*, belonging to the same natural order as the nettle, is the plant which yields the somewhat inferior "rubber" of Central America. Guatemala rubber is the worst kind, and is quite black and resinous. The juice of the *Castilloa* is not coagulated by heat, but by the juice of a vine-like plant, which grows in the same forests, and is called "Achuca." Species of *Micrandra* and *Siphocampylos* (Euphorbiaceæ) yield small quantities of "rubber," of good elasticity. The Asiatic "rubber" has a different appearance to the American, and is much inferior, on account of its frequent impurities. From Penang, Sumatra, Malay Peninsula, and Borneo a "rubber" is imported, the produce of *Urceola elastica* (Apocynaceæ), discovered in 1798, but its value till lately was only 2*d.* a pound, whilst Para fetched half-a-crown; its value is now about half that of the Para. From Assam the rubber brought is the produce of the *Ficus elastica*, which we so often see now as a drawing-room plant. In Java, species of *Ficus* (Urticaceæ) and *Vahea gummifera* (Apocynaceæ) yield a good "rubber." The African india-rubber is brought from Mauritius and from the West Coast; that from Mauritius is probably imported from Madagascar, where *Vahea* and *Ficus* grow; that from the West Coast is imported in casks, in the form of balls, slabs, and "tongues." It has a very foul smell, and is only valued at 11*d.* a pound—the cheapest of any. By some this is believed to be produced by *Sycomorus Guineensis* (Urticaceæ), whilst others believe that it exudes from some Apocynaceous plant, at present not known. Fragments of rubber have been [illegible] received from Australia, but it is not known what plant produced them. [illegible] 1867. Ho[illegible]

The Dragon-tree of Teneriffe.—It appears that this celebrated botanical curiosity has recently been removed from its time-honoured situation; in fact, has been blown down by a storm. No care appears to have been taken by the Spaniards to avoid such a mishap, which was, to say the least, not unlikely to happen, when we remember that the tree's ag is by many competent persons estimated at more than six thousand years. When Baron Humboldt visited the tree in 1799, he calculated its circumference at about forty-five feet near the root, whilst M. Fenzi, of Florence, who has been there since, gives a circumference of no less than seventy-eight English feet. Last year it was in good health and condition, the crown covered with innumerable panicles of scarlet fruit, and altogether as vigorous as ever. The great trunk is hollow, and it is maintained by some authorities that the tree as it at present stands, or till lately stood, is to be regarded not as a single tree, but as an agglomeration of individuals, which have grown up in the humus provided by the decay of the old tree. The name of dragon-tree, or dragon's-blood tree, is derived from the resin which exudes from the trunk, and is known as dragon's-blood, though the dragon's-blood of commerce is obtained chiefly from the *Calamus Draco*, an East Indian palm.

FRANCE.—*Action of the Induction-current upon Plants.*—M. Blondeau has pursued his investigation of the effect of the induction-current upon the vegetable organism (see our last Chronicle), by examining its action upon fruit and seed. Acting upon fruits the current hastens their maturity. Apples, pears, and peaches, which had been subjected to the action of the current, arrived at complete maturity when the other fruits of the same plant, which had not been operated upon, were still far from being ripe. The most curious results were obtained by electrifying seeds before placing them in the ground; seeds were rendered conductive by soaking them for some time in water, and then submitted for a few minutes to the action of the current. Peas, French beans, and wheat were experimented on. The electrified seeds always germinated sooner than those which had not been acted on by the current; the development of the plant was more rapid, and the stalks and leaves greener and more vigorous. Some of the electrified French beans presented a very curious peculiarity; they germinated downwards, the gemmule and cotyledons remaining in the ground, and the root rising into the air. The author remarks upon this peculiarity, which he compares to the effect of the current upon the poles of a magnet, and indicates that the embryo may hence be assimilated to a little magnet, having its neutral line and its two poles each charged with a peculiar fluid, tending to cause its organs to grow towards the centre of the earth or towards the sky. (!)

Green Rotten Wood.—Mr. Berkeley says in his 'Outlines of Fungology,' that "when wood is impregnated with the spawn of *Peziza ærugniosa*, it assumes a beautiful green tint. This is applied to various ornamental uses by the turners of Tunbridge Wells. Few people who admire it when manufactured are probably aware to what it owes its attraction." A writer in the 'Student' quotes this in reference to a colouring matter which has recently been obtained from rotten wood by two French chemists, and which evidently is what Mr. Berkeley alludes to, although they appear to be quite ignorant of its origin. M. Fordos found it to be soluble in sulphuric and nitric acids, and to be precipitated without alteration by water, and called it Xylochloric acid. M. Rommier, on the other hand, finds that, like indigo, it dissolves in alcohol (85° strength) in presence of potash and glucose, and the solution, which is at first brown, becomes green on contact with the air, and soon deposits the colouring matter in a gelatinous form. Silk and wool are easily dyed with it by adding acetic acid to an aqueous or ammoniacal solution of the colouring matter, steeping the thread in it and heating the solution to 80° C. M. Rommier calls this colouring matter Xylindeine. It is not stated whether an examination has been made with the spectroscope. It would certainly be very desirable to ascertain whether there are definite absorption bands or not. Has it any relation to the colouring matter, Phycocyan of Cohn, of which we have spoken here before?

ITALY.—*Artificial Hybrids among Cotton-plants.*—M. J. E. Balsamo found from experiments tried in the province of Terra d'Otranto in the South of Italy, during the American war, that the Siamese type of American cotton-plants, *viz.* the Louisiana and New Orleans, flourished well in that district, whilst the more valuable Sea Island or long-staple cotton was rendered valueless by the autumn rains. The cotton-trees which have been cultivated from time immemorial in the southernmost part of Italy are the *Gossypium herbaceum* and *G. hirsutum*, and these M. Balsamo thought might be advantageously supplanted by the American cotton-tree (*Gossypium barbadense*), if only the long-staple form could be made to ripen at a more convenient period. Accordingly he endeavoured to obtain hybrids between *Gossypium hirsutum* and *G. barbadense*, and has succeeded so far as to present specimens of the hybrids to the French Academy. Each species of cotton-tree has five petals and a great number of monadelphous stamens, all bearing anthers, and surrounding the pistil at different heights. They seem to be so many radii implanted obliquely upon the central cylinder or bundle formed by the styles. There are as many styles as stigmata, and they may easily be separated with the point of a penknife. They may be recognized by the naked eye in the form of three, four, or five delicate nervures, united together on the inside. The number of cells in each capsule invariably corresponds to that of the styles;

it is therefore of importance to select the capsules which have the greatest number of cells, in order to obtain a greater number of tufts of cotton. The oblique position and nearly radiating arrangement of the stamens renders artificial fecundation difficult, in consequence of the difficulty of cutting them all down to the bottom of the calyx, and removing them without the falling of a little seminal dust upon the stigmata. Nevertheless M. Balsamo succeeded in avoiding the contact of the anthers, and in transporting the pollen to the pistil of the flowers from which he had removed all the stamina. The cotton-flowers open about noon and close up again after fecundation, the stamina acquire a more vertical position, and the pistil lowers its stigmata towards the stamina which are beneath it; the corolla changes from yellow to rosy red, and on the following day it falls withered. If it happens to rain on the day of the flowering of the cotton-tree, the water which remains in the flower alters and blackens the pollen; in that case natural fecundation itself may fail, and the withered flower does not fall or falls very late.

Besides his experiments on artificial hybridization of cotton-trees, M. Balsamo has investigated the action of light on the germination of the seeds. He found by using a glass jar full of vegetable mould, that seeds exposed to the action of sunlight were greatly retarded in, if not entirely prevented from, germination. Seeds to which only yellow light had access were not affected.

GERMANY.—*The Origin of Bacteria.*—A German lady, Frau Lüders, of Kiel, has been investigating this matter with the microscope, and has published her conclusions in Schultze's 'Archiv.' Her paper is one of very great interest, and her researches have been ably and carefully conducted. She believes that she has proved—what many fungologists were prepared for—that Vibriones (leaving aside the question of there being more than one species) are produced from the spores and germinal filaments of various moulds or fungi—amongst which are enumerated Mucor, Penicillium, Botrytis, Torula, Manilia, Aspergillum, Leptosporium, Arthrobotrys, Acremonium, and Verticillium. It is impossible here to give an account of the precautions adopted in growing these fungi, but they appear to have been satisfactory. Professor Hensen, of Kiel, strongly supports all Frau Lüders says. She is also induced to believe that the blood of living animals contains *Vibriones*, either in the catenated form, or in that of the constituent granules; but during life, and until putrescence commences, these are always quiescent, and show no signs of active existence. In support of this, the following experiment by Professor Hensen is quoted. The extremity of a glass tube bent in the form of a W, with the ends drawn out and quite closed, and which had been exposed for half-an-hour to 200° C., was thrust into the heart of a recently killed guinea-pig, and then broken off. After the blood had sucked into the tube from the other end, which was melted off in order to remove any fluid that might adhere from the lips, the ends of the tube were sealed, and it was kept at a temperature of from 13° to 15° C. From one of the several tubes thus prepared, the point was removed after two days, and a drop of blood expelled on the next day, which, when examined with the microscope, showed large quantities of fungus-granules, chains and rods; mobile rods were rare. Milk, eggs, the mouth, and many organic fluids contain vibriones in this condition. Though Professor Hallier, the greatest authority on microscopic fungi, does not accept Frau Luders' results as to the connection of "moulds" and "vibriones," yet her researches on the blood have great importance in connection with his own. Professor Hallier has recently announced that he has been able to isolate and identify from the blood of typhus-fever patients a distinct form of fungus; also in vaccine matter and in other cases. Dr. Salisbury, of New York, has also recently made known the observation of distinct fungi in the fluids of persons suffering from other contagious diseases. Are we not advancing to a great fact as to the nature of such diseases? Fermentation and vaccination may come to mean much the same thing. Frau Luders has also successfully shown that "yeast" may be grown from many "moulds," as first demonstrated by Hallier.

5. CHEMISTRY.

(*Including the Proceedings of the Chemical Society.*)

Among the papers calling for prominent notice in this Chronicle, the first place is due to the Researches on Vanadium, an account of which was given by Dr. Roscoe in his Bakerian lecture before the Royal Society. The metal to which the name Vanadium has been given was first discovered by Del Rio in 1801. That chemist was, however, persuaded that the substance he had in hand was Chromium, and the new metal was again overlooked, until rediscovered by Sefström in 1830. Having hitherto been found in very small quantities, few chemists have had the opportunity of studying the metal and its compounds, and our knowledge of them is consequently limited. Almost all we know of them is, in fact, derived from the writings of Berzelius, whose conclusions have seldom been open to dispute. The remarkable exception, however, which vanadium compounds offer tô the law of isomorphism, if the views of Berzelius are accepted as correct, has greatly puzzled chemists, who were more ready to admit an exception to a law, than to suppose an error in an analysis by the "solemn Swede." But it follows from the researches of Dr. Roscoe that what Berzelius took for the metal vanadium is really the monoxide, and that the true formula of vanadic acid is $V_2 O_5$ (O=16). If this be correct, it follows that the vanadates form no exception to the law of isomorphism, and vanadium must be classed with phosphorus and arsenic. The atomic weight of the metal is necessarily corrected. Berzelius assigned to it the number 68·5 (O=8); but these researches prove that the true atomic weight is 51·21 (O=16). For a full account of Dr. Roscoe's investigations we must refer the reader to the 'Proceedings of the Royal Society,' No. 97, and shall here give only a short account of the oxygen compounds. The most interesting of these is the monoxide (Berzelius's metal), which Dr. Roscoe regards as a basic radical, and appropriately names it Vanadyl. It forms with chlorine a trichloride $V O Cl_3$, which Berzelius considered the terchloride of the metal. The monoxide is obtained when the vapour of vanadyl trichloride mixed with hydrogen is passed through a combustion-tube containing red-hot carbon. It is a grey powder possessing a metallic lustre. It may be prepared in solution by the action of nascent hydrogen on a solution of vanadic acid. After passing through all shades of blue and green, the solution acquires a permanent lavender tint, and then contains vanadium in the state of monoxide. The solution absorbs oxygen with great avidity. It bleaches indigo and other vegetable colouring matters as rapidly as chlorine, and far more powerfully than any other known reducing agent. Vanadium sesquioxide, $V_2 O_3$ (Berzelius's suboxide), is a black powder obtained by reducing vanadic acid in hydrogen at a red heat. This oxide has also a strong affinity for oxygen. When warmed in the air it glows and is reconverted into vanadic acid. At the ordinary temperature it absorbs oxygen slowly, and is changed into the dioxide, $V O_2$, forming blue shining crystals. Dr. Roscoe goes on to describe the constitution of the vanadates, and the compounds of vanadium with chlorine and nitrogen. We have no space for an account of these, and need only add, that these researches are in the highest degree creditable to their author.

In a practical point of view, recent researches offer to us but little of interest. We notice, however, a note by Mr. R. Warington, "On the Detection of Gaseous Impurities in Oil of Vitriol,"* which may be useful to our readers. These gaseous impurities are usually sulphurous acid and lower oxides of nitrogen. To detect the former, the author employs a strip of paper imbued with starch, and rendered blue at the time of using by immersion in a weak aqueous solution of iodine. In making the experiment, about two pounds of oil of vitriol are placed in a bottle, which it about half fills, and the bottle is violently shaken. The gases in the liquid are thus washed out by the atmospheric air, and if sulphurous acid

* 'Chemical News,' vol. xvii., p. 75.

be present, the strip of blue paper will be bleached when introduced into the air space of the bottle. The reaction in this case the author shows to be five times more delicate than the opposite one, when iodic acid and starch are used on the paper. To detect nitric oxides, Mr. Warington employs paper imbued with iodide of potassium and starch, which will be made blue by either of the oxides. Since, however, sulphurous acid destroys the blue iodide of starch, the presence of an excess of this gas will prevent the detection of the nitric oxides. But as these latter are without effect on the test paper employed for sulphurous acid, it is possible to obtain the reactions of both gases from the same oil of vitriol, if the sulphurous acid is not in excess.

Another paper of great practical value is that by Mr. W. Valentin, "On the Estimation of Sulphur in Coal Gas." * On few matters have greater discrepancies appeared in the reports of different experimenters than on this important question of the amount of sulphur in coal gas. Allowing that the quantity is very variable, these discrepancies admit of easy explanation. Still a process for its accurate determination is a great desideratum, and Mr. Valentin supplies one which has obvious recommendations. The gas, mixed with a proper proportion of atmospheric air, is passed through a porcelain tube, heated to redness by means of a combustion furnace. Within the porcelain tube is placed another tube made of fine platinum gauze, and filled with spongy platinum, and then a short platinum tube about four inches long, containing a few grammes of pure soda-lime. As the mixture of gas and air passes through the heated spongy platinum the sulphur compounds are completely oxidized, and the sulphuric acid (or the greater part of it) is fixed by the soda-lime as sulphate of sodium and calcium. The little that escapes may be fixed by causing the products of combustion to pass through a flask containing a solution of pure caustic soda. For the complete details respecting the operation, we must refer our readers to the place indicated below, with the remark that a process for estimating sulphur in gas is quite secondary in importance to one for removing sulphur before the gas reaches the consumer.

Another paper worthy of notice, is one by Mr. J. Hargreaves, "On the Manufacture of Steel from Cast Iron by the use of Nitrates and other Oxidizing Agents."† The subject of this paper, however, belongs properly to our Metallurgical Chronicle.

In organic chemistry a vast number of papers have been published which only possess interest for the advanced chemist. We may notice, however, the reported conversion by Siersch of methylic into ethylic alcohol‡ as a novelty of general interest.

The researches of Dr. Thudichum on the "Colouring Matters

* 'Chemical News,' vol. xvii., p. 89. † Ibid., vol. xvii., p. 20.
‡ 'Ann. der Chem. und Pharm.,' Jan., 1868.

of the Bile and Urine"* also deserve a notice for the vast amount of labour which seems to have been bestowed upon them.

Among new chemical literature, we notice with pleasure the first publication of the Berlin Chemical Society.† This society was founded by Dr. Hofmann, upon the pattern of the London Chemical Society, and this record of the earliest communications made to it gives the promise of a great success.

This paper cannot be concluded without a brief reference to the losses chemistry has sustained within the last three months. It may seem an anachronism to place first on the list the name of Dr. John Davy, F.R.S., for he gave up the active pursuit of the science very many years ago. Still his connection with his more eminent brother at the Royal Institution, and the great promise of success contained in his early writings on chemistry, make this perhaps the most fitting place for a short record of his life.

Dr. Davy was born at Penzance, on the 24th of May, 1790, and was the youngest of five children, of whom Sir Humphry was the eldest. In the autumn of 1808, the subject of our notice came to London, and began the study of chemistry in the laboratory of the Royal Institution. The pupil was in a very short time advanced to the position of assistant to Sir Humphry, then in the zenith of his fame and happiness.

Within the period 1808–1811, the elder Davy, it will be remembered, made some of his most brilliant discoveries; and the younger brother was associated in all the laborious researches which led to them. Among these was that elaborate investigation which confirmed the views of Scheele as to the simple nature of chlorine. The name oxymuriatic acid, which until then was applied to that body, expressed the belief that it was a compound gas containing oxygen. The experiments of Sir Humphry Davy proved beyond a doubt that no oxygen could be separated from the so-called oxymuriatic acid; but they did not suffice to convince all the chemists of that day. Among those who remained unconvinced was Dr. Murray, the Lecturer on Chemistry at the University of Edinburgh; and it was in reply to the objections of this gentleman that Dr. (then Mr.) John Davy published his first scientific paper. It will be found in 'Nicholson's Journal,' vol. xxviii. (1811), and may be read with pleasure at this day for its lucid style and clear reasoning. This paper won the approval of Sir Humphry so much that he flatteringly told his brother he had never written anything half so good at the same age. The controversy went on for a couple of years, and led eventually to the discovery of Phosgene Gas, or chloro-carbonic acid, by Dr. Davy. In trying to repeat an experiment indicated by Dr. Murray, he exposed to sun-

* 'Proceedings of Royal Society,' No. 97, p. 215.

† 'Berichte der deutschen chemischen Gesellschaft zu Berlin,' N. 1, 2, 3.

light a mixture of equal volumes of chlorine and carbonic oxide, and found condensation to one volume take place. This induced him to make a complete examination of the new compound, an account of which is published in the 'Philosophical Transactions' for 1812. It was followed in a short time by two other papers, one "On the Compounds of Chlorine with the Metals," and another "On Certain Compounds of Fluoric Acid." These papers exhibit great diligence in research, and are marked by great accuracy in the analyses.

Here, we regret to say, Dr. Davy's career as a chemist may be said to have almost closed. He resolved upon the study of medicine, and proceeded to Edinburgh for the purpose. After taking his degree, he returned to London in 1814, and held for a short time the lectureship on chemistry at Windmill Street School of Medicine, vacated by Mr. Brande, who had been appointed Sir Humphry's successor at the Royal Institution. He delivered only one course of lectures, and we do not find any record of original research during this time.

Early in 1815, Dr. Davy entered the medical service of the army, and served as hospital assistant in the Waterloo campaign. He was afterwards sent to Ceylon, and served with Sir R. Brownrigge during the rebellion. The 'History of Ceylon,' which he published in 1819, is still referred to as authoritative.

Dr. Davy left Ceylon in 1820, and in the years which followed was employed in various parts of the world as staff army surgeon. He was doing duty in this capacity at Malta, when he was summoned to attend his brother in his last illness, which ended at Geneva.

Wherever he was, Dr. Davy was never idle. While a student at Edinburgh, he had commenced researches on the blood, which he continued at every possible opportunity. While at Malta, he was also engaged in some anatomical investigations, and made some experiments with the torpedo, in which he obtained some new results, showing the identity of the effects of its electrical organ with other forms of electricity. Nor was chemistry altogether neglected. At this time he examined the compounds of ammonia and carbonic acid, and made experiments on the oxidation of phosphorus. The results obtained were published in Jameson's 'Edinburgh Philosophical Journal,' which also contains a short paper, written about the same time, on silicated fluoric acid.

From 1835 to 1839 Dr. Davy was principal medical officer at Fort Pitt, Chatham, and then found time to write the 'Life of Sir Humphry,' published in two volumes. This work was called into existence by the appearance of another biography of the great chemist, "not gentlemanly done," as Sir Walter Scott said. The work referred to is now forgotten, and it is well to say that a very full biography of Sir Humphry Davy is to be found in the smaller compass of a single, the first, volume of the eight volume edition of his works by Dr. Davy.

In 1839 Dr. Davy again left England to undertake the hopeless task of reforming the Turkish hospital system. A tour of inspecting service in the West Indies during the years 1845–8 terminated his active professional career, and he retired to what to most men would have been well-earned leisure at Ambleside. But leisure with Dr. Davy only meant time to occupy himself with his favourite pursuits; and up to the period of his last illness he continued an active investigator of facts, and a writer of papers and books. A mere catalogue of the subjects of his investigations, and the titles of his papers and books, would occupy too considerable a space. We may mention three, however,—a second series of "Anatomical and Physiological Researches;" another entitled "Army Diseases, with Contributions to Pathology," embodying the results of his experience as an army physician; and the "Fragmentary Remains of Sir Humphry Davy," from which, as having been published in his later years, and including many of his earlier papers, an adequate knowledge may be gained of the various fields of labour upon which he entered.

One of his latest publications was a successful vindication in the 'Philosophical Magazine' of Sir Humphry Davy's reputation from certain assertions made by Mr. Babbage. In this task he was assisted by the late Sir James South. His very latest paper, "On the Temperature of the Common Fowl," was read before the Royal Society of Edinburgh a few weeks after his death. The subject of animal temperature occupied him more or less the greater part of his life. Wherever he happened to be, he was busy with his thermometer, which found its way into the mouths of all sorts of animals, including the tiger, the leopard, the Indian elephant, the shark, and the adder.

Dr. Davy was seized with his last illness on January 15th, and died on the 24th, at the advanced age of 78. His first paper was published in 1811, his last this year. Thus his activity as an experimenter and author is seen to have lasted over fifty years. We have before expressed our regret that he did not confine himself to the study of chemistry. Anatomists and physiologists will probably regret that his attention was not concentrated on their sciences. He was, indeed, calculated to shine in any pursuit that requires patient and laborious investigations, for therein lay his strength. For mere hypothesis he had small respect, but spoke in praise of theories which in his first paper he defined as "generalizations upon observed facts." He made it his business, however, to observe the facts, and we may rest assured that he who generalizes upon the observations of John Davy has a safe foundation. Such as he are the men who really advance science.

Mr. Wm. Herapath, F.C.S., died at Bristol on the 13th of February, in his 73rd year. Although a sound general chemist, he was best known as a toxicologist, having been brought into notoriety by the celebrated Burdock case, some thirty years ago. He was one of the founders of the Chemical Society, and Lecturer on Chemistry at the Bristol Medical School.

Proceedings of the Chemical Society.

The first meeting we have to notice was held on December 19. On that evening Mr. A. Tribe read a paper "On the Freezing of Water and Bismuth." Bismuth, it has been said, is a body which, like water, expands near the point of solidification. The author's experiments prove that although the metal does increase in bulk at the moment of solidification, there is no evidence to show that any expansion takes place before the solidification.

At the meeting on January 16, a paper by Mr. Pedler "On Isomeric Forms of Valeric Acid" was read, in which the author showed that the acid prepared from inactive amylic alcohol—*i.e.*, the alcohol which does not affect the plane of polarization, is also inactive towards a polarized ray, while that prepared from the active alcohol rotates the ray 43° to the right.

After this, Dr. Debus made a verbal communication "On Thioformic Acid," an acid produced when formiate of lead is treated with sulphuretted hydrogen. The views expressed were of a hypothetical nature; but the speaker promised some investigations on the subject.

Dr. Frankland then delivered a lecture "On Water Analysis." In this lecture, the author first gave a critical review of the methods commonly employed for the determination—1, Of the total solids; 2, the organic and volatile matters; 3, the amount of oxygen required to oxidize the organic matter; 4, the nitrites and nitrates; and 5, the ammonia.

1. To estimate the total solid constituents, it is usual to evaporate a measured quantity of the water with the addition of a known amount of carbonate of soda, and to dry the residue at from 120° to 130° C., until the weight is constant.* In this process the lecturer pointed out two sources of error. In the first place, if salts of ammonia are present, they are changed into carbonate, which is volatilized; and, in the second place, urea will also be decomposed, and some of its products dissipated. An experiment

* Dr. Frankland was in error in ascribing the first employment of carbonate of soda to Messrs. Hofmann and Blyth. The method was adopted by those gentlemen in the examination of the London waters (1856); but was first employed by Mr. Edwin Schweitzer.

showed that as much as 44 per cent. of the urea might be lost in this way. These two sources of error may be avoided by leaving out the carbonate of soda, evaporating at a low temperature, and drying at 100° C. A little water will be left behind in this way, but it will be chemically combined, and may be fairly considered part of the solid constituents. The differences of weight in residues dried at these different temperatures was shown by a few examples. Thus, a residue which dried at 100°, weighed 27·02, when heated to 120°—130°, weighed 26·54. Another, dried at 100°, weighed 26·70, and at 120°—130°, 26·20. Before, however, a residue is ignited to determine the organic matter, the water must be expelled by carrying the heat to the higher temperature.

2. To determine the organic and volatile matters, the residue is heated to dull redness. By this the carbonates of lime and magnesia are causticized, and must be recarbonated by means of carbonic acid water; the addition of which, and the redrying must be repeated until the weight of the residue ceases to increase. In this process there are also two sources of error. The organic matter may not be entirely destroyed. When, for example, urea is evaporated with sodic carbonate, the loss on ignition represents but a small part of the urea in the original residue. Sometimes also after recarbonating an ignited residue it weighs more than before ignition. In any case a loss on ignition may represent organic matter, or it may represent mineral nitrites and nitrates, while the organic matter may remain.

3. To ascertain the amount of oxygen required to oxidize organic matter, a solution of permanganate of potash is employed. This process Dr. Frankland said is utterly untrustworthy, many organic substances refusing to be completely oxidized by this means. In the cases of urea and hippuric acid, for example, the oxygen consumed represented only one-fiftieth of that required by theory.

4. To determine nitrous and nitric acids, Dr. Pugh's method has been generally followed, but Messrs. Chapman and Schenck have shown that many organic substances affect the result.

5. To estimate ammonia the water is usually distilled with baryta or carbonate of soda, and the ammonia determined in the distillate either by neutralization or Nessler's test. When, however, urea is present, ammonia may be liberated, which will be estimated as free. After this criticism of the usual processes, Dr. Frankland made some suggestions for their improvement. To determine the amount of solid ingredients, he recommended that half a litre, or a litre, of the water should be evaporated as rapidly as possible, and the residue dried at 100°. Our space will not allow us to describe the particular manner by which Dr. Frankland determines the amount of organic carbon and nitrogen from which he deduces the amount of organic contamination. We may say

briefly, however, that the determination is effected by a combustion of the fixed residue after the expulsion of the carbonic, nitrous, and nitric acids, by the addition of sulphurous acid. For a full description, we must refer our readers to an excellent report in the 'Chemical News' for February 14, and the 'Journal of the Chemical Society' for March.

For an account of Mr. Crum's process for the determination of nitric acid, which is adopted by Dr. Frankland, we must refer our readers to the same places, or to the original paper, "On the Analysis of Bodies containing Nitric Acid" in the 'Philosophical Magazine,' vol. xxx., 1847.

Lastly, for the determination of the ammonia, Dr. Frankland employs Nessler's test with the original water, decolorized, if necessary, by the addition of a little chloride of calcium, carbonate of soda, and a few drops of potash.

The lecture was followed by a very long discussion, which turned mainly upon the value of the process of Messrs. Wanklyn, Chapman and Smith for estimating albumenoid nitrogen in waters. (See 'Q. J. S.,' vol. iv., p. 532.) We believe we state fairly the general opinion, when we say that the value of the process is considered doubtful, scarcely two experimenters obtaining concordant results with it. The discussion occupied the greater part of two evening meetings.

At the meeting on February 6, Dr. Russell gave a lecture "On Gas Analysis," in which he described a greatly improved and simplified form of the apparatus he devised some years ago. A description and drawing of the original apparatus is given in the 'Chemical News,' vol. ix., p. 282; and an account of the improvements now made are contained in the same journal, vol. xvii., p. 95.

Mr. W. H. Perkin, F.R.S., afterwards read a paper "On some New Benzylic Derivatives of the Salicyl Series."

At the same meeting the Secretary read a short note from Professor Kolbe, announcing the discovery by Dr. E. Drechsel of a means of *reducing carbonic to oxalic acid.* A mixture of pure sodium and dry sand is placed in a flask, and heated to the boiling point of mercury. A current of carbonic acid is then passed. After some time the metallic appearance of the sodium is lost, and the metal becomes almost black. The heat is then moderated to avoid reduction of the carbon, and the mass is allowed to slowly cool. When the mass is afterwards extracted with water, the solution is found to contain oxalate of sodium. Potassium amalgam it has been found will effect the same reduction.

Dr. Frankland described this discovery as one of the greatest triumphs of modern synthetical chemistry.

On February 20, Mr. David Forbes, F.G.S., delivered a lecture "On Chemical Geology," which attracted a large audience. An adequate report of this highly interesting discourse, and the discussion which followed its delivery, could hardly be given in the small space we can devote to the matter; and we shall only say that Mr. Forbes considers that a combination of the Plutonic and Neptunian theories will best account for the results developed by modern research. He showed that silica occurred in nature as an igneous product in recent lavas; that it occurred also as an aqueous product in different forms deposited from solution; and also as a gasolytic product in tubes from the decomposition of fluoride of silicon. As regards the origin of granites, while he is satisfied that many of the so-called granites and gneisses are really sedimentary products of the breaking-up of true igneous rocks by aqueous agency, and subsequently reconsolidation, he also believes that true igneous and eruptive granites do exist, and he replied at some length to the arguments of those who dispute altogether the igneous origin of these rocks. Assuming that the whole of the constituents of this earth were once in a state of vapour, he considers that these vapours obeyed the law of gravity and arranged themselves in zones according to their densities. He thus concludes that the central nucleus of the earth must contain an accumulation of the denser metals and their compounds, an hypothesis which is supported by the fact, that while the mean density of the earth is about 5·4, the density of the exterior crust is only 2·75. At the moment of solidification the earth must have formed a true sphere; but the outer crust becoming subject to volcanic and other forces, the surface would be soon broken up into mountains and valleys, and subsequent aqueous action would produce other changes in the first-formed rocks. Metamorphic action, promoted by heat, pressure, chemical action, aqueous or gasolytic agency, or altogether combined, would continue to go on, and produce that state of our earth which offers itself for the study of the modern geologist. The discourse, of which the foregoing is the merest outline, was followed by a discussion, in which Sir R. Murchison and Professors M'Donald and Morris took part. For an excellent report of this we may refer the reader interested in the matter to the 'Chemical News' for February 28.

The last meeting of the Society which we can notice was held on March 5. On that evening Professor Wanklyn gave the substance of a paper "On the Action of Oxidizing Agents on Organic Compounds in the presence of an excess of Alkali—Part 1. Ammonia evolved by Alkaline Permanganate, acting on Organic Nitro-compounds."

The paper related to the author's process, before referred to, for determining the amount of nitrogenized organic matters in waters; and he gave a list, first, of the substances which he found to yield all, or very nearly all, their nitrogen in the form of ammonia, when distilled with permanganate of potash in the presence of free alkali. Among these were amylamine, diamylamine, asparagine, hippuric acid, piperine, and narcotine. Next followed a list of substances which yielded about half of their nitrogen under the same circumstances, among which we have morphia, codeia, papaverine, sulphate of quinine, and nicotine. Kreatine is an example of a substance which gives up one-third of its nitrogen as ammonia, while theine only yields one-fourth. Gelatine, casein, and dry albumen give up smaller, and apparently uncertain proportions; while picric acid and true nitro-compounds give up none.

Mr. E. T. Chapman then read a note "On the Decomposition of Nitrates by Sulphurous Acid; and another "On the Detection and Estimation of Nitrates in Potable Waters." The estimation the author makes by converting the nitric acid into ammonia, by the action of aluminium and an alkali. The limits of error by the process he believes to be within five per cent.

Mr. Perkin, F.R.S., afterwards read a paper "On the Hydride of Aceto-salicyl," which was followed by two by Dr. Stenhouse, F.R.S., "On Chloranil," and "On the Action of Nitric Acid on Picramic Acid." Lastly, Mr. Chapman gave a short account of the "Action of Zinc Ethyl on Nitrous and Nitric Ethers," which is, it seems, sometimes attended with very violent explosions.

The Secretary also read papers by Mr. Hunter, "On the Absorption of Vapours by Cocoa-nut Charcoal," and by Mr. F. A. Claudet "On the Crystalline Form of Arsenious Acid." The author had obtained from the Pyrites Mine of San Domingos, Portugal, a quantity of fine crystals, similar in form to those first described by Wöhler, as obtained by sublimation under peculiar circumstances. The crystals belong apparently to the same system as those of gypsum. This form cannot be reproduced by either solution or sublimation, in either case only the ordinary octohedral crystals being obtained. There are reasons for believing that active spontaneous combustion is going on in a part of the mine mentioned, and the arsenious acid was probably sublimed in an atmosphere of sulphurous acid.

6. ENGINEERING—CIVIL AND MECHANICAL.

Whilst the fear engendered by the late collapse of several railway and other companies still exercises its influence on capitalists, causing the suspension or abeyance of numerous promising undertakings in Civil Engineering, the combinations of mechanics, under the influence of Trade Societies, is rapidly having the effect, not only of disturbing the relations between employers and employed, but of diverting trade from its former centres, and in too many instances of driving it out of the country. Of this latter result, numerous examples might be instanced; but perhaps the most remarkable of all that have come to our knowledge is the fact of a Preston mill owner having recently obtained spinning machinery from Belgium.

Shipbuilding, Docks, Piers, &c.—Iron shipbuilding is beginning to show symptoms of recovery from its recent depression at most parts except London, where the suicidal combinations of workmen effectually prevent builders from taking orders. On the Clyde and Tyne a fair amount of business has been done during the past year. On the Mersey most of the shipbuilders are tolerably busy, and at Messrs. Laird's yard two or three ironclads are under construction. A new paddle steamship, for the City of Dublin Steam Packet Company, was launched at the end of November last from the yard of Messrs. Walpole, Webb, and Bewley, of Dublin. This is worthy of note, since it is the first vessel of that class hitherto constructed at Dublin. M. Giquel, a Frenchman, is stated to have arrived at Tientsin with one hundred French engineers and workmen, where he is about to build sixteen steamers, of 300 tons each, for the Imperial Customs. A new iron steam ferry-bridge has recently been constructed for the Govan Ferry, which carries two loaded waggons or three loaded carts, together with sixty or eighty passengers; with these it crosses the Clyde in 1½ minute. This vessel is constructed in six water-tight compartments. The machinery for propulsion consists of a pair of 20 horse-power diagonal steam-engines, geared to the driving wheel, round the circumference of which is wound the driving chain, whose ends are secured on each side of the Clyde.

During 1867 about 350,000 cubic yards of earthwork and 24,000 cubic yards of masonry and brickwork were executed at the Hull Western Dock; and it is the opinion of Mr. Hawkshaw that, if due diligence be shown, the dock may be completed this year. The Hull Graving Dock is to be increased by 83 feet, which will give it a total length of 300 feet; the depth is also to be increased to the extent of 4 feet 6 inches. From the report of the engineer to the Mersey Docks and Harbour Board, it appears that the amount required to complete works in progress and contemplated is upwards of 700,000*l.*

A new pier has recently been ordered to be erected in Woolwich Arsenal, to facilitate the shipment of heavy ordnance, which will be fitted with cranes capable of hoisting 30 tons weight. The pier with its T head will extend 300 feet towards the bed of the Thames; it will be 25 feet broad, and the head of the pier will be 100 feet long. A new wrought-iron pier is in course of construction at Clevedon, in Somerset; the length of the approaches is 180 feet, and of the pier itself 800 feet, having a head 42 feet in length, making a total length of over 1,000 feet. The pier is composed of eight 100-feet spans, consisting of two continuous wrought-iron girders, 3 feet 6 inches deep, which serve partly to form the parapet. The pier head measures 42 feet by 50 feet, and is supported on eighteen piles, standing 65 feet in height above the ground. A new pier is about to be carried out at Saltburn-by-the-Sea, and a contract for the ironwork has been taken by Messrs. Cochrane, Groves, and Co., of the Ormesby Ironworks. Some time ago a premium was offered for the best design for the protection of the headland at Hartlepool, and we now learn that the plans and estimates of Mr. Thomas Fenwick, C.E., of Leeds, have been selected.

A swing bridge has recently been erected over the river Hull, near its junction with the river Humber. The bridge consists of two parts, namely, a movable part on the eastern, or citadel, side, which, when open, gives a clear waterway of 100 feet; and a fixed part on the western side, having a clear space of 40 feet. The London and North-Western Railway Company have been making good progress with their great bridge over the Mersey at Runcorn; the sixth and last great girder is placed, and traffic is expected to be commenced over the bridge in June next. The scheme for bridging the Forth at Alloa was fairly set afloat on 3rd January last; the structure will be similar to that across the Tay at Perth, having spans of 64 feet in width. In the centre the bridge will swing from both sides and open a space of 200 feet for vessels to pass through. A bridge has been thrown across the Boug, on the Balta and Olviopol Railway, which is 800 feet in length, and contains 1,640 tons of iron in its structure. The Perkiomen Railway Bridge, to be constructed across the Schuylkill, will consist of three spans of 170 feet, and one span of 125 feet, and having a total length of 635 feet. It is to be built on the plan known in America as the "isometrical truss."

Lighthouses.—A novel sort of lighthouse has recently been erected at Lowestoft. In consequence of the tendency of the foreshore to move steadily in a fixed direction, the design has been so arranged that the structure may be easily removed; and for this purpose the superstructure has been made independent of the bearing-piles and foundation-frame. The height from the level of high-water spring-tides to the centre of the lantern is 40 feet, and the illuminating apparatus is a second-order dioptric light by Messrs. Chance, Brothers, of Birmingham. The new lighthouse at Cochin, on the Madras coast, was inaugurated on the 15th January last. Two lighthouses have been erected by the Abyssinian Expedition at Assaike and Adjnee Island in Annesley Bay.

Railways.—The construction of the Sloane Square station of the Metropolitan District Railway involved, amongst other works, the destruction of a length of the Ranelagh sewer. The cast-iron tube, which has replaced the old brickwork, is supported on two wrought-iron main girders, and on two smaller girders of cast-iron, which span the staircase constructed at the back of one of the retaining-walls of the station. The widening of the Metropolitan Railway between King's Cross and Farringdon Street stations was officially inspected, upon completion, on 15th January last. The widening commences in King's Cross station, and for some distance it runs parallel with the old line; then dipping, it crosses beneath the Metropolitan, and rising on the other side, again runs parallel with it. The covered way on the East London Railway is completed to within 200 yards of the Thames Tunnel, and the works to connect the covered way with the Tunnel are in progress. The embankment is nearly completed to the junction with the Brighton Railway, and from this point to the north bank of the Thames the line may be ready for traffic before the end of the summer. It is expected that the Sutherland Railway, extending from Bonar Bridge to Golspie, will be opened for traffic about the end of March. The Swansea section of the Llanelly Railway was opened for passenger traffic throughout on January 1st. By the opening of this section the narrow gauge has been completed from Swansea to Carmarthen, and, by means of the Central Wales line, the London and North Western system will now have direct access to the ports of Swansea and Llanelly. On Saturday, December 7th, an important step in the construction of the railway viaduct across the Solway Firth was accomplished by the meeting of the two portions which have been worked from the English and Scotch shores. The portion of the viaduct now completed, which was commenced about two years ago, is about a mile in length, consists of 183 piers, and has a height of about forty feet above low water. The three large bridges on the Callander and Oban Railway, and which span the Teith three times between Callander village and Loch Lubnaig, are now finished. The middle one, which is at the Pass of Leny, is 140 feet span, and the others are within a few feet of the same length.

The progress of the Mont Cenis tunnel in December last was 73·25 mètres in length; 35·40 mètres having been pierced on the Italian side, and 37·85 mètres on the French side. Up to 31st December last 7,846·65 mètres had been excavated, leaving 4,373·35 mètres still to be done. The Summit Railway over Mont Cenis still hangs fire, and has not yet been brought into use, although it was officially opened some months since. It is now, however, given out that it will commence regular work on 1st May. Meanwhile, the railway over the Brenner seems to be acquiring popularity as a means of transit from Western Europe to Italy. On the Ligurian line of railway the Porto Vado tunnel, 1,200 mètres in length, is nearly finished, as is also the section of railway between Vado and Sportono.

The second section of a line of railway from Moscow to the south has been opened for traffic. The first section from Moscow to Serpoukhoff, 59⅜ miles, was opened for traffic in 1866, and the section now opened extends from Serpoukhoff to Toula, 59⅛ miles; traffic is thus now conducted over a distance of 117½ miles. The third section, between Toula and Orel, and the fourth, from Orel to Koursk, will be opened to the public next summer. The Ryason-Morschausk line, a portion of the Moscow-Volga line, has also been recently opened; it is 150 miles long, and has only taken a year and three months to construct. The Koslow-Woronesh Railway, a link in the long line to be laid down between Moscow and the Sea of Asof, is probably by this time completed. The Moscow-Odessa line is progressing so fast that it will most likely be completed this year; and the works between Poti and Tiflis, a line which, after its extension to the Caspian harbour of Baku, will monopolize a considerable portion of the Persian trade, have just been begun.

The Ciudad Real and Badajoz Railway Company completed its branch line to the Belmez coal-basin in January last. This result is expected to have an important influence upon the original undertakings, as it will not only lead to the development of a coal traffic, but will also assist in the reduction of working expenses.

The railway tunnel at Constantia, in Algeria, is finished. It is nearly 3,000 feet long.

The first half of the experimental elevated railroad in Greenwich street, New York, is fast approaching completion. The Pacific Railroad is now stated to have been carried 520 miles beyond Omaha; more than 4,000 men are employed on the earthworks and the construction of rolling stock. An unbroken railway communication is now open from the Atlantic seaboard to the Rocky Mountains, a distance of more than 2,000 miles. An additional railway section has just been opened for traffic in Chili.

The doubling of the Great Indian Peninsula Railway between Egutpoara and Nassick was expected to be finished by the end of last year. Plans and sections of the Neemuch and Delhi extension of the Bombay, Baroda, and Central India Railway, from Saugor to Nusseerabad, have been completed, as has also the survey to Jeypore, a section of which is about to be started, and another party is working towards Agra. The extension of the same line to the river Saburmuttee, at Ahmedabad, a distance of 2¼ miles, will shortly be commenced. The railway bridge over this river, which was designed by Mr. A. W. Forde, formerly Chief Engineer of the Bombay and Baroda Railway, has been let to that gentleman for 4½ lacs of rupees. The opening of the Chittravutty Bridge on 8th January last, together with the completion of the Madras and Bombay Railway to Tadpatri, will have the effect of opening up the important district of Bellary. This bridge is 2,800 feet long, or a little over half-a-mile; the end girders are supported on masonry piers, and in the centre on wrought-iron screw piles.

River Improvements and Canals.—In order to avoid any disastrous flooding of the River Irwell, Mr. Hawksley, C.E., recommends the construction, at a cost of 120,000*l.*, of a tunnel, 2 miles long and 10 yards in diameter, for the purpose of carrying off the superfluous water.

The works for improving the Godavery have made such progress that it is anticipated the river will be open for navigation as far as the second barrier, 225 miles from the sea, before the next monsoon. Works have been commenced for the construction of a new canal from the Sutlej; it will leave the left bank of the river near Roopur, and, passing southwards, will irrigate the arid parts of Puttiala, Ferozepore, and Sirsa. The Grand Canal, in China, which has been gradually drying up since 1857, has now become utterly impassable, vessels drawing a few inches only being unable to find water to float them. A project for a canal for the irrigation of Lombardy by water, from the Lago Maggiore, has recently been brought forward.

Mechanical.—A series of experiments have recently been carried out in London on a new form of furnace invented by Mr. T. J. Leigh. This furnace is applicable for puddling, steel-melting, or other purposes for which an intense heat is required, and it is adapted for burning slack coal as fuel, which is instantaneously converted into gas as it is fed in, and a perfect combustion and very intense heat are obtained. Crop ends of steel rails placed in the furnace are reduced to a perfect fluid state in 25 minutes, and wrought-iron is also readily melted. The Russian Government are making great efforts to develop the mechanical industry of that empire. The construction of a bridge proposed to be thrown across the Boug, on the Warsaw and Terespol Railway, has been let to a Russian house. The Russian Government also intends to order a quantity of plant —including locomotives and tenders—from four works on its territories; and it is further rumoured that the Government is disposed, where necessary, to stimulate Russian mechanical industry by direct pecuniary advances. We have already alluded to a consignment of spinning machinery from Belgium having recently been received at a cotton mill in Preston. As another instance of the successful competition of foreign manufacturers with our own, it may be stated that Alexander, of Barcelona, is now making marine engines of several hundred horse-power for a Liverpool firm.

7. GEOGRAPHY.

(Including the Proceedings of the Royal Geographical Society.)

Whilst attention is most earnestly directed to Africa, the Nile is not the source of this engrossing speculation. Dr. Livingstone is, as far as we know, progressing in a northerly direction for Nyassa, and solving the problems left by his predecessors in the neighbourhood of the great lakes. The information received that, some year or more back, he was alive and well, will be found in the latter part of this Chronicle, amid the Proceedings of the Royal Geographical Society. The main object of consideration at present is the small strip of land on the western shore of the southern part of the Red Sea, which forms the eastern slope of the highlands of Abyssinia. Here a small British force are doing work at the expense of the nation, which it usually falls to the share of the unpaid contributors to the Royal Geographical Society to perform. New passes have been discovered, and the whole of the water system of the district carefully surveyed. In the meantime the present state of our knowledge and our ignorance is accurately laid down in a cheap Blue Book, in which is collected almost everything known about this country previous to the landing of the expedition. The most valuable addition to our knowledge since that period is the report of Mr. Clements Markham, an abstract of which will be found at the end of this article.

The captives, from time to time, send letters, in which they approve of what is being done for their release. In the meanwhile the doubt still remains whether any Europeans are detained in the Somali country. An opportunity has offered of obtaining information on this point, but we do not know that the Government have availed themselves of the assemblage at Berbera, at the annual fair, of all the principal people from the whole of this eastern peninsula of Africa. It has been suggested that rewards for information, and greater ransoms for living men, would soon bring every European detained up the country to some point on the coast easily accessible from Aden.

The result of the appeal in aid of the Palestine Exploration Fund was the collection of a large sum, which will enable the work to be carried on for some considerable time, and it is to be hoped that many discoveries will be made, for undoubtedly much remains to be laid bare. Many ancient buildings must be simply covered with the accumulated rubbish of ages; and whatever may have been the will of conquerors for the destruction of the city, a great deal must be only hidden, to be brought to light, it is to be hoped, by the engineers now at work. At all events, the various levels of different parts of the town are being discovered by shafts let down to the rocky foundations.

A great deal of careful investigation of the country through Nepaul and along the whole length of Thibet to Lhasa has been made by a pundit at the instance of Captain Montgomerie, R.E , who was prohibited by his official position from making the attempt himself. The country described, of which we shall probably soon get very full information, runs along the valley of the Brahmaputra almost from its source. The pundit had to travel in various disguises, but succeeded in carrying philosophical instruments with him, and in making a large number of accurate observations, thus settling both positions and elevations of many places. The road between Gartokh and Lhasa, a distance of 800 miles, is one of the most important features of the country. It passes the head waters of the Indus, the Sutlej, and the Brahmaputra, and continues to keep very closely to the line of the latter river. The Government couriers traverse it in twenty-two or twenty-three days, only dismounting to change horses and to pass rivers, never resting or changing their clothes, which are sealed on, and arriving at their journey's end haggard and worn, and eaten into sores by lice. The description of Lhasa, 11,400 feet above the sea, differs little from that of Huc and Gabet. The Grand Lama, whom the pundit saw, lives at a fort a mile from the town. He is a boy of thirteen, surrounded by priests, who show him every respect. He exhibited some considerable intelligence, but the government is entirely in the hands of the prime minister. Tea is imported in large quantities from the north-east, and musk is the principal article of commerce which finds its way into the Indian market.

The whole Chinese empire seems to be in a state of dissolution. Province after province has revolted. Rumours, with what foundation it is impossible to say, speak of defections on the western boundary. Russia, probably, will in time take advantage of this, and increase her already overgrown dominion. A survey has been made to discover the best route to the south-western part of China from Rangoon.

In this survey the country of the Karens, an independent tribe, has been traversed. The people are peaceable, but they appear to dread their neighbours, for they invariably flee as soon as strangers visit their villages. Paths are rare, and there is but little to mark that the country is inhabited, though it is extremely fertile. The custom seems to be to clear a piece of land, crop it until it is exhausted, and then abandon it for a new clearing. The most valuable product is the iron-tree, frequently rising 80 ft. straight up without a branch.

In New Zealand, the district of the Lower Waikato, to the south of Auckland, has been surveyed. It is a fertile country, suited for pasturage and roots, but not well adapted to corn, being covered with brush. The soil is of a loamy nature, but deposits of limestone and of a so-called "brown coal" are found. The limestone is fit for building, and for some finer work, and the coal has been used on the river steamers. The amount of the latter is considerable, and promises to be easily worked, without sinking shafts or difficulty from water.

In Australia, the exploration of the Gulf of Carpentaria has been continued by the expedition sent out by the Government of South Australia. Several hitherto unknown rivers, and a bay of 20 miles width by 10 broad, have been discovered on the north-western promontory of the Gulf. A large quantity of gold has been found on the Mary River, about 100 miles to the north of Brisbane, which, of course, has had a great effect upon the labour market.

In Europe, the greatest geographical event has been the eruption of Mount Vesuvius, with its attendant disturbances of landslips and earthquakes. In the midst of Naples itself, a portion of a cliff which overhung a main street slipped forward, burying houses and, it is said, even carriages in its fall. That the continued earthquakes have had something to do with this disaster there cannot be any doubt: how much is a question that cannot be solved at present. The eruption itself has now gone on for some considerable period. Part of the older crater has been broken away; a new cone has arisen; several streams of lava have poured down the sides, threatening in turn Resina, Torre del Greco, the Hermitage, and the Observatory. As yet, no great damage has been done to the cultivated lands; but the people of the neighbourhood have been prepared to flee at the first appearance of danger. The form of the mountain is considerably changed, and it has been covered at various times with sublimates of different salts, which are washed away by the rain, a new deposit soon taking the place of the old one. The mountain in the meanwhile has been a magnificent sight, especially by night. The streams of lava glow with various degrees of brightness, whilst that which appears a pillar of cloud by day is a fountain of fire at night. Continuous discharges of various characters accompany the earthquakes, which are so violent, that the instruments at the Observatory have to be detached from the walls, and laid on the ground. Professor Phillips, of Oxford, has gone to the spot to settle some points with regard to the deposition of lava.

The Gulf Stream is said to have become much more rapid since the disturbances in the West Indies. Changes in this current cannot but affect our climate. The subject of this stream has been carefully handled by J. G. Kohl, in his 'Geschichte des Golfstroms und seiner Erforschung.' Amongst the new works on Geography, either published or promised shortly, are 'Vambery's

Sketches of Central Asia,' Major's 'Life of Prince Henry of Portugal,' Chapman's 'Interior of South Africa,' Hochstetter's 'New Zealand,' Maurer's 'Die Nicobaren.'

Proceedings of the Royal Geographical Society.

At the first meeting of the Society this year a report was read from Mr. C. D. Young who was present, and afterwards explained some points at further length, giving an account of the expedition sent to Southern Africa for the purpose of ascertaining the truth or the falsehood of the reported death of Dr. Livingstone. Mr. Young and his party landed at the mouth of the Zambesi, and pursued the course of that river past Senna to the Shire, which stream again was followed first to the Lake Panalombe and then to the Nyassa. The southern portions of this great lake were explored, and everywhere the same story was recounted by men hostile to one another, and willing enough to throw the blame of a white man's death upon their enemies. About a year previously a white man, recognized by several to be like a photograph of Livingstone, passed through the country on both sides of the Nyassa, travelling slowly towards the north-west side of the lake. The Makololo, the Ajawas, Mananjas, the Machinkas, some Arabs settled on the lake, all gave the same account. Mr. Young might have gone much farther, and explored a larger surface of the lake, had not his boatmen, Makololo, been afraid of the Mizitu, who had invaded the whole district of the Shire. Several articles given or bartered by Livingstone were produced; and there is no doubt that he is the white man who passed along the shores of the lake a year ago.

At the next meeting, Captain Sherard Osborn, R.N., read a paper on a subject towards which he has directed public attention before, and lately more particularly in a letter to the 'Times,' *viz.* "The Exploration of the North Polar Regions." Captain Osborn's argument is, that no better training exists for scientific purposes during peace than the dangers and trials of arctic navigation. A few years hence a party to observe the transit of Venus in antarctic regions will be required, and officers who have already served in similar regions will be the best adapted for making use of this rare opportunity of settling many moot questions in astronomical science.

M. Lambart in France, and Dr. Petermann in Germany, are inciting their fellow-countrymen to send expeditions to attempt to reach the North Pole; the former by Behring Straits, the latter by Spitzbergen. Englishmen have ever been the foremost in discovery in these regions, and it would seem hard indeed if some continental and unmaritime nation were to snatch the crowning discovery from the chief navigators in the world. There seemed to be some difference of opinion in the Society as to whether the route by Smith's Sound is really the most practical, a difficulty fatal to any strong pressure upon the Government to send forth an expedition at the expense of the nation. So long as scientific men are divided as to the expediency of an expedition, or as to the best route to be observed, so long will mere politicians be able to withstand their importunities.

The reasons for the preference of Smith's Sound seem to be, that it is possible to travel far northwards along the coast, leaving depôts where necessary, until the open water believed to exist around the pole itself may be reached; whilst by both the other routes the journey will be by sea until the pack is met with which encloses the open water; this must be passed on foot, the explorers carrying boats with them until they come to a second sea, which must be traversed again in the small vessels which have been carried across the pack. Some authorities think the pack might be passed by well-built steam vessels, but anyhow whalers have penetrated nearer to the pole already by Smith's Sound than by any other route.

The most important papers read this Session were communications from Mr. Clements Markham, describing the physical geography of that portion of Abyssinia which has been visited by our troops. The country explored stretches along the coast from Zoulla to Howakel Bay, and includes the intervening peninsula; it then runs inland by the Tekonda Pass to Senafé, around which place a variety of expeditions have enabled Mr. Markham to form a good idea of the general character of the highland. A large river system, unknown to the maps, called Ragolay, runs from above Senafé towards the peninsula mentioned before, where, at some distance from the sea, the river is swallowed up in a salt plain, which is covered with incrustations caused by evaporation. This river appears to receive the drainage of all the eastern slope of the highlands; a circumstance that forms a fair argument for supposing that the floods, during the rainy season in the Senafé Pass, are not usually so great as they have been reported to be. The country adjoining the coast is a sandy plain, intersected by the dry beds of torrents. The tide rises usually about 4ft. 6in., a slight increase of which lays a considerable portion of the shelving plain under water. The mountains rise rather suddenly at a distance varying from 10 to 16 miles' distance from the coast. The passes are hemmed in by enormous boulders, or by perpendicular sides, first of gneiss, and farther inland of dark schistose metamorphic rocks, and these again are succeeded by sandstone. The rise extends for 46 miles, until at Senafé—7,464 feet above the sea level—the tableland is reached: but few natural passes in the world are easier than those that have by this time been traversed by our troops. The vegetation grows richer and more varied as an advance is made inland. Tropical trees and plants are abundant in the valleys, whilst on the sides of Mount Sowayra ("Sowera" of Keith Johnston and of Wyld) sub-tropical, and then temperate, even English, vegetation is to be found; the latter ranges from 9,000 feet to 6,000 feet above the sea-level. Senafé is the boundary between the Mahometan and Christian inhabitants. The country seems fairly fertile, and a variety of animals afford employment for the naturalist. The whole of Mr. Markham's communication, of which the above is but a slight sketch, is most interesting and well deserving of attention, at a time when our thoughts must be directed to the advance of our troops in a country otherwise so little known to us.

8. GEOLOGY AND PALÆONTOLOGY.

(Including the Proceedings of the Geological Society.)

The second volume of the geological portion of the results of the Novara expedition has just been published. It contains essays of more or less interest on widely separated portions of the globe, some containing much new and important matter, while others chiefly confirm the observations of former explorers. In the latter category we must place the opening essay "On the Geology of Gibraltar," for although it contains much additional information on the Pliocene beds of St. Roque, and a copious list of its fossils (chiefly Foraminifera), the general facts of the case were known previously; and the same may be said of the Jurassic limestone forming the Rock of Gibraltar, and the caves with their bone-breccia. In the next memoir, "On the Gneiss of Rio de Janeiro," Dr. Hochstetter distinguishes two varieties of that rock, and a surface-formation—the result of its decomposition—analogous to the Laterite of India. The essay "On the Geology of the Cape of Good Hope," which follows next, contains a clear and concise description of the facts, but Dr. Hochstetter's interpretation of them does not differ materially from Mr. Bain's. The description of the peculiar surface-configuration of the country will be read with interest now that so large a share of the attention of geologists is occupied by such phenomena.

The geological description of the Island St. Paul, in the Indian Ocean, is remarkably interesting. This island is of volcanic origin; it has a form roughly resembling one-half of a pentagon which has been bisected by a line drawn from the apex to the centre of the base, and out of the middle of which has been scooped a semicircular portion which shows the position and extent of one-half of the crater. We thus have a volcanic atoll of a peculiar shape, with this remarkable feature in addition, that the opening, which in coral islands is almost invariably on the windward side, is here on the leeward. Taking all these facts into account, Dr. Hochstetter arrives at the conclusion that one-half of the island is still beneath the sea, having been detached from the upheaved portion by a great dislocation. As soundings prove the existence of a considerable submarine plateau in the required position, which, if upheaved, would complete the pentagon, it seems tolerably clear that this explanation is the correct one.

An interesting description of the geology of the Nicobar Islands follows, Dr. Hochstetter assigning their Tertiary deposits to the same period as those of Java (the Upper Miocene), with which he believes them to have been more or less connected; later formations, consisting of coral-banks raised to a greater or less height above the sea, connect that period with the present. An excellent memoir on Java is closely connected with the last; it contains descriptions of the chief physical features of the island, and especially of its wonderful volcanoes. The stratified deposits are classified under the heads Eocene and Miocene. To the former belong a lower coal-bearing group and an upper nummulite-limestone; to the latter are referred a lower fossiliferous group, and an upper tufaceous group, with younger coral-banks, which may be of even more recent date. A description of the Stewart Atoll in the Pacific Ocean ends the geological part of this volume, and then follow two palæontological memoirs, one "On the Fossil Corals of Java," by Dr. Reuss, and the other "On the Fossil Foraminifera of Car Nicobar," by Dr. Schwager.

Dr. Hermann von Meyer has published an important memoir "On Mastodon" in the 'Palæontographica' for last year, and a summary of it in the 'Neues Jahrbuch' for December. He accepts Dr. Falconer's subdivision of the genus, but at present discusses only two of the subgenera, namely, *Trilophodon* and *Tetralophodon*. Each of these he still further subdivides into two groups, one having the valleys open, and the other having them closed by the adjoining hill. In *Trilophodon*, *Mastodon Ohioticus*, *M. Turicensis*, and *M. virgatidens* (Meyer) belong to the former group; and *M. angustidens*, *M. Pentelici*, *M. Humboldti*, and *M. Pandionis* to the latter. In *Tetralophodon Mastodon latidens* has the valleys open, and *M. Arvernensis*, *M. longirostris*, *M. Andium*, and *M. Perimensis* have them closed. The subgenus *Pentalophodon* he does not discuss.

We may here mention that the late Dr. Falconer's collected Memoirs have been published, edited by Dr. Murchison, in two very thick octavo volumes. Of these, the first contains a reprint of the 'Fauna Antiqua Sivalensis,' the plates also being in octavo, and interleaved with the descriptions; and the second volume contains his miscellaneous papers, including those on *Mastodon* and *Elephas*. Unfortunately, these volumes are a mere fragment, many of Dr. Falconer's determinations and discoveries, though current amongst geologists, having never been published in detail by their author.

Among the reports on the Progress of Literature and Science in France is an important one by M. Daubrée on Experimental Geology, in which the author records the success which has attended those who have endeavoured to solve geological problems by imitating nature.

M. Renevier has published, in the ninth volume of the 'Bulletin de la Société Vaudoise des Sciences Naturelles,' the conclusion of his essay on the Cheville fauna. He comes to the conclusion that the Cheville beds contain three divisions, the upper being equivalent to our Lower Chalk, the middle to the "Upper Gault" of the Alps and Jura, corresponding, in the author's opinion, to our Upper Greensand, and the lower to the Middle and Lower Gault of Switzerland, or the Gault proper of English geologists. It is satisfactory to find that M. Renevier's elaborate investigation has led him to endorse our English classification, and to state his conviction that the "zone of *Pecten asper*," or "Lower Cenomanian" of French geologists, the Upper Greensand of England, and the Upper Gault of Switzerland, are but three *facies* of the same formation, having a position intermediate between the Gault proper and the Lower Chalk.

Professor Karl F. Peters has published an interesting memoir in the twenty-seventh volume of the 'Denkschriften' of the Vienna Academy, entitled "Grundlinien zur Geographie und Geologie der Dobrudscha." This district, which includes the lower basin of the Danube, is in many respects very remarkable. It contains representatives of the Bojic and Hercynian Gneiss, the Trias, the Lias, the Middle and Upper Jura, and the Cretaceous formation, with Miocene freshwater deposits, Steppe-limestone, and Loess. All these are described by the author, as well as many fossils from the Muschelkalk and the Middle Jura.

"Aus dem Orient. Geologische Beobachtungen am Nil, auf der Sinai-Halbinsel und in Syrien," by Dr. O. Fraas, is a very important book on a region but too little known to geologists. The author describes the crystalline rocks of the Sinai district and between the Red Sea and the Nile; the Cretaceous rocks of Palestine; the Eocene and Miocene formations of Egypt; the younger marine deposits, and the fluviatile formations of the Nile. There are many tempting subjects in this book, had we but space to recount them; amongst them we must mention the author's theory of ancient glaciers on Mount Sinai; the peculiar features of the "Wadis," and his theory of their formation; the description of the works on the Suez Canal, &c. There is one palæontological fact of great interest and importance, namely, the discovery of three species of Nummulite in the Cretaceous rocks of Palestine; one of these is a variety of a species known to occur in the Eocene rocks of Europe, and cited also from Asia Minor and Kurdistan; one is an American species, said to occur in the Cretaceous beds of that continent; and the third, occurring in the Hippurite-limestone of Wadi Jös, is a new species.

Two works of great importance in Alpine geology have appeared within the last few months; but they are so extensive that no adequate idea of their contents can be given in this Chronicle. The larger work, by M. Favre, is entitled 'Recherches géologiques dans les parties de la Savoie voisines du Mont Blanc.' It consists of three octavo volumes of text, and a folio atlas of 32 plates, and is an exhaustive geological account of the Mont Blanc district. The smaller work plays the same part for the Swiss Jura, though not so completely. Its title is 'Essai géologique sur le Jura Suisse,' by Dr. J. B. Greppin.

The 'Geological Magazine' for the past three months has contained many articles of interest, including the continuation and conclusion of Mr. Belt's memoir "On the Lingula-flags," which the author treats as Upper Cambrian, and which he divides into six stages. Dr. Sterry Hunt has replied to Mr. David Forbes's criticisms on his Lecture at the Royal Institution, and the latter author has printed a rejoinder to the former's reply. One fortunate circumstance in this controversy is that students of chemical geology may, by reading these articles, become acquainted with many facts which they might otherwise lose sight of. Mr. Carruthers has a useful article "On British Graptolites," with an analytic key to the genera, which will be of great service to those endeavouring to master the subject. Mr. Maw has very cleverly found—or, rather Mr. Kippist has—a closer parallel to the much-discussed flower-like forms considered by Heer to be referable to *Porana*, and the first-named palæontologist has published his conclusions in a note, entitled "On a flower-like Form from the Leaf-bed of the Lower Bagshot Beds, Studland Bay, Dorsetshire." Finally, Mr. Ruskin has given another of his papers "On Brecciated Concretions."

Proceedings of the Royal Geological Society.

The Supplement-number to the volume of the Society's Journal for last year contains but two papers, both of great length and of considerable importance to British geology. The first paper is by Mr. Charles Moore, "On Abnormal Conditions of Secondary Deposits when connected with the Somersetshire and South Wales Coal Basins; and on the Age of the Sutton and Southerndown

Series." The author considers that the Mendip Hills were upheaved during the period of the Upper Trias by the intrusion of the basaltic dyke which runs along the ridge, and that they formed an island-barrier to the sea on its southern flank, where shore-deposits were formed during the succeeding periods; the Carboniferous Limestone forming then the bed of the ocean. Hence arose the accumulations of Liassic date which the author has found in veins in the Carboniferous Limestone of the neighbourhood, and from which he has obtained a most remarkable series of fossils comparable in many respects with those of the Halstatt beds. The Rhætic and Liassic beds within and those without the Somersetshire coal-basin present a striking contrast in their development; for while the latter attain a thickness of 3,320 feet, the former reach only to 169 feet. In one of the veins (the Charterhouse lead-mine) Mr. Moore discovered a *Helix*, a *Vertigo*, and a *Proserpina*, being the first traces of land-shells hitherto discovered in strata intermediate in age between the Tertiary and the Carboniferous periods. Mr. Moore also discusses the age of the Sutton Stone with considerable ability, coming to the conclusion that it is truly Liassic, and he seems to place it on the horizon of the *Ammonites-Bucklandi* beds of other localities. Many other questions are discussed in this valuable paper, which is rich in detailed sections, lists of fossils, and descriptions of new species, many of them being extremely remarkable.

The remaining paper is by Mr. Etheridge, "On the Physical Structure of North Devon, and on the Palæontological Value of the Devonian Fossils." It is so very elaborate, that we cannot possibly give an abstract of it. The chief aim of the paper is to show that (in opposition to Mr. Jukes's view) in West Somerset and North Devon the Devonian rocks form a regular unbroken ascending succession from north to south; that there is no fault of sufficient magnitude to invert the order of succession, or to cause the repetition of any considerable portion of the rocks. The paper is partly geological and partly palæontological, the former portion consisting of descriptions of sections, and deductions drawn from a consideration of them; the latter of tables of fossils illustrating the subject from every point of view, analyses of these tables, and conclusions drawn therefrom. The author proves—if lists of fossils can prove it—that the marine Devonian series constitutes an important and definite system distinct from the Carboniferous. We must refer our readers to the paper itself for further information, merely remarking that the tables of fossils are a perfect marvel of method and industry.

Only three papers in the February number of the 'Quarterly Journal' demand our attention. The first, by Dr. Duncan, brings to a conclusion that author's researches on the Fossil Corals of the

West Indies. In those islands Cretaceous, Eocene, and Miocene forms occur (the two former exclusively in Jamaica); but while the Cretaceous corals are singularly like those known from the lower chalk of Gosau, &c., and the Eocene present close affinities with the species of the London Clay and the Paris Basin, the Miocene fauna is very extensive, and its affinities are extremely diverse, but leaning especially to the existing Coral-fauna of the Pacific Ocean. Dr. Duncan shows also that recent extensions of our knowledge of the Miocene fossil corals lend strength to the hypothesis he had previously put forth with respect to the former existence of a belt of scattered islands across the Atlantic.

Mr. Medlicott's paper "On the Alps and the Himalayas" contains a comparison of the two ranges, chiefly in reference to their relations with the flanking Tertiary deposits. The clays, sands, and conglomerates of the Sivaliks resemble the equivalent portions of the Molasse, and are arranged in a similar order, the coarser deposits prevailing towards the top. In the Himalayas, as in the Alps, the younger Tertiary deposits dip *towards* the mountain-range which they fringe, and the plane of contact dips in the same direction, thus producing actual, though not parallel, superposition of the *older* rocks. In the Alps this abnormality has been explained by reference to prodigious faulting, and the same explanation, if true in one case, the author thinks should hold good in the other; but he brings forward evidence to show that in the Himalayas the present contact of the Sivalik formation with the mountains is the original one, modified only by pressure without relative vertical displacement. This pressure the author considers was produced by the sinking of the mountain-mass, which caused at the same time those contortions in the fringing Tertiary deposits which have hitherto been so difficult of explanation in the case of the Alps. He therefore submits that his explanation is the true one for both regions.

The last paper we shall notice is one by Mr. W. R. Swan, "On the Geology of the Princes Islands in the Sea of Marmora." The author describes most of these islands as consisting in great part of Devonian strata, differing somewhat in age from those of the Bosphorus, which belong to the Lower division of the formation. He therefore refers most of the stratified deposits to a Middle Devonian series, while others appear to him to belong to the Upper division. The rocks which form the remaining portions of the islands are—(1) Trachytic, of younger age than the Devonian strata, and (2) Trappean, more recent than the Trachytic. The quartz-rocks, of which some of the islands are largely, and others entirely composed, are altered sandstones of Devonian age.

The Council of the Society have awarded the Wollaston Gold Medal to Professor Carl Friedrich Naumann, of Leipsig, in recogninition of his labours extending over nearly half-a-century in the departments of Geology, Mineralogy, and Crystallography; and especially for the admirable series of Geological Surveys of Saxony and adjoining countries, executed by himself and his coadjutors between the years 1836 and 1843; and for the great standard work on Geology (Lehrbuch der Geognosie), which, with the excellent courses of lectures delivered by him at Freiberg and Leipsig, has exercised a powerful influence on the education of the newer generation of continental geologists.

The balance of the proceeds of the Wollaston Donation-fund they have awarded to Mons. J. Bosquet, of Maestricht, in aid of the valuable researches on the Tertiary and Cretaceous Mollusca, Entomostraca, and other fossils of Holland and Belgium, on which he has been so long and successfully engaged.

We cannot conclude this Chronicle without bearing testimony to the great loss recently sustained by Natural Science in the death of Professor G. C. B. Daubeny, who was equally eminent as a geologist, a chemist, and a botanist, and who was also favourably known as a contributor to this Journal.

9. METALLURGY AND MINING.

Metallurgy.

Professor P. Tunner, of Vienna, has written very favourably* of a modification of the blast-furnace introduced by Mr. Fr. Lürmann, manager to the Georg-Marien Mining and Iron Company at Osnabrück, Prussia. From the recommendation of so eminent an authority as Professor Tunner, and from the fact that in many of the more important ironworks in Germany M. Lürmann's principle has been adopted, we feel compelled to notice it.

In this invention, the walls of the hearth are carried to the bottom on all sides, so that there is no opening in the front—no tymp and no dam. In the blast-furnace, as usually constructed, there is an opening in front—the short fore-hearth—about four feet long and three feet wide, which is closed in front by a wall called the dam. In Lürmann's furnace the scoria is discharged through a scoria-outlet about six inches below the twyers, which is dovetailed into a cast-iron plate fastened in the wall, and provided with canals for the circulation of cold water.

The professed advantages of the invention are said to be as follows:—

The slag discharges itself through the scoria-outlet, at about

* "Oesterreichische Zeitschrift für Berg und Hüttenwesen," 9th Dec., 1867.

the same level, and thus vacillations of the slag in the hearth are prevented.

As there is no fore-hearth, there are no repairs of it, equal to a saving of at least twenty days in each year; and as there are no interruptions, the furnace does not cool.

The doing away with the dam and the fore-hearth allows of the removal of the tamping-hole from the former into the wall of the hearth, by which its opening is rendered easy, it being close to the greatest heat. It is stated that the pressure of the blast can be increased without risk; that the number of charges can be greater, and a larger produce ensured. Beyond this, that the number of hands may be lessened, as the operations are few and easy. The smelters who, at Georg-Marien Hütte, when working with the old arrangement, were almost stripped, are now always in full working-dress.

We are not aware that any experiments have as yet been made with Mr. Lürmann's arrangement in this country.

A Mr. Plimsoll, who is, we are informed, a coal-dealer, and, if we mistake not, an unsuccessful aspirant after parliamentary honours, has published four letters "On Iron Manufacture" in 'The Times.' Mr. Plimsoll has visited some of the blast-furnaces of this country and many of those on the Continent, and he comes to the conclusion that the ironmasters of France and Belgium are far in advance of ours. It fortunately happens that Mr. Plimsoll, in his letters, furnishes sufficient examples of his own want of knowledge of the subject about which he has presumed to write, to carry conviction to all who are acquainted with it, of the total unfitness of such a man to offer an opinion on any branch of iron manufacture.

Mr. Plimsoll's letters have received a reply in the 'Pall Mall Gazette' from Mr. J. Lowthian Bell, the ironmaster of the Clarence Works, Cleveland, which fully and satisfactorily shows how little reliance can be placed upon any of the statements made by the 'Times' writer.

An economical application which we have lately seen requires some notice. It does not strictly come under the head of metallurgy; but as it results in the production of intense heat at low cost, we know of no more fitting section of the Chronicles for it. At the works of Messrs. Miller and Company, of Glasgow, the "dead oils" from the gas works—which are a waste material for which the gas manufacturer is glad to get a penny a gallon—are burnt under two steam boilers with great advantage and economy. In the morning the fire is lighted with coke or coal, and the fire-bricks heated. Then the *dead oil*, which flows down a long-necked funnel, is forced, by a small jet of steam, into the furnace. It ignites at once, producing an intense heat, which is maintained all day without the addition of any other fuel. We were informed that some experiments were about to be made with those *dead oils* in the locomotives for the coal trains of the Caledonian Railway.

It is well known that lead, with a specific gravity of 11·5, will float on molten iron, the specific gravity of which is 7. There has ever been some difficulty in explaining this phenomenon. Professor Karmarsch, of Hanover, has lately, with the assistance of an ironmaster, been examining the subject. It appears that the moment the lead melts it forms a spheroid, which is hollow, and hence specifically lighter than the iron. The Professor supposes the formation of some vapour of lead, which becomes enclosed in the shell formed. Is it not probable that this is only another condition of the well-known spheroidal state of matter? Certain ores of iron contain sometimes considerable quantities of lead. When these are smelted, it is not unusual to find the lead "sweated out" at the *bottom* of the pig of iron, where we should expect to find it, according to its specific gravity.

A paper was read before the Liverpool Polytechnic Society, at the end of the year, "On the Manufacture of Steel from Cast-iron" by the use of nitrates and other oxidizing salts, by Mr. J. Hargreaves. The object of the invention is to effect the acieration of cast-iron by a direct process, and thus dispense with the many permutations which it is at present made to undergo before the condition of steel is attained. This is effected by the agency of oxidizing salts and oxides of iron and manganese. The oxidizing salts which are most suitable for the purpose are the nitrates, and especially the nitrate of soda, on account of its low cost, higher percentage of oxygen, and the highly electro-positive character of its base, which renders it a most effective agent in removing the metalloids—silicium, sulphur, and phosphorus—and the semi-metal arsenic from iron, by forming with them compounds of sodium, thus enabling inferior qualities of cast-iron to be used in the manufacture of steel, and also to improve the qualities of malleable iron by depriving it of those objectionable substances.

The above seems to be but a modification of Headon's process, which process was mentioned in a former number of the Journal.

There have been several patents taken out of late for improvements in the casting of Bessemer steel. Mr. James Astbury, of Smethwick Foundry, has patented a scheme for preventing the irregular cooling and chilling of the metal when poured into the iron moulds from the Bessemer ladle, which often produce cavities, of a honeycombed appearance, in the middle of the casting. For this purpose the moulds are made of plumbago, and previous to casting they are heated in a furnace sufficiently to prevent the metal from solidifying, and then when full are gradually cooled from the lower part, and as contraction takes place, the fluid metal from the upper part descends, thereby preventing the formation of cavities in the casting.

Messrs. Waddington and Longbottom, of Barrow-in-Furness, have introduced improvements in the *moulds* for casting Bessemer steel, by dividing them into two parts horizontally, so that when the lower part becomes worn away by the splashing of the metal, it may be replaced by another, the upper part serving for several lower ones. The two parts are fastened together by bolts, which pass through lugs on the outside of the mould.

Mining.

Technical education is at the present time so much the subject of discussion, that it is of interest to receive the Report of the Miners' Association of Cornwall and Devonshire. This Association has for nearly ten years carried out, amongst the miners of Western England, a system of instruction in such branches of science as appear to be directly applicable to Mining and Metallurgy. One feature is peculiarly its own: instead of establishing a school in some centre to which those who desire instruction may come, a system of classes in the very midst of a group of mines has been adopted. The teacher visits these classes in regular order, and delivers his lectures, gives his demonstrations, and carries out his examinations. From the report we learn that many young miners who have availed themselves of the instruction given in the classes have secured positions of responsibility both at home and abroad, which they could not have taken but for their advanced knowledge.

Out of twenty-nine persons who passed the Government examinations in 1867 in Mineralogy, as many as twenty received their instructions from the lecturer of this Association, and of these fourteen have passed sufficiently high to be entitled to a prize. One of them, Francis Oats, a working miner in Botallack Mine, succeeded in obtaining the Gold Medal in Mineralogy from the Department of Science and Art. A plan of employing the more advanced pupils to teach the elementary branches in the schools has been carried out, with apparent advantage to all concerned, and by this arrangement the lecturer is enabled to cover more ground.

In the report before us, the papers read at the annual meeting of the Association are printed. They are peculiarly fitted to the requirements of the miner. There are eight papers on different descriptions of Rock-boring Machines, which are illustrated; two on Hydraulic Machinery applied to mines, fully illustrated, and several other papers of local and general interest on mines and mining.

Altogether, the experiment which has been carried on, with very limited means, by the Miners' Association of Cornwall and Devonshire is most encouraging. The report shows especially that a system of well devised and properly applied technical instruction has the merit of eliminating from amongst the intelligent working men the best of the class, who are fitted by the instruction they receive to become the agents to whom will be committed in future the development of the British and Colonial mines.

We have been speaking of Boring Machines—a word on Coal-cutting Machines. The Lancashire Coal Association offered some time since three pr'zes of 500*l.*, 200*l.*, and 100*l.* for coal-cutting machines worked with compressed air. The conditions attached to the offer appear to have prevented inventors from entering their machines for competition. Three machines only have been entered at the present time. These are by Mr. Fidler, of Wigan; Mr. Sturgeon, of Leeds, and Messrs. Farrar & Booth, of Barnsley. We shall watch with interest the reports of the trials, and duly inform our readers thereof.

In the Eastern hemisphere the discovery of coal progresses, although much of it is far more recent than the true old coal of these islands. At Formosa, coal is found in depressions of the Red Sandstone; it burns freely, giving out much heat, and leaving fifty per cent. of ash. The coal of Labuan, Borneo, has been long known, but Dr. Cuthbert Collingwood calls attention to it in a paper read before the Geological Society. Several seams crop out conspicuously near the coast, the lowest seam being 11 feet 4 inches in thickness. The quality of this coal is thus given:—"It is heavy, close-grained, fast-burning, giving out considerable heat." This is also a recent coal—Damara resin and leaves of recent date being found associated with it. The coal of Japan is described as a bright, clean coal, resembling that obtained in the neighbourhood of Sydney. All these and several other small deposits of coal in the East are destined ere long to become of importance.

So important do the coal beds of India appear to our Government, that the India Board has just appointed Mr. Mark Fryar, who was formerly the teacher in the Mining School of Glasgow, as a surveyor, under Dr. Oldham. His duties are to carefully examine the conditions and the extent of the coal deposits, and to inspect the workings, with an especial view to their improvement and extension.

Mr. Bauerman, formerly of the Geological Survey of the United Kingdom, with Dr. C. Le Neve Foster, who has been for the last two years teacher to the Miners' Association of Cornwall and Devon, have started for Egypt. Those gentlemen are engaged by the Viceroy to make a mineral survey of several districts which are reported as producing minerals of commercial value.

Dœring's Rock-boring machine has been at work for several weeks in one of the levels of Tincroft mine, near Camborne, in Cornwall. The agent, Captain Teague, has expressed himself most favourably as to the results obtained by this machine; and so favourably does the engineer, Mr. Matthew Loam, think of it, that he is about to introduce this boring machine into West Seton, a neighbouring mine, of which Mr. Loam is the engineer.

It will be in the memory of our readers that some interesting and important experiments have been carried out in some of the collieries of Durham, and in the gas works at Barnsley, on safety-lamps. It had been found that, with improved ventilation, many of the lamps called safe were not so, owing to the rapidity with which the current of air, mixed with carburetted hydrogen, was driven through the wire gauze. The result of the experiments, most of which have been reported in the 'Transactions of the Institute of Mining Engineers,' has been to prove that, with but slight modifications, several forms of the safety-lamp can be rendered actual lamps of safety.

10. MINERALOGY.

Even in a science that makes such tardy advance as Mineralogy, it is highly desirable that its literature should from time to time be collected, classified, and epitomized, so that the student may possess periodical records of its progress, arranged in a form convenient for reference. In 1843 Von Haidinger of Vienna undertook this task, and prepared a report on mineralogical progress during that year. Haidinger's example was followed by Dr. Kenngott, who issued similar works, reviewing the science from the year 1844 to the close of 1861. At length, however, the perseverance even of a German gave way, and since 1861 nothing of the kind has appeared. The much-felt want of a continuation of Kenngott's "Forschungen" induced the Imperial Academy of Sciences of Vienna to offer a prize of 1,000 Austrian florins, placed at its disposal by the Archduke Stephen, for a record of mineralogical research, extending from the beginning of 1862 to the close of 1865. We now learn from the German journals that the labour of collecting and arranging this four years' literature has been accomplished, and that the prize has been awarded to some diligent compiler whose work bears the motto, "*Nunquam otiosus.*" On the publication of this work, the mineralogist may congratulate himself upon having a complete series of reference-books, extending over nearly a quarter of a century. Let us hope that the good work of continuing this record may never again be allowed to lapse.

Under the name of *Woodwardite,* Professor Church some time ago described a new mineral, which occurs as a beautiful blue incrustation coating a Cornish killas or clay-slate. M. Pisani, the French chemist, has lately examined this mineral, and does not scruple to demolish the species at once. Woodwardite, says M. Pisani, so far from being entitled to a specific distinction, is simply a mixture of the basic sulphate of copper called Langite, with a hydrous alumina such as Gibbsite. By way of confirming this assertion, he points to another Cornish mineral, which in its general characters —colour excepted—bears a close resemblance to Woodwardite, but which on analysis proved to be a mixture of Langite with Allophane or some such silicate of alumina. It would seem then that this Langite has the sociable habit of mingling itself with other minerals, thus giving rise to a number of indefinite mixtures, which, however deceptive in appearance, must by no means be regarded as distinct species.*

For the last twelve years large quantities of *Cryolite* have been worked in Greenland, partly for use in the manufacture of aluminium, and partly for the production of a pure soda-ash; but although extensively employed in commerce, the mineral has never been found in a crystallized form. Recently, however, small crystals have been discovered, and some of these specimens we have had an opportunity of examining. They are coated with a thin film of hydrous peroxide of iron, but on the removal of this incrustation the vitreous lustre and transparency of the crystals are at once evident. At a cursory glance they appear related to the cubic system, but on careful measurement Dr. Websky finds that they must be referred to the doubly-oblique system.† It is pleasing to note that this determination verifies a conjecture thrown out some years ago by Descloiseaux, who was led to his conclusion by studying the optical characters of the massive mineral.

In a recent memoir Dr. Dana discusses at length the chemical composition of the felspars, in order to explain the close relation which exists between the different members of this natural group— a relation extending not only to crystalline form and chemical composition, but also to the colour, hardness, optical characters, and other physical properties of the minerals. Among these felspars the species *leucite* occupies an anomalous position; for, although clearly related to the family in most of its features, it yet crystallizes in cubic instead of oblique forms. To reconcile this anomaly Dana ingeniously shows that the cubic and oblique crystals are in truth intimately connected; that "the monoclinic crystals of orthoclase and the triclinic of anorthite, &c., are in fact nothing but distorted, or, rather, *clinohedrized dodecahedrons*, variously modified by cubic, octohedral, trapezohedral, and other planes."‡

Every right-minded student cherishes so profound a respect for

* "Sur la Woodwardite du Cornouailles," 'Comptes Rendus,' lxv., No. 27, p. 1142.

† "Ueber die Krystallform des Kryolith's." 'Leonhard's Jahrbuch,' 1867. Heft, vii., p. 810.

‡ "Crystallogenic and Crystallographic Contributions:" 'Siliman's Journal,' vol. xliv., No. 132, p. 398.

the name of Dana that we are loth to notice an alleged charge of plagiarism recently brought against him in connection with his views on the relation between crystalline form and chemical composition.* Professor Hinrichs, of Iowa, alleges that some of the ideas expressed in the papers on this subject had their source in a memoir of his own recently written on "Atom Mechanics." It is needless to say that Dr. Dana refutes this charge triumphantly, and shows it to be utterly groundless. By the way, the "Atom Mechanics" just noticed contains some curious arguments which will at least amuse the reader if they fail to convince him. The professor believes in the chemical unity of matter, and recognizes the existence of only one true element, one all-pervading form of primitive matter, or *Urstoff*, which forms the basis of everything material, and which he introduces to us under the name of *Pantogen*. The "Atom Mechanics" may, however, be commended to the reader, if only for its curiosities of style and elegance of illustration. For example, wishing to express the impossibility of basing a mineralogical classification upon crystalline form, the professor tells us that "One might quite as well classify asses according to the lengths of their caudal appendages expressed in centimetres, as minerals by their systems of crystallization!"

Availing himself of some specimens of ruby, or red corundum, exhibited in the Colonial Department of the Paris Exhibition, M. Jannettaz has studied the nature of the colouring matter of this gem. He found that on exposure to heat the red colour rapidly gave place to a bright green, but that on cooling, the mineral resumed its original tint. Previous experiments on the spinel-ruby had shown that this gem when heated exhibits precisely the same behaviour.†

Analyses of between 30 and 40 different coals from various localities in Prussia, together with a comparison of their respective calorific powers, have been published by M. Mène,‡ who obtained his specimens from the Paris Exhibition. The analyst throws his results into a tabular form, and, trusting to their intrinsic value, leaves them without comment.

In the clefts of some of the Lower Silurian sandstones of Bohemia, a couple of new minerals have lately been discovered, and described by Von Zepharovich.§ Both of these are hydrous phosphates of alumina, closely related to the well-known species Wavellite. One of them is to be called *Barrandite*, in compliment to the zealous geologist of Bohemia, Joachim Barrande; and the

* See 'Quart. Journ. of Science,' Jan. 1868, p. 103.

† "Observations minéralogiques sur quelques minéraux de l'Inde, et en particulier sur la nature de leur coloration." Bull. de la Soc. Géol. de France. XXIV. No. 5, p. 682.

‡ 'Comptes Rendus,' LXV. No. 20, p. 807.

§ Sitzungsb. d. k. Akad. Wiss. Bd, LVI., p. 19.

other *Sphærite*, in allusion, we presume, to the nodular forms in which it occurs.

Some peculiar blowpipe re-actions have been detected by Captain W. A. Ross, R.A.* Having fused a borax bead in the usual way, he charges it with the substance under examination, and then blows the bead into a small bubble or vesicle of extreme thinness. After standing for some hours, this vesicle exhibits under the microscope a peculiar crystalline structure, often of great beauty, and as this structure apparently varies with the nature of the dissolved substance, it promises to become of value in blowpipe analysis. "Every metal, with its salts, appears like a kind of mineralogical kaleidoscope throwing its crystallizations apparently at random into the most elegant shapes, each of which must be made to yield its atom of information as to the source of all."

Professor G. Rose has also studied some curious phenomena exhibited by certain blowpipe beads. He finds that the opacity which they frequently assume on cooling, results from the separation of microscopic crystals. His researches on the reactions of titanic acid appear to have some bearing on the natural formation of anatase.†

The Russian chemist Hermann proposes the name of *Rewdanskite* for a new nickel-ore from Rewdansk in the Urals. It occurs as an earthy greenish mineral, consisting of hydrous silicate of nickel, in which much of the nickel-oxide is replaced by magnesia and protoxide of iron.‡

In the deposits of sulphate of lime largely worked in Hants Co., Nova Scotia, no fewer than three new borates have been discovered within the last few years,—thanks to the zeal of the local professor, Dr. How. These minerals have been described under the names of *cryptomorphite*, *natroborocalcite*, and *silicoborocalcite*. The chemical relations, as well as the differences between these three species, may be best seen by placing their formulæ side by side.§

Cryptomorphite.........	$NaO2BO^3,6HO + 3\,(CaO2BO_3,HO) + BO^3,3HO.$
Natroborocalcite	$NaO2BO^3,10HO + 2\,(CaOBO_3,HO) + BO^3,3HO.$
Silicoborocalcite	$2CaOSiO^2 + 2\,(CaO2BO_3,HO) + BO^3,3HO.$

Splendid samples of brown pyromorphite, or phosphate of lead, from the mines of Nassau, have lately been met with in commerce. Dr. Fuchs has analyzed some of this "Braunbleierz," and finds it to be a remarkably pure chloro-phosphate, exactly agreeing in composition with the formula already established. The same chemist has examined the Swedish mineral *Tubergite*.‖

In a paper "On the Constitution of the Aluminous Augites and Hornblendes," Professor Rammelsberg discusses the chemical com-

* 'Chemical News,' Dec. 20, 1867; and Feb. 7, 21, and 28, 1868.
† 'Akad. z. Berlin,' 1867, p. 129.
‡ 'Journ. f. prakt. Chemie,' Bd. cxx., p. 405.
§ 'Phil. Mag.' Jan. 1868, p. 32. ‖ 'Leonhard's Jahrb.' 1867, Heft vii., p. 822.

position of an important class of minerals; and in another paper offers some remarks "On the Scheelite of the Reisengebirge" in Silesia, a new locality, which yields this rare mineral in crystals of surpassing beauty.*

Professor vom Rath's "Mineralogical Contributions" to 'Poggendorff' relate to the antimonio-sulphide of lead, called Meneghinite, from the silver-lead mine of Bottino in Tuscany; and to some new and rare forms of calcareous spar.†

The zeolitic mineral called *Lerderite*, found in the trap rocks of Nova Scotia, has been shown by Professor Marsh to be identical in composition with Gmelinite.‡ Mr. E. W. Roots announces a new locality for the Canadian mineral, *Wilsonite*; § and Von Hanthken describes the occurrence of *Meerschaum* in the Lyubicer mountains, in Bosnia, where it is found in large fragments associated with serpentine, embedded in a conglomerate.||

11. PHYSICS.

Light and Heat.—The action of light on chloride of silver has been studied by M. Morren. He arranged an experiment in the following way. Two bulbs, one containing nitrate of silver, the other, chloride of potassium, in equal equivalents, were placed in a tube sealed at one end. The tube was then filled with water saturated with chlorine gas, and sealed before the blowpipe. By agitation, the bulbs were broken, and chloride of silver was thus formed in an excess of chlorine water. Exposed to the rays of the sun for several days, the chloride of silver remained white as long as the liquid retained the yellow colour given to it by the chlorine. When the colour disappeared, owing to the action of chlorine on the water, under the influence of light, the chloride of silver slowly assumed a red-brown tint. The tube being then placed in obscurity (or in the diffused light of the laboratory), the brown colour gradually disappeared, and the chloride of silver reassumed, in all its intensity, its original white aspect. Replaced in the sun's rays, the coloration returned, disappearing as before when screened from the light.

Mr. J. Browning, F.R.A.S., has published a paper in the 'Chemical News,' "On the Influence of Aperture in Diminishing the Intensity of the Colour of Stars." Mr. Browning, during the late lunar eclipse, had failed to detect either the coppery or the

* 'Zeitsch. d. Deutsch. Geol. Gesell.' Bd. xix., Heft 3, pp. 493, 496.
† 'Pogg. Ann.,' 1867, No. 11, p. 372.
‡ 'Silliman's Journal,' 1867, No. 132, p. 362. § Ibid., Jan. 1868, p. 47.
|| Verhand. d. geol. Reichsanst, 1867, No. 10, p. 227.

blue tints generally seen during the occurrence of this phenomenon, while other observers had noticed these tints distinctly. The paper alluded to is an explanation of the discrepancy. Mr. A. Brothers had previously, at a meeting of the Manchester Literary and Philosophical Society, read a paper, in the course of which he compared the statements of different observers. He had himself distinctly seen colour, with a refractor of five inches aperture. The moon's surface presented, owing to the presence of this colour, an appearance of great beauty, which seemed to increase as the penumbral shadow stole over it. The colour of the eclipsed limb was of a coppery hue, much brighter towards the part most deeply within the shadow. The part of the moon not eclipsed was of a beautiful bluish-grey colour. Mr. Browning's evidence, published in the 'Astronomical Register,' was—"I looked most carefully for colour, both with the 10½-inch silvered-glass reflector, furnished with an achromatic eye-piece of very low power, and also with a five-feet refractor; with neither could I detect a trace." Mr. Slack observing in the same locality, with a silvered-glass reflector, writes in the 'Intellectual Observer'—"After twelve the eclipsed limb grew noticeably redder, the red coppery tint chiefly affected the lower parts of the obscured limb, but was visible further in, gradually blending with the inky tints presented by the umbra at its advancing edge." Lastly, Mr. Weston, who was observing at Lansdown, near Bath, saw colour. He recorded the following in the 'Monthly Notices':—"The prevailing colours were red-bluish and grey, *and grey:* the redness increased towards the darkened edge of the moon." Mr. Brothers thinks that the appearance of colour cannot be caused by the telescope or by peculiarities in the eyes of the observers, proved by the fact that the same colours are seen, whether refractors or reflectors, either of metal or silvered glass, be used; and as the majority of observers of the phenomenon see colour, he thinks the eyes of those who remark its absence are perhaps afflicted with colour blindness.

• Mr. Browning, in the paper first alluded to, says that his having used a telescope of larger diameter than that possessed by the telescopes employed by most of the other observers had been suggested as a probable explanation by Mr. Slack, as well as by Mr. Huggins. The result of inquiries he has instituted completely confirms the idea. He finds that while most observers who used telescopes of only three or four inches aperture speak of the colour as being less than usual yet very noticeable, observers who used telescopes of seven or eight inches aperture saw very little colour. Three other observers using telescopes with large apertures failed to detect any colour. Experimenting in connection with this subject, he has noticed that the chocolate colour of the so-called belts of *Jupiter* is much more perceptible with 6-inch apertures than with apertures of 12 inches: also a small star in the cluster in *Perseus* appears of an indigo-blue with 8½ inches, Prussian-blue with 10¼ inches, and royal-blue with 12¼ inches of aperture. From this it follows that colours estimated by comparison with Admiral Smyth's chromatic scale, in which each colour is represented of four degrees of intensity, can possess no relative value unless taken with the same aperture.

The spectroscope has received from Professor Osborn, of Lafayette College, U.S., improvements which have rendered it applicable to a variety of practical purposes, particularly in metallurgy. By means of the instrument thus modified it is possible to detect in a room many hundreds of yards from a furnace, the sodium in the coal, or decomposed fire-brick, also any lime, potash, &c., proceeding from the furnace-mouth. Professor Osborn is hopeful of important uses being found for the form of spectroscope he has devised.

Dr. Emerson Reynolds, at a meeting of the Dublin Chemical and Philosophical Club, read a paper "On the Action of Ozone on Sensitive Photographic Plates." He had found in experimenting upon this subject that the latent or undeveloped image submitted to the action of ozone was completely obliterated: a second image might be taken on the plate. Dr. Reynolds remarked that this fact was at variance with what might be called the mechanical theory of photographic images, and proved conclusively that the production of an image was due to a chemical change in the sensitive film. He thought that the disputes with regard to the time dry plates might remain sensitive, arose in some degree from the variable amounts of ozone present in the atmosphere. The ozone used in the experiments was in some cases obtained by passing atmospheric air over phosphorus, in others by the aid of electricity.

A new photometer has been devised by Mr. C. H. Bennington, M.A., and described by him in the 'Philosophical Magazine.'

In a paper "On Phosphorescent Light," Dr. Kindt mentions that a piece of chlorophane, which heated in a tube gives a green light visible in daylight, viewed through a spectrum apparatus in the dark shows homogeneous green only. Phosphorite of Estremadura shows green, yellow, and red. A green fluorspar, from the Breisgau, shows two dark lines in the green, one of which is near the orange red. The dark lines are as powerful as in solutions of didymium. Two other bright green fluorspars give rise to the same bands.

Mr. William Huggins, F.R.S., has described to the Royal

Society a Hand Spectrum-Telescope devised by him in the summer of 1866, for the purpose of observing the spectra of meteors and their trains. The apparatus consists essentially of a direct-vision prism placed in front of a small achromatic telescope.

A paper "On the Action of Sunlight on Glass" has been published by Mr. Thomas Gaffield in 'Silliman's American Journal.' Mr. Gaffield found the greatest change in the colour of glass to take place in the summer, the least in winter, and that in spring and autumn about equal, and midway between these extremes. Crystal or lead glass and a piece of optical glass, containing probably little, if any, manganese, suffered no change by two years' exposure. Coloured glasses after two or three years' exposure showed no perceptible change in any instance, excepting a slight one in a single purple specimen. Experiments made with artificial heat of various degrees of intensity showed the colour of glass to be unacted upon by heat; the same or similar specimens, almost without exception, undergoing change by a few months' exposure to sunlight. Specimens exposed in hot water for a month indoors and out of sunlight experienced no change in tint; similar ones exposed during the same length of time in a dish with two or three inches of water out of doors, suffered a decided change, though only about half as much as when exposed directly, without the aqueous medium. Mr. Gaffield arrives at the conclusion that air moisture and artificial heat effect no change in the colour; the change appears to be due to the actinic rays of the sun alone.

HEAT.—Dr. J. P. Joule, F.R.S., has described a thermometer unaffected by radiation. It consists of a copper tube about one foot long, having another tube open at both ends in the centre, and the annular space filled with water. In the inner tube there is a spiral of fine wire, suspended by a filament of silk, and having a mirror attached to it. The lower end of the tube is closed by a lid, capable of removal at pleasure, and when this lid is removed, if the air in the tube have a different temperature from that of the outside atmosphere, a current of air and a consequent turning of the spiral will be the result. In Dr. Joule's apparatus, one degree Fahrenheit produces an entire twist of the filament. He finds the temperature in the tube to be generally warmer than in the outside atmosphere of a room, owing to the conversion of light and other radiations into heat on coming in contact with the copper tube. This result is also manifested in the open air on a still day; when there is wind the effect is masked. Dr. Joule feels confident that this difficulty may be overcome by increasing the length of the tube.

In a memoir on Dissociation, by M. Debray, presented to the Academy of Sciences, he has stated that a hydrated salt has for each temperature a tension of dissociation which is measured by the elastic force of the aqueous vapour which it emits at this temperature. Applying this to the explanation of the phenomena of hydration and efflorescence, he states further that a salt becomes hydrated when the tension of the aqueous vapour contained in the atmosphere is greater than that which the salt emits at the same temperature. Efflorescence results when the tension of the water-vapour of the salt is greater than that of the aqueous vapour existing in the atmosphere. Hydrous salts which do not effloresce owe, then, this property to the inferior tension of aqueous vapour emitted by them at common temperatures to that ordinarily possessed by the aqueous vapour in the atmosphere. These identical salts effloresce when placed in an atmosphere where the elastic force of the aqueous vapour contained in the air is below that which they emit.

Professor Knoblauch has made an investigation on the interference-colours of radiant heat. Some of his results are embodied in the following:—When two groups of rays meet under certain conditions, radiant heat differs in its properties after the meeting; for instance, as regards its property of traversing diathermanous bodies, it manifests an interference-colour. If this is produced in doubly refracting crystals, under the influence of a polarizing agent, placed for instance between two Nicol's prisms, and the plate of crystal fixed while one prism is rotated, the colour passes through white to the complementary. On rotating the plate of crystal in its plane, when the principal sections of the Nicol's prisms are parallel, only one thermal colour occurs; when they are at right angles, the complementary colour; while when they form an angle of 45°, both thermal colours appear.

Experiments have been made in Germany which tend to show that molten lead dropped upon liquid iron remains floating on the surface of the latter. Since the specific gravity of lead is more than one-half greater than that of cast-iron, the fact seemed anomalous. Professor Karmarsch, of Hanover, has explained the matter very satisfactorily. Some samples of these drops of lead lying embedded in the surface of a cast-iron block were sent to the Professor by an ironmaster. Professor Karmarsch found, upon close examination, that these drops of lead were not solid globules, but hollow, formed apparently as bubbles. According to this explanation, the lead is kept resting on the surface of the iron by its own vapour. In large quantities the result is known to be different, lead being occasionally tapped from the bottom of blast furnaces employed in smelting certain classes of ores.

The value of petroleum as fuel for steamship boilers has been for a considerable time under investigation by the United States

Naval Department. The Secretary has finally reported against petroleum; the only advantage thus far shown is a not very important reduction in bulk and weight of fuel carried.

ELECTRICITY.—H. Poggendorff has published an account of a new electrical phenomenon observed by him. This physicist was experimenting with exhausted tubes containing a certain quantity of mercury, having either at one end or both, platinum wires, when he encountered the phenomenon. More precisely the circumstances under which his first observation was made were the following:—A tube of the kind described above, containing only one wire, coated towards both extremities with a broad band of tinfoil, was placed as an exhausted double jar across the electrodes of a Holtz's machine. While the tube lay in this position on the electrodes, there appeared to be a certain motion in the mercury. As this motion could have no definite character, the current in such a jar being an alternating one, another tube was made provided with platinum wires at both ends, and the current passed through the length of the tube, the tube being placed as far as possible horizontally. In this case a more decided motion of the mercury was observed, but still scarcely as decisive as could be desired. A third, fourth, and fifth tube showed the phenomenon in about the same degree. A sixth tube, however, removed all doubt. This had not only been carefully exhausted, but the mercury in it had been kept briskly boiling for some time; the mercury was kept out of contact with the platinum wires by the tube being bent at right angles at about an inch from each end. The tube thus prepared was hung by wire hooks to the electrodes of the machine, in such a manner that the body of it was perfectly horizontal, the mercury serving as a level. As soon as the adjustment was properly made, the machine was set in action. When the current passed through the tube, the mercury rapidly travelled from the negative to the positive pole. However the current was sent, the result was always the same. In experimenting, the mercury was generally made to occupy a thread of about 4 inches in length; the horizontal part of the tube was about a foot in length, so that the thread had to move over a space of 8 inches. Two or three seconds was the time generally occupied by the mercury in travelling from one end to the other. The thread changes shape as soon as it commences to move, becoming considerably longer; the elongation amounted in these experiments to an inch. The quantity of mercury set in motion was one ounce; very small quantities of the metal will not move, probably a result of adhesion.

H. Poggendorff also believes himself entitled to state generally that the electro-negative metals, platinum, gold, palladium, silver, &c., render the following insulators positive by friction, while the electro-positive metals, zinc, cadmium, iron, &c., induce in these insulators the negative condition—ebonite, gutta-percha, caoutchouc, waxed cloth, white wax, resin, shellac, sealing-wax, sulphur, amber, copal, silk, pyroxyline, collodion, and gun-cotton. There are a few exceptions in the behaviour of the metals. A good example of the general law laid down is furnished by ebonite. Gently rubbed with platinum it becomes positive, zinc or iron inducing the negative condition.

M. H. de Saussure has published a paper in the 'Bibliothèque Universelle,' "On the Humming Sound produced on Mountains by Electricity." In June, 1865, M. de Saussure and a friend climbed the peak of Piz Surley. When the summit had been reached, sleet fell abundantly; preparatory to taking their repast, they laid the alpenstocks against a little cairn of dry stones. Almost at the same moment, M. de Saussure felt acute pain in one shoulder, speedily in the other also, and in the back. The pain resembled the pricking of pins. Soon the alpenstocks resting against the rock commenced to sing loudly, the sound resembling that emitted by a kettle of water about to boil. Strong currents of electricity flowed from all the salient parts of the body, and the hair stood out. M. de Saussure remarks that in every instance where the phenomenon has been observed, the mountain peak has been enveloped in a shower of frozen sleet.

A new voltaic battery has been devised by Dr. Hugo Müller and Dr. Warren De la Rue. The negative element is chloride of silver fused around a silver wire, which serves as conductor; this wire is bent over and connected by means of a small caoutchouc collar to a rod of zinc, which need not be amalgamated. The exciting liquid is salt water. In course of time the liquid becomes saturated with chloride of zinc; when metallic zinc begins to deposit on the negative plate the battery must be renewed with fresh solution. The tension of a battery of ten cells (the couples being very small, about three inches in height) is sufficiently great to decompose water enough to yield a cubic inch of the mixed gases in about twenty minutes. Dr. De la Rue has constructed a battery of two hundred cells.

M. Bourgoin continues his investigation regarding the electrolysis of organic acids. The current acts on acetate of potassium as on a mineral substance. In a moderately alkaline solution the oxygen reacts on the elements of the anhydrous acid, giving rise to carbonic acid and hydride of ethylen. A certain quantity of acid is totally consumed under the influence of oxygen furnished either by the salt or by the alkaline water. The portions of liquid at the two poles suffer unequal losses; almost the whole is lost at the positive pole. When the current is made to act on free acetic acid it concentrates the acid at the positive pole. He has also examined the action of the current on neutral tartrate of potash, on a mixture of tartrate and alkali, also on free tartaric acid. With the neutral tartrate, as soon as the current passes, the solution becomes alkaline at the negative pole; the principal result is the formation of a white precipitate at the positive pole. Analysis has shown this substance to be cream of tartar. The gas evolved at the positive pole was found to be composed of carbonic acid, oxygen, carbonic oxide, and nitrogen. When the current acts on a mixture of neutral tartrate and alkali the results are different. The gas evolved at the positive pole is then composed of carbonic acid, carbonic oxide, oxygen, and hydride of ethylen: acetylen has also been detected in it. The decomposition of free tartaric acid yielded the same products as the neutral tartrate, but in different proportions. Acetic acid was formed at the positive pole, and after an experiment had been in progress five days, a considerable quantity was isolated as acetate of baryta.

12. ZOOLOGY—ANIMAL MORPHOLOGY AND PHYSIOLOGY.

(Proceedings of the Zoological Society of London.)

Morphology.

The Size of the Brain in Different Races of Men.—Dr. J. Barnard Davis has communicated a paper on this subject to the Royal Society. There has always been considerable difficulty in getting at a knowledge of the variation of the brain in various races, because it has been thought necessary to examine and weigh the brain itself, and this has not been done in the case of many exotic races. The method of gauging the skull cavity has been said to be of no real value, and hence has not been extensively applied. Dr. Davis shows that this is a mistake, and possibly the method of gauging is more reliable than that of weighing, for thereby the error likely to arise from the shrinking of the brain during fatal disease and from post-mortem changes is avoided. Dry Calais sand is used for gauging the brain-case, and an allowance of 15 per cent. is deducted for other structures present in addition to the brain. This amount has been very carefully estimated from a large series of observations. The sand is then weighed and reduced to its equivalent in cerebral matter of 1,040 specific gravity. Professors Tiedemann and Morton, who have made similar observations to those of Dr. Davis, omitted to make this allowance, and also (a much more important omission) did not discriminate male and female skulls. This led to serious error, since the female brain is on the average 10 per cent. less in weight than the male. As the result of his investigations Dr. Davis gives a long list which is very interesting. He gives as an average $47\frac{1}{2}$ oz. for the English brain, $45\frac{1}{2}$ oz. for the French; Italians, Lapps, Swedes, and Dutch nearly the same as English. As to the Germans, he has not got a satisfactory result. Hindoos have $44\frac{1}{8}$ oz. of brain, the aboriginal Khonds of India only $37\frac{4}{8}$ oz., whilst Chinese and Siamese have 47 oz. Of African races, the more northern negroes have from 44 to 46 oz. of brain, whilst in the south we find the greatest contrast of capacity known, for whilst the Bushmen range from 31 to 39 oz. only, the Kafir has on an average over 48 oz., a greater weight of brain than has the average Englishman. The bold and enterprising Malays present a high brain-weight (over 47 oz.), as also do the supposed aboriginal inhabitants of the Western Pacific. Dr. Davis does not state what collection of skulls it is which he has used in making these calculations. From some of his remarks, it is evident that the collection is not a very large one, and thus the value of the results is diminished. Several hundred cases ought to be collated in each race to give a satisfactory result.

Fur-seals and Hair-seals.—Dr. J. E. Gray has been recently writing on these animals, which are not only matters of curiosity to the world at large, on account of their strange forms, and of interest to zoologists especially, but also have a very considerable commercial importance in respect of their skins and their fat. The Eared-seals (*Otariadæ*) inhabit the colder parts of the southern hemisphere; they are also called "Fur-seals" by the sealers, because they have a soft under-fur between the roots of the longer and more rigid hairs. Some are called "Hair-seals" because they have only rigid hairs, and are not worth making into "seal-skins." These are only hunted for their fat, the skins if used being only applied to common purposes, such as covering boxes, &c., as with the skins of the ordinary Earless-seals. Though zoologists have had great difficulty about distinguishing the various species of Eared-seals, it is not so with the practical dealer in skins; he knows the difference between the various kinds of skin at a glance, just as the dealers in whalebone were in advance of scientific men in distinguishing the species of whale by their baleen. With regard to the Sea-bear which was lately exhibited in the Zoological Gardens in London, Dr. Gray decides that it is the *Otaria jubata*. There has been great difference of opinion on this point, but Dr. Gray has examined the skull of the animal. He is anxious to see the account of the anatomy of this specimen, which Dr. Murie is to publish. The French sailor, Leconte, who brought this Sea-bear to England from Cape Horn, has been sent by the Zoological Society to the Falkland Islands, for the purpose of procuring some other seals of the southern hemisphere.

The Sea-horse and its Young.—We in England have lately had the opportunity and pleasure of seeing those extraordinary little fish the *Hippocampi* alive, and supported by their strange prehensile tails clasping rocks or corals, in the aquaria of the Zoological Gardens in London. In the 'American Naturalist,' we read an account of the habits and young of the American Sea-horse, written by the Rev. Samuel Lockwood. He had long wished to ascertain in what condition the young first appeared, and had repeatedly failed, owing to the death of the males which he obtained. In these fish, and also in the Pipe-fish and Pegasus, the female lays her eggs into a cavity of considerable size, which is placed along the tail of the male, and there the eggs remain until they are hatched, when the father squeezes them out of his pocket. Mr. Lockwood believes that the walls of this pocket in some way or other furnish nourishment to the ova, since they increase so largely while within it. After many failures he obtained a Hippocampus which did not prematurely turn out his young, but squeezed them out duly—active, transparent little creatures—to the number of several hundreds. Immediately on coming into the water the young fish began to use its prehensile tail, and curious mishaps were noticed—two or three often intertwining their little hair-like caudal appendages, and pulling in opposite directions. Mr. Lockwood did not succeed in rearing his young troop of Sea-horses, nor did he examine them with the microscope, which he should have done.

A Fish living inside a Gigantic Sea-Anemone.—Whilst searching about for animals on the shores of the China Sea, Dr. Cuthbert Collingwood saw an enormous blue sea-anemone, two feet in diameter, and a little fish swimming near it. On raking out the inside of the anemone with a stick, six other little fishes swam out of it, and these he caught with a hand-net. Several times he saw these anemones and their fish, but unfortunately the specimens of the fish he brought were destroyed. In the 'Voyage of the Astrolobe,' a fish is mentioned as living inside a *Holothuria,* and several of these were seen by Dr. Collingwood about Labuan. But the fish which goes inside the sea-anemone is distinct from this species. Mr. Low, of Labuan, kept one alive for some months in a tub without the anemone, which seems to show that its habit of taking shelter within the capacious stomach of that benevolent creature is not a necessity of its existence. Fishes which inhabit the body cavities of large medusæ are well known even on our own coasts. The writer saw such a medusa and fish recently in the Channel Islands.

The Silkworm Delusion.—In an interesting new magazine, by name 'The Student,' Mr. Shirley Hibberd gives an account of an attempt at silk cultivation in Britain. He describes how an estate of a thousand acres was bought, and carefully planted with the

Ailantus glandulosus, the tree on which the *Bombyx cynthia* worm feeds. This species is the only one with which there is any chance in Great Britain, and accordingly it was the one chosen for cultivation. After the trees had grown up, the eggs were obtained and hatched, and the process of feeding and growing went on finely. At length the cocoons were obtained; and now came the question, What is the value of the cocoons when you have got them? To this the answer is indeed very disappointing. They are the least in value of any silkworm's cocoon, and are in fact almost rubbish. They do not give a continuous thread of one or two thousand yards, as does the *Bombyx mori;* no, nor even of one or two yards: like cotton, they have to be carded. And this being done, it was found after a year or two that the estate yielded about ten shillings per acre; by great good fortune, the next year it yielded eight, while potato-fields yielded twenty pounds; and then, much to the relief of the unhappy silkworm-cultivator, a good sharp frost killed off his *Ailanti* and *Bombyces*, one and all, in the same night. Silkworms are all very well as toys or entomological specimens, but in Britain they are commercially a failure.

Polymorphism among Corals.—The name "polymorphism" among animals has been applied to the phenomenon which consists in the co-existence of two, three, or more forms of a species, each serving some appropriate function for the benefit of the species collectively. In males and females, we have the ordinary case of "dimorphism;" in the males, females, and neuters of bees we have a case of polymorphism, which might be designated trimorphism. Among the great ants of South America, Mr. H. W. Bates has described a case in which, besides males and females, there are three forms of workers. In the Cœlenterata, polymorphism is well known by striking examples among the Hydrozoa,—the various individual polyps which make up a polypary having often different forms in different regions, and fulfilling various functions—*e.g.*, mouths, swimming bells, grasping appendages, and reproductive bodies, attached or becoming separated, as free jelly fish; all acting as members of one household. Professor Kölliker has lately made the discovery of true polymorphism among various genera of Anthozoa also. This polymorphism consists in the existence, besides the large individuals capable of taking nourishment and furnished with generative organs, of other smaller, asexual individuals, which appear essentially to preside over the introduction of sea-water into the organisms, and then over its expulsion, and which are, perhaps, at the same time, the seat of an excrementitial secretion. Like the others, these asexual individuals possess a body-cavity divided into chambers by eight septa, and a pyriform stomach with two orifices. On the other hand, they are entirely destitute of tentacles; and instead of the eight ordinary mesenteric filaments, there are only two, supported upon two consecutive septa. The cavity of the body of these individuals is always in communication with that of the sexual individuals; but the mode in which it is effected varies in the genera. Among the coral forms which exhibit this interesting polymorphism are the sea-pens, *Virgularia* and *Pennatula*. With the exception of *Sarcophyton*, Professor Kölliker has not observed this dimorphism in any of the Alcyonidæ or Gorgonidæ.

Do Molluscs bore by Acids?—There are some naturalists, devoted conchologists, who lose their temper whenever this question is asked, considering that it has been completely settled that acids have nothing to do with the holes made in limestones by *any* animals whatever, because a *Pholas* has been found to have bored into a piece of gneiss. Ten years ago M. Troschel, an eminent observer, detected a considerable quantity of free *sulphuric acid* in the saliva of a Gasteropod — *Dolium galea*. MM. de Luca and Panceri have lately resumed the investigation of this subject, and have found between three and three-and-a-half per cent. of free sulphuric anhydride in the saliva of this animal; they did not find any hydrochloric acid. They have detected sulphuric acid also in four species of *Tritonium*, in a *Cassis*, a *Cassidaria*, two *Murices*, and an *Aplysia*. The part played by these acids and the carbonic acid which they also obtained in large quantities is still obscure; but there can be no doubt whatever that were one of these molluscs to eject its fluid on a piece of carbonate of lime (either the shell of its prey or the rock on which it lives), that carbonate of lime would be dissolved, destroyed, and eroded. The detection of an acid, and the ascertaining of its chemical nature, is interesting in connection with the discovery by Mr. Ray Lankester of an acid excretion from the body of a species of *Leucodore*, and of *Sabella* which bore cavities in limestone rocks.

The Nature of Monads.—It appears from the researches of the last five years, that many forms of minute life, which at one time were regarded as forming families or groups by themselves, are really the common modification or stage of existence through which many and widely differing organisms pass. At the same time it appears probable that this common stage of existence is represented in a few cases by adult forms. The cases to which we allude are, firstly, *Monas forms*; secondly, *Amœba forms*; and thirdly, *Acineta forms*. There is little doubt that Amœba is an adult and distinct form, as also is Acineta; at the same time, Cienkowski has shown that certain minute vegeto-animal organisms pass through first a Monas stage, then become small actively creeping Amœbæ, and finally, becoming encysted in cellulose and tinted with chlorophyll, break up into spores, which again become Monas forms; whilst De Barry has described a Monad and Amœba stage in the *Myxomy-*

cetes. Stein and others have shown that a large number of Infusoria, when first they emerge from the parent Infusor—by the breaking-up of whose nucleus or ovary they have been formed—assume the Acineta form, exhibiting those peculiar sucker-like pseudopodia which are characteristic of the remarkable *Acineta*. Now it is freely admitted that there are *Amœbæ* and *Acinetæ* which are not mere transient stages of an existence; but is it so with *Monas?* Professor H. James Clark, of Philadelphia, has recently done much to solve this question. He has used very high powers of the microscope, and has studied the Monas forms of ponds and streams. He describes and figures, in a very careful and satisfactory manner, a mouth, nucleus, and contractile vesicle in what he calls the *Monas termo* of Ehrenberg; and he describes, in addition, a series of forms exhibiting two, six, or more monads, united by stalks, and lying within cup-like sheaths. These forms he maintains lead ultimately to the ciliated Sponges. Just as we may regard the ordinary "sponge particles" as Amœbæ, and the sponge therefore as an aggregation of Amœbæ with a horny and siliceous skeleton, so in the case of *Leucosilenia* and others, Professor James Clark thinks we must consider the sponge-particle as a flagellate Monad—a more or less complete gradation leading from the simple Monas, through the compound forms with their cups and stalks, up to the ciliated Sponge.

A New Group of Protozoa.—Professor Cienkowski has discovered a new organism, which like some others of simplest structure, holds a doubtful place between plants and animals. These creatures, to which he gives the name *Labyrinthulea*, were found encrusting the weed-grown posts in the harbour of Odessa. They are of microscopic dimensions and form a network of thin, reticulate, colourless filaments, on which fusiform bodies circulate very slowly in various directions. In various parts are embedded globular masses, from and into which the filaments appear to arise and to be inserted. The reticular arrangement is sometimes supplanted by an arborescent form. The network as well as the arborescent ramifications spring from a central mass, which is sometimes as big as a pin's-head. The substance of the filaments is solid and non-contractile, hence they are not like the pseudopodia of Rhizopods. The fusiform corpuscles are nucleated and nucleolated, and appear to consist of a protoplasmic substance. The cause of their movement is very obscure. The relation of these organisms to other groups of Protozoa or Protophyta is very difficult to pronounce upon, since they seem to present but very little definite relationship with any one more than another. The corpuscles multiply by division, and occasionally the whole Labyrinthula becomes encysted, but there is nothing known of the reproductive process which will help to determine their affinities. They must be considered as a new group of Protozoa.

New Manual of Physiology.—A new text-book of Physiology, in two thick octavo volumes, has been written by Mr. John Marshall, F.R.S., Professor of Surgery in University College, London. The merit of the book lies chiefly in this, that a certain amount of Comparative Anatomy is introduced, together with the Human Anatomy and Physiology. A really good and original work on general physiology for the use of students is sadly wanted. It is reported that Dr. Michael Foster, of University College, is preparing a treatise on Development (in the whole animal kingdom), which is just the book that is wanted. There is *nothing* at present in English on the development of the lower animals.

Hunterian Lectures.—Professor Huxley is giving his lectures as Hunterian Professor this year on the Invertebrata. The lectures are very largely attended, and are of great interest. Professor Huxley does not believe that a sharp line can be drawn between plants and animals, but would regard man and the magnolia-tree as extreme terms of one long series, diverging on the one hand to the vegetable, on the other to the animal kingdom. In the first lecture the various groups of the Protozoa were discussed, and the general classification of Invertebrata. Two series were pointed out leading upwards from the Protozoa—one passing through infusoria, worms, and annelids to the articulate animals, the other through the sponges, corals, and polyps to the Mollusca. The gradation which thus existed was, Professor Huxley considered, an undeniable fact; it was another question as to whether that gradation indicated genetic relationship, and one which could not yet be discussed.

Zoological Society of London.

At the commencement of the present session in November, Dr. Sclater, the secretary of the Society, read an account of several recent additions in the Society's menagerie; amongst these were a penguin (*Spheniscus demersus*), from South Africa, two great ant-eaters (*Myrmecophaga jubata*), one from Brazil, presented by Dr. A. Palin, and the other from New Granada, presented by Mr. P. Brandon, and a young walrus (*Trichecus rosmarus*). The walrus has since then died, and investigations of its anatomy and of the cause of death have been carried on by Dr. Murie, the prosector. Dr. Murie reports that the animal's death resulted from ulceration of the stomach, due to the presence of very numerous entozoa, which were new, and named by Dr. Baird *Ascaris bicolor*.

Amongst communications made to the Society relative to the mammalia are the following:—Mr. W. H. Flower, "On the Osteology of the Sperm Whale," in which he showed that there was no sufficient evidence of the existence of more than one species of sperm whale, for which he was of opinion that Linnæus's name, *Physeter macrocephalus*, ought to be retained; Dr. Blyth, "On Asiatic Species of Deer;" Dr. J. E. Gray, "On the Cats (*Felidæ*) in the British Museum," and "On the Pigs (*Suidæ*) in the British Museum;" Captain Dow, on a young living specimen of the new Tapir, from Central America (*Tapirus Bairdii*), which he has obtained for the Society's menagerie, and is shortly about to forward to Europe. Dr. Sclater drew the attention of the Society to the fact that the Eland was becoming recognized as a meat-giving animal, specimens having been exhibited by Lord Hill at the late Smithfield Club Cattle Show, which he believed were the first that had appeared in the European markets. Mr. Gerard Krefft, who is curator of the Australian Museum at Sydney, has discovered, amongst the very fine collections of fossil bones in that institution, a specimen of the humerus of a gigantic fossil *Echidna*; of this he sent a notice to the Society, not giving the new fossil species a name, since he was not sure if the species were known in Europe or not.

With regard to Birds, besides very many papers describing new species from various exotic localities, we have to record a note by Dr. Peters, of Berlin, "On the Homology of the Quadrate Bone in the Class Aves," in which he controverts the view recently maintained by Professor Huxley as to its supposed correspondence with the *incus* in the mammalia. Dr. Hector announced to the Society the discovery of an egg of the Great Moa (*Dinornis gigantea*), containing an embryo, found in the province of Otago, New Zealand, at a depth of about two feet below the surface. Professor Owen has also communicated two memoirs on the same great birds, being the eleventh and twelfth of his series of papers on this subject. These papers contained descriptions of the integument of the sole of the foot and of the tendons of a toe of *Dinornis robustus*, and a description of some bones of *D. maximus*. Professor Alfred Newton, of Cambridge, exhibited to the Society the humerus of a large species of extinct Pelican, which he has discovered in the Cambridgeshire fens. Several other new birds, reptiles, amphibia, and fishes have been described to the Society. The work done in Invertebrata has also been of considerable importance. Dr. Baird, of the British Museum, has laid before the Society a monograph of the group *Gephyrea*, those very strange worms which in external appearance seem to connect the Annelids with the Echinoderms, but are really true worms. Dr. Bowerbank read a paper "On the European Glass-rope"—the *Hyalonema Lusitanicum* of Bocage—which he maintained from examination of its minute structure was not even specifically distinct from the Japanese species, although Dr. Gray had placed the Lusitanian form in a new genus. Dr. Gray, at the following meeting, maintained that he was right, in spite of what Dr. Bowerbank alleged. According to Professor Max Schultze, however, both these gentlemen hold erroneous views as to the coral or sponge nature of *Hyalonema*.

THE PUBLIC HEALTH.

SINCE our last report the Registrar-General has published his yearly summary of the weekly returns of Births and Deaths, and causes of death in London during the year 1867. The whole is contained in a pamphlet of twenty-seven pages, which mainly consists of tables summarizing the information contained in the weekly returns issued from Somerset House. From these dry figures, however, much useful information may be extracted for the use of those who are interested in the Public Health. Nor are we quite confined to the consideration of the Metropolis in the present annual survey. A new feature has been recently added to the weekly returns in the form of a return of the weekly mortality of thirteen of the largest cities and towns of the United Kingdom. The result of these returns is also given in the present summary, and we are thus enabled to compare the mortality of London with other towns in the kingdom. It would be, however, wrong in any estimate of sanitary conditions and requirements to regard London as one city. The Metropolis, in fact, is a congeries of cities and towns, which have become agglomerated by the growth of each. London and Westminster were once separated by a district as free from houses as London is now separate from Harrow, but the interspace has grown up, and thus Hampstead and Islington, Hackney, Bow, Greenwich, Woolwich, Dulwich, Clapham, Wandsworth, Kensington, and Paddington form now but parts of the great Metropolis, which takes its name from the central city, whose sleeping population does not at present exceed 115,000 persons. Nevertheless, the occupations, wealth, soil, elevation of these several united towns and cities vary so much as to render a close scrutiny necessary, in order to ascertain what are the physical and social conditions that are influencing the health of the Metropolis.

In 1867 the population of the Metropolis was estimated to be 3,082,372. The ascertained population in 1861 was 2.803,989. This vast aggregate of human beings live in a district of 122 square miles, which is intersected by the river Thames. On the north side of the river lie 51 square miles, and this is occupied by three-fourths of the population; on the south side there are 71 square miles, with the remaining fourth of the population. This vast mass of people live in 340,917 houses, in which must be enumerated 46 workhouses, 12 prisons, 4 military and naval asylums, 31 civil hospitals, 8 military and naval hospitals, and 19 lunatic asylums. The Metropolis is, in fact, a kingdom in itself, representing and repeating the whole empire. In this population of above three millions there died in 1867, 70,588 persons; during the same period there were born 112,264: thus giving to London an increase in her population by birth alone 41,676 persons. It is, however, to the death that we must turn our attention. The death of London in the last year contrasts favourably with that of the four preceding years. The proportion of deaths to 1,000 living persons being a little less than *twenty-three.*

In 1862 it was twenty-three-and-a-half in the thousand, in 1863 it was twenty-four-and-a-half, in 1864 it was twenty-six-and-a-half, in 1865 it was twenty-four-and-a-half, and in 1866 it was twenty-six-and-a-half. In 1864 the large mortality was produced by the cold of that year, and in 1866 by cholera. The mortality of the present year, like all years succeeding visitations of great epidemics, has undoubtedly been reduced by the weaker members of the population having fallen victims to the epidemic cholera of the previous year, but also and chiefly to greater sanitary activity. In order to estimate the saving of life between 1867 and 1864 or 1866, we must multiply each thousand of the population by three, which gives us 9,000. Some estimate may be formed of the saving to the community thus occasioned, when we recollect that not only has much valuable and wealth-producing life been saved, but that the expense of funerals and the loss of time and expense occasioned by at least 120,000 illnesses—calculating that where one person dies from an unsanitary cause, twenty are attacked with illness and get well—have been avoided.

The death-rate of London contrasts favourably with the death-rate of the twelve large towns quoted in the Registrar-General's weekly reports.

Thus for the year 1867 we find the following death-rates:—

1.	Manchester	31·40	in the 1,000 living.
2.	Newcastle-on-Tyne ..	30·79	"
3.	Liverpool	29·57	"
4.	Glasgow	28·54	"
5.	Salford	28·50	"
6.	Edinburgh	27·13	"
7.	Dublin	27·06	"
8.	Leeds	26·96	"
9.	Hull	24·93	"
10.	Sheffield	24·67	"
11.	Birmingham	24·27	"
12.	Bristol	23·08	"
13.	London	22·98	"

At the end of 1866, London did not stand so well in the list, and this was clearly due to the outbreak of cholera. Great comparative credit must be given to London for this pre-eminence in health. In connection with this high sanitary position, it should be recollected that London has had now for above ten years a body of Medical Officers of Health, and none of the other towns on the list have had the advantage of such an officer for that period. We believe, however, with the exception of Manchester, that they all have a Medical Officer of Health. It is a significant fact, that Manchester in 1867 presents the highest mortality. We have, however, to announce that Manchester has at last appointed a Medical Officer of Health, and we hope soon to have to record the advantages conferred on the city by his agency. In order, however, that it may be seen what is the real difference between the mortality of London and Manchester as indicated in the above table, we would remind our readers that if the death-rate of Manchester had been in 1867 as low as that of London, that 3,258 *lives would have been saved!* Manchester has a school of politicians of its own, addicted according to some writers to a mercenary consideration of profit and loss. Will not some of their statisticians calculate for them the loss upon these three thousand two hundred and fifty-eight lives? Manchester has Christian Churches and Philanthropic Societies, and a Ladies' Sanitary Association. Cannot some of the ministers and secretaries of these associations cast up, for the benefit of Manchester people, the amount of agony that might have been saved, wretchedness and want and disease short of death that might have been prevented, had the causes that slew this mass of human beings been withdrawn in time?

It will be seen that Newcastle-upon-Tyne stands second on the list. The mortality of this town stands much higher than formerly, and its present high rate demands attention. It should be recollected in these towns that a few years ago a death-rate of 30 in the 1,000 was considered so exceptional, that the Government has power to interfere when the mortality of a town has continued above that rate more than a year.

Liverpool has gone through a fiery trial, and after long taking the lead as the most deadly city in the empire, may be congratulated in standing third on the list. It is to be hoped that even the present rate of mortality will be diminished before long. We need not comment further on this list except to point out the low mortality of Hull, Sheffield, Birmingham, and Bristol as compared with the other large towns of the United Kingdom. Hull more especially is to be commended: it lies low, below the sea-level (as the recent flood showed), and is surrounded by a swampy country. It should, however, be remembered that a death-rate of 24 in the 1,000 is unnecessarily high, and that where it exists at that point, it can most assuredly be reduced by sanitary measures to a lower figure.

Although London presented the low rate of 23 in the 1,000, it must not be supposed that this is not subject to lower and higher rates in its various districts. As a rule we find that the closer and thicker the population, the greater the mortality. We are not able to say how this influences the relative mortality of Manchester and Birmingham, but it is remarkable in the registration divisions into which London is grouped. The Registrar-General recognizes five divisions:—1. The Central, which includes St. Giles, Strand, Holborn, Clerkenwell, St. Luke, East and West London, and the City: in this group the mortality was 24 in the 1,000. 2. The Eastern district comprises Shoreditch, Bethnal Green, Whitechapel, St. George's-in-the-East, Stepney, Mile End Old Town, and Poplar: the death-rate in this district was also 24 in 1,000. 3. The Northern division, including Marylebone, Hampstead with its Heath, Pancras, Islington, and Hackney, all with great unbuilt-on spaces; here the death-rate was only 23 in the 1,000. 4. The Western district, including Kensington, Chelsea, St. George's, Hanover Square, Westminster, St. Martin-in-the-Fields, and St. James, Westminster: in this group there is less free space, but it includes the wealth of London, and its mortality was 22 in the 1,000. 5. The Southern group; this includes all the south side of the water; it comprises the teeming populations of Lambeth, Southwark, Deptford, and Greenwich, but also the almost country districts of Wandsworth, Clapham, Dulwich, and Blackheath: here the death-rate is 21 in the 1,000. This last division has an area almost six times as great as the Eastern and Central divisions together, and a population not equal to these two divisions combined. It is a fact worthy of notice that the south side of the Thames from 1845 to 1864 has exhibited a higher rate of mortality than it does the present year. There is no doubt that this is due, first, to a supply of purer water, by the water companies having obtained supplies of purer water; and, secondly, that the new system of metropolitan drainage is beginning to tell favourably upon the health of the south side of London.

An interesting feature in the weekly bills of mortality of a large population is the fluctuation which it presents. Thus, taking the London returns, we find that the highest number of deaths registered in any week in the year 1867 was 1,891, occurring in the week ending the 12th of January. The lowest number of deaths in any week in the same year was in the week ending June 22nd, when only 1,052 deaths were registered. The study of these figures in connection with atmospheric vicissitudes, of which copious details are given in the Registrar-General's Reports, would appear to throw some light on the causation of disease; but, with the exception of temperature, we are not able to connect the fluctuation of the death-rate decidedly with any other meteoric condition. The relation of temperature to the great death-rate of the second week in January, 1867, is very obvious. It not only occurred in London, but in all the other twelve populations. In London the death-rate went up from 27 in the 1,000 to 33, in Salford from 29 to 39, in Sheffield from 22 to 32, in Dublin from 25 to 31. Now during the first week in January the mean temperature at Greenwich was 25°, and the lowest temperature was 6°. It was in the second week this wave of cold told upon the communities of the United Kingdom, and although the temperature during the next three weeks was not so low, it was still low, and the populations all had high death-rates during the remainder of January. The first quarter of the year consequently presented a higher death-rate. The next highest death-rates we meet with are in the third quarter, and these manifestly arise from a high temperature. The mean temperatures of the first four weeks in August were above 60°, and we find during and after this increase of heat the death-rates increasing. Although sanitary arrangements can do nothing to prevent the fall and the rise of the thermometer, they can point out what ought to be done to mitigate the effects of cold and heat on the human body. Warm clothing and fires indoors are the great means of preventing the disastrous effects of cold in winter, whilst fresh air and pure water are needed to neutralize the effects of overcrowding and profuse perspiration in the summer.

Of the 69,000 deaths in London, 15,000, or nearly a fifth of the whole, were due to zymotic diseases. This is probably about the proportion that these diseases would bear to the whole death of each of the large populations whose death-rate has been given. Zymotic diseases are especially regarded as preventible diseases. They all depend on a contagious poison conveyed from one body to another, and it is quite possible by proper means to prevent their spreading. Amongst these diseases we mention first small-pox, because its very existence amongst us is a disgrace. We know how to prevent it, yet from ignorance, carelessness, and grosser oversight, 1,332 people died of this disgusting disease in London alone. We have no means of ascertaining the extent to which this disease prevailed in other populations of England in 1867; but in the Twenty-eighth Annual Report of the Registrar-General we find that in England and Wales alone there died of small-pox—

1862	1,628
1863	5,964
1864	7,684
1865	6,411
	21,687

These figures are truly alarming, and if the mere statement of facts in this way could produce any impression, it ought at once to induce action of a much more efficient kind than the passing of the Vaccination Act of last year. We fear that no mere legislation will effect much for staying this plague. There must be a deep sense of responsibility with regard to the existence of this disease impressed upon the community, so that every parent and neighbour may recognize it as a duty to see that the only means of preventing its occurrence, early vaccination, is had recourse to.

Sir James Simpson, in a recent communication to one of the Medical Journals, proposes to "stamp out" small-pox in the same manner as the cattle plague has been stamped out. Of course he excepts the process of immediately killing the animal attacked. What he really means is this, if a case of small-pox is at once taken in hand, placed in strict quarantine, and only those allowed to approach the individual attacked who have already had the disease, or been vaccinated, and every article of clothing in contact with the diseased body destroyed, you may defy the extension of the disease. This is true of all other infectious diseases. If a child attacked with scarlet fever is at once placed in a room by itself, and only those allowed to enter who have had the disease, and every precaution taken to destroy poison in the excretions, and in the clothes worn and used by the patient, then the disease will not spread. It is a well-known fact that when a case of typhus fever is taken into a hospital, and every precaution taken to prevent the spread of the poison, it seldom or never spreads. It is the utterly careless and abandoned way in which these pestilential diseases are treated in the homes of the poor that causes their spread and the desolation that follows. When these diseases occur, whether it be in London or other towns, no serious efforts are made to "stamp them out;" a *laissez-faire* system is adopted, which at the end of the year is summed up in such forms as follow: "Whooping-cough carried off many children all over London; and diarrhœa, which was the most fatal of the Zymotic class, caused 2,294 deaths. Cholera, chiefly *cholera infantum*, was fatal in 241 cases; typhus and typhoid fever, &c., in 2,174 against 3,232, and 2,681 in the two previous years."

The London people have, no doubt, occasion to be thankful that those two last diseases had diminished in severity. But why should there be 2,000, or 200, or any typhus and typhoid at all? These fevers are bred of causes which are well known. Typhus is the offspring of overcrowding, and typhoid of bad drainage. In some districts of London, as Mayfair, in St. George's, Hanover Square, Eltham, and Lee not a single case occurred in the whole year. In Dulwich, the Golden Square district of St. James, Westminster, and St. Olave's, Southwark, only one fatal case occurred in the year. These instances taken at random from the Registrar-General's returns, show that these diseases may be kept at bay, and are kept at bay, and very diligent inquiries ought immediately to be set on foot, where deaths from these diseases occur in large numbers. Paddington, Westminster, Marylebone, Pancras, Shoreditch, Hackney, Mile End, Whitechapel, on the north of the Thames, and Walworth, Lambeth, Battersea, and Camberwell, are the great seats of these diseases on the south side of the Thames. Of all forms of zymotic disease, typhus and typhoid are the most easily arrested, and the most worth arresting, and for the same cause. They chiefly attack and carry off the adult. The adult can more easily be taught the value of and danger to his own life, than the child who is at the mercy of others; whilst the sad fact that it is the fathers and mothers of families who are carried off by these diseases, ought to quicken the apprehension of all rate-payers as to the great economy in saving this valuable life to the community.

Of the remaining 55,000, some are not, but some are clearly under the control of sanitary agencies. Thus, for instance, there were 8,817 deaths from consumption. This is essentially a disease of underfeeding, overcrowding, and deficient muscular activity. It is found present in the cottages of the agricultural poor, where the wages are insufficient to support the rapid growth of girls and boys approaching adult years; it is found in the workshops of tailors and milliners, who are herded together in close rooms all day, and who sleep in overcrowded bedrooms at night; it is found especially amongst those who sit all day at their occupations, and have little or no leisure for bodily exercise. Returns for the Metropolis, of which no account is taken in the Registrar-General's summary, clearly show that where the population is dense and where the occupations are sedentary, there the deaths from consumption are at a maximum; and that where the population is less dense, and open-air occupations are the rule, the mortality from this disease is at a minimum. This shows the importance of securing a sufficient amount of healthy space for those who work at sedentary occupations, as well as the necessity of providing in all densely populated districts open spaces for their exercise and recreation.

Whilst on this subject, we would refer to an Act passed during the last Session of Parliament, entitled "An Act for regulating the Hours of Labour for Children, Young Persons, and Women employed in Workshops." This Act is supplementary of the Factory Extension Act, by which all establishments employing more than fifty persons in a manufacturing process are subject to the inspections and other requirements of the Factory Act. It is intended especially to apply to all shops where children, young persons, and women are employed. The following are the principal requirements of this Act:—

1. No child under the age of eight years shall be employed in any handicraft.

2. No child shall be employed on any one day in any handicraft for a period of more than six-and-a-half hours, and such employment shall take place between the hours of six in the morning and eight at night.

3. No young person or woman shall be employed in any handicraft during any period of twenty-four hours for more than twelve hours, with intervening periods for taking meals and rest amounting in the whole to not less than one hour and a half, and such employment shall take place only between the hours of five in the morning and nine at night.

4. No child, young person, or woman shall be employed in any handicraft on Sunday or after two o'clock on Saturday afternoon, except in cases where not more than five persons are employed in the same establishment, and where such employment consists in making articles to be sold by retail on the premises, or in preparing articles of a like nature to those sold by retail on the premises.

All persons employing women or children in contravention of this Act are liable to fines set forth in the Act. All inspectors and officers of health suspecting the Act to be infringed can have power granted them to enter premises by the order of a justice. Further provisions are made in this Act for the education of children employed in factories.

This Act, like all other sanitary Acts, is only permissive. Should it please a vestry to shut its eyes to the evils of overworking children and women, they may allow the Act to remain a dead letter. There is, however, one vestry in London that has moved in this matter, and that of a parish which has perhaps more overworked women in it than any parish in London, and that is the parish of Saint James, Westminster. This parish which, in a population of 36,000, numbers 1,500 sempstresses, presents a legitimate field for the operation of this Act. The vestry have ordered that the Act be circulated through the parish, and that all complaints of the infringements of its regulations shall be registered at the vestry-hall for the purposes of inquiry, and prosecution if necessary. The same has been done in some country-towns in Scotland.

LEEDS.—We have to submit to our readers this time a special report on the sanitary condition of Leeds. Coincident with the generally improved state of the public health, Leeds, as contrasted with the past, presents a favourable aspect. The mortality during the present year, up to March 7th, has been at the rate of 24 per 1,000 per annum, against 32, 36, and 29 in the corresponding periods of 1865–1867. The sanitary condition, however, can be more correctly gauged by reference to that truest of all tests, the comparative number of deaths from Zymotic diseases.

The following table shows the relative proportion of deaths from this class during the corresponding periods of 1866, 1867, and 1868:—

Deaths from principal Zymotics during corresponding Periods of 1866, 1867, *and* 1868.

From January 1st to March 7th.

	1866.	1867.	1868.
Small-pox	15	12	6
Measles	32	12	1
Scarlatina	41	19	22
Whooping Cough	44	42	26
Croup	33	17	18
Diarrhœa	33	6	21
Typhus, Typhia, and Typhinia ..	154	60	50
Dyphtheria	5	8	1
Total	357	176	145

Such results as the above are satisfactory and encouraging to those who are endeavouring to elevate the healthiness of the towns but unfortunately this improvement in the sanitary status produce, another effect, *viz.*, that of creating in the minds of town councillors a desire to rest and be satisfied, deducing, as such gentlemen are apt to do, the inference that a low death-rate affords a ready subterfuge against charges of inert policy. In Leeds there are hundreds of cesspools immediately under, or adjoining dwelling-houses, which the Town Council, in their Improvement Act of 1866, obtained powers to abolish; yet that body now hesitate to enforce the law, forsooth, because such a course would probably incur the risk of loss of seat in the coveted council chamber. After perusing the above, our readers will not be surprised to hear that the powers delegated to the local authority by the Sanitary Act of 1866 are but feebly executed, and that the members of the Corporation require awakening to the necessity of adopting vigorous prophylactic measures in order to combat—if not stamp out—preventible diseases, like typhus, typhia, small-pox, scarlatina, &c.

For want of a public abattoir in Leeds, there are upwards of a hundred private slaughter-houses, in the hands of private individuals, distributed in various parts of the town, where in many instances they are not only a source of prodigious nuisance, but afford also, in consequence of difficulty of supervision, facile opportunities for unprincipled butchers to slaughter and dress diseased animals. The large profits to be derived from such a trade are, as can easily be imagined, an immense temptation to engage in the traffic; and should the colour or consistence of the meat be such as to prevent the vendor from disposing of it in the shape of ordinary joints, it undergoes what is termed in the technical phraseology of the craft "boning"—to be then consigned to the meat-pie or sausage manufacturer.

One more instance will suffice to show how far town councillors can be entrusted to carry out existing laws, or the demands of modern science.

The Nuisances and Scavenging Committee themselves possess one of the most gigantic nuisances that can possibly be conceived—to wit, a depôt for town garbage, placed in one of the most densely populated neighbourhoods of the town, where this refuse in its passage through the various states of putrefaction is converted into a saleable manure for the farmers, who fetch it away at their convenience. Surely such facts prove how much the public mind in Leeds needs educating concerning the immense advantages which flow from obedience to sanitary laws; and moreover, such knowledge, when generally diffused, would produce the utterance of unmistakable language, and teach our local rulers, that in order to retain their seats on the aldermanic bench, they must—regardless of sordid interests—busy themselves in promoting the social well-being of the poor and ignorant in their wretched homes.

SCOTLAND.—Since the last reference was made in this Journal to the subject of Public Health in Scotland, much has been done, both in the cities and large towns, and among the smaller communities, towards bringing about an improvement in their sanitary condition. Town Councils, Police Commissions, Parochial Boards, and other corporate authorities have been organizing measures for improving the Public Health, and lowering the very high death-rate which has too long prevailed. During the last few months the desire to put the "house in order" has been very manifest throughout the greater part of Scotland, especially in small communities where there were no police acts to empower the authorities to deal with sanitary matters. Now the provisions of the General Police and Improvement (Scotland) Act, 1862, commonly known as Provost Lindsay's Act, and Public Health (Scotland) Act, 1867, are at their disposal, and certainly it is a healthy sign to note the energy that is being displayed in many places to have those provisions put in force, especially in respect of such matters as the drainage and water-supply.

It may not be inappropriate to commence with sanitary affairs in Scotland as they present themselves to our notice in Glasgow.

One might naturally expect that in Glasgow there would be such an amount of energy and public spirit among her merchants, manufacturers, clergy, and others, that such measures as are known to be conducive to the maintenance of a high standard of Public Health would not only be taken by the public authorities, but that they would soon be put in operation through the assistance and for the benefit of the people at large. A measure which, in the minds of some of its promoters, undoubtedly had this object in view, is the Improvement Act, which was passed by Parliament in the session of 1866. It may be remembered that this Act provides for the expenditure of 1,250,000*l.*, in order that the unhealthy dens, wynds, courts, and lanes that have been allowed to grow up and accumulate in the lapse of centuries might be rooted out, and be supplanted by open squares and thoroughfares, and by dwelling-houses constructed according to the most approved plans for the sanitary well-being of the occupants; and that, in short, the denizens in the heart of the city should no longer be secluded from the healthy influences of the sun's rays and the pure air of heaven. The benefits expected to ensue from the operations of the Improvement Act are removed farther into the future than was wished by ardent sanitary reformers. So soon as the police assessment papers were issued for the first year under the Improvement Act, complaints both loud and general were raised against the Act, because it was found by the taxpayers that, to the already heavy load of taxation for general police and sanitary purposes, there was to be superadded no less than sixpence per pound on the rental for improvement purposes. That amount of assessment was the utmost limit allowed by the provisions of the Act. The people began to consider that they were to purchase the improvements at too great a cost, that they were "to pay too much for their whistle." What made the load seem still heavier, was that the occupiers were compelled to pay the whole of the assessments, while the owners of household property were allowed to go "scot free." The Lord Provost, who was the chief promoter of the improvement scheme, lost his place in the Town Council in consequence; and very soon thereafter the rate for improvement purposes was reduced to fourpence per pound for the second year. Considering the great depression and dulness prevailing during the last year or two in the engineering, shipbuilding, and other staple trades of Glasgow, the resolution come to by the Improvement Act Commissioners was certainly a wise one, as it is not desirable that the lawfully constituted local authorities should be guilty of such conduct as is prone to provoke opposition to their decisions from any large body of the ratepayers, many of whom have always ample demands made upon their hard earnings.

The position which Glasgow occupies in respect of water-supply is one that may well be envied by London and many other large communities. In a city of upwards of half-a-million of people the supply of water is 26,400,000 gallons daily, and of this quantity about six-sevenths is obtained from Loch Katrine by an aqueduct whose total length is thirty-four miles. The aqueduct could convey as much as 50,000,000 gallons per day; and this, be it noted, is water of great purity ($2\frac{1}{4}$ grains of soluble matter per gallon), with might naturally conclude that the mortality among the people living on the banks of the Clyde, receiving a daily average supply of about fifty gallons of water per head, would not mount up to 28, 29, 30, and 31 per thousand as it frequently does;* indeed it is one of the rarest things imaginable for the Glasgow death-rate to fall below 28 per thousand. Unfortunately, however, the river on whose banks Glasgow is built is still a *cloaca maxima*, a great common-sewer, into which the refuse, filth, and abominations of the city are freely discharged, so as to make the harbour, during summer more especially, a seething cauldron from which putrid exhalations arise to poison the atmosphere, and slowly but surely to poison the people who are compelled to breathe it. Glasgow has shown a good example to London by its Loch Katrine water scheme, but it has yet to learn from the Metropolis how to improve its condition in respect of the great project of intercepting the sewage-matter and conveying it to such a distance as will prevent it exerting any detrimental influence on the health of the people, and possibly to such a part of the West of Scotland as will be directly benefited by its fertilizing power.

However unfortunate the present state of things in Glasgow may be, still there is room for hope that it cannot exist much longer, and sanitary reformers even think that they already almost see the "beginning of the end." In the course of last year the authorities embraced in the Town Council, the Police Board, and the Clyde Trustees, jointly agreed to remit the consideration of the whole question of the sewage to Mr. J. F. Bateman, the engineer-in-chief of the Loch Katrine Water-works; Mr. Bazalgette, the engineer of the Main Drainage and Thames Embankment schemes; and Professor Anderson, chemist to the Highland and Agricultural Society of Scotland. The gentlemen just named have been devoting a good deal of attention to the subject; and in the month of February last the two eminent engineers spent some days in Glasgow in giving audience to persons who take an interest in this life-and-death question. That the subject has excited a vast amount of local interest (and deservedly so) may be inferred from the fact that during the past winter there has existed an organization called "The Association for the Consideration of the Sewage Question." It embraces in its membership Town Councillors, engineers, chemists, physicians, manufacturers, merchants, and others. Meetings have been held regularly every fortnight, at which papers, treating on almost every conceivable plan, have

* Even in the mild weather of January last, the death-rate per thousand of the population was during five weeks, respectively, 27, 33, 32, 31, and 32.

been read and discussed with much energy and intelligence. Abstract reports of the papers and discussions have been published in the local papers, and, as a matter of course, the interest felt in the subject is very general among intelligent people. The wet systems and dry systems, water-closets and earth-closets, the separation of liquid from solid sewage, house from street sewage, and the refuse of chemical works om both, irrigation and discharging into the sea, have all had their advocates; and frequent references have been made to Croydon, London, Carlisle, Wolverhampton, Paris, Naples, the Craigentinny Meadows at Edinburgh, and other illustrations of more or less successful attempts to dispose of the sewage refuse of large communities. It is to be hoped that the proceedings of the Glasgow Sewage Association may soon be published, so that any valuable information contained in the papers and discussions may be placed at the disposal of other people who are interested in sanitary progress. It is likewise to be hoped that the eminent engineers already named may soon mature such a plan for Glasgow and the Clyde as will be a pattern to other large towns that have the same difficulty to overcome as still meets the sanitarian in the Scottish commercial metropolis.

Apart from the two questions already referred to, a good deal of sanitary work is being accomplished in Glasgow by and through the Police Board, and especially by the Sanitary Department. Acting on the maxim that bad drainage and damp, dark, ill-ventilated, and overcrowded dwellings are a fruitful source of typhus fever, the members of Dr. Gairdner's Sanitary Staff are continually on the alert to check and remove the causes of this and other forms of epidemic disease. But with all their alertness, typhus is constantly asserting its presence in the midst of the community. During last year, no fewer than 3,143 cases of fever were reported to the Sanitary Committee of the Police Board, as against 3,541 in 1866, 7,707 in 1865, and 4,294 in 1864. A large number of the fever cases are treated in the Fever Hospital, erected especially for the treatment of free patients a year or two ago. In it there are 120 beds, of which only 20 were reported to be unoccupied at the end of January last. The numbers of cases of fever reported at some of the fortnightly meetings held in December, January, and February last, are 156, 144, 165, 176, 189. Small-pox also shows itself in Glasgow, for in December, 1867, there were as many as 35 cases reported, notwithstanding that Jenner lived, and that medical schools since his day have never ceased to indoctrinate their pupils in the sanitary truths which he taught and practised during his professional career.

At a recent meeting of the Glasgow Police Board, attention was called to the existence of a range of buildings close to the West-end Park, in a district otherwise entirely occupied by the wealthy members of the community. The buildings were spoken of as intended for dwelling-houses, one story in height, in a narrow lane closed up at each end, and to which access can only be had by means of a covered passage. We say "intended," for at the time of the report they were not ready for occupation. Will it be believed that in enlightened Glasgow, with its boundless wealth, its hundreds of churches and other institutions of a religious, moral, and philanthropic character, that dwelling-houses *placed back to back*, without any provision for ventilation, could be erected in the year of grace 1868, and that under the eye of the police authorities? We may well ask, of what use is the Glasgow Police Act, passed in the year 1866?

It will be seen from the foregoing remarks, that there is not much of a very favourable character to report regarding Glasgow from a Public Health point of view. Of the sanitary state and prospects of other towns in Scotland much might be said, were there sufficient space at our command. All that is possible under the circumstances is a very brief reference to a few points of the greatest interest.

During a large part of the last twelvemonth, the city of Edinburgh has undergone such a minute and systematic visitation and inspection as have revealed a social and sanitary condition so hideous that one is tempted to regard with great doubt many of the statements just recently made at a meeting where the formal reports of the visitation committees were submitted to discussion and for approval. The movement originated in April last, with Lord Provost Chambers, of the eminent publishing firm. In his remarks as chairman at the meeting referred to, he said:—"We have called attention to the gross condition of the lower classes of Edinburgh—the intemperance, the want of proper houses, the discomfort of their dwellings, the want of proper air, light, and water, the demoralizing influences which prevail throughout the city in many ways, and the appalling fact, more particularly, that one in every nine of the population is a pauper! That is a very distressing thing."

Dr. Alexander Wood directed attention to the total absence of water and water-closets in the houses of many of the poor, and mentioned that some of the new houses which had recently been erected for the poor had the same defects as the old houses, referring especially to some buildings in the classic Canongate, where there are 33 families living in 35 rooms—including 24 children under five years of age and 101 adults—with no sink, water, or water-closet. The rooms, it seems, in which whole families live, average about 10 feet square. Another speaker, Sir James Y. Simpson, made the astounding statement that in Edinburgh—the "modern Athens"—there are 60,000 people—one in every three of the population—living in houses of one room only. That is something like sacrificing one or two of the inhabitants by preventible disease daily. It is sincerely to be hoped that Sir James Simpson's statistics are wrong, and that Edinburgh is better than it is painted. From one of the reports read at the meeting, the following data regarding the mortality and density of the population are taken :—

Districts.	Deaths per 1000.
Lower New Town	15·47
Broughton	17·
Grange	13·78
Grassmarket	32·52
Tron	34·55

and in some tenements in the last-mentioned districts, the mortality amounts to 60 per 1,000 of the population.

Districts.	Population per acre.
Lower New Town	95·4
New Town	21·2
Grange	7·5
Grassmarket	237·6
Canongate	206·7
Tron	314·5

and it is confidently affirmed that in some of the districts of Edinburgh the density of the population is so great as to be unequalled in any town in Britain. Is it any wonder that Mr. Chambers should have determined to mark his magisterial reign by an Improvement Act, to root-out the fever-haunted dens and other plague-spots that form such a hideously foul blot on the boasted piety and refinement of Edinburgh? The Act secured powers in the last session of Parliament for borrowing 350,000*l.*, and for laying on as the *maximum* annual assessment fourpence per pound for twenty years, the same to be paid in equal proportions by the owner and the occupier. The Act is now being put in force by the Improvement Commissioners, and a sum of 50,000*l.* is to be placed at their disposal this year. When the report referred to is published, it will doubtless excite much surprise beyond the limits of the city with which it deals.

The thriving and important town of Dundee acquired an unenviable notoriety during the cholera epidemic of 1866, owing to the ravages made amongst the people in the district of Lochee. Hitherto this district has been proverbial for its periodical visitations of epidemic disease, and it has practically been a separate district from Dundee in respect of drainage and drainage rates. Indeed it has hitherto had neither the one thing nor the other. While Dundee proper has been most completely and effectually drained, the effects of which were seen in its almost total exemption from cholera at the last visitation, and have for some years been seen in the less virulent character of other epidemic diseases, its Lochee suburb has been growing more and more densely populated, and its want of drainage, its overcrowding, its nuisances, and its general insanitary state have at last led to a revolt, and action is now being taken by the Police Commission under the provisions of the Public Health Act (1867). In the face of that Act the nuisance-mongers sink into utter nothingness.

It is probable that the same cholera epidemic produced a greater proportionate amount of misery in the town of Leven, Fifeshire, than in any other town in the kingdom. It was terribly fatal, so fatal, indeed, that the people fled in great numbers from the plague-stricken spot, and left it comparatively deserted. The town was all but without sewerage, and the well-water, on which the people almost entirely depended, was found to be strongly impregnated with putrefying animal matter, which had percolated through the soil from the numerous cesspools. Such direful results as attended the non-observance of the ordinary rules of health roused the people to a sense of their danger, and in March, 1867, they resolved on adopting Provost Lindsay's Police and Improvement Act (1862). Commissioners were appointed, and the requisite measures taken to carry out the provisions of the Act. Already a bountiful supply of excellent water is introduced into the town, and now the commissioners are proceeding with the necessary drainage improvements. Leven is one of the most pleasantly-situated watering places in the ancient kingdom of Fife, and it promises soon to be one of the tidiest towns in Scotland, to be no more, it is to be hoped, a hotbed of epidemic disease.

It is a hopeful sign to notice the general anxiety prevailing throughout Scotland with regard to the adoption of measures to improve the Public Health. Where other statutory authority does not exist, the Acts of 1862 and 1867 are being called into requisition, and in various places a supply of water is brought in where it is wanted; drainage works are being constructed; nuisances removed, and sanitary inspectors and medical Officers of Health appointed. Stumbling-blocks, however, of various kinds are here and there showing themselves; but the right will ultimately come to the surface. Upwards of eighty towns and populous places have already adopted, in whole or in part, the General Police and Improvement Act (1862). Amongst the other places in Scotland in which there are signs of sanitary commotion, we may, in conclusion, mention the following:—Aberdeen, Montrose, Nairn, Hawick, Aberdour, Thornhill, Elgin, Pennicuik, Galashiels, Perth, Paisley, Greenock, Kirkcaldy, Dysart, and Vale of Leven.

Quarterly List of Publications received for Review.

1. The Variation of Animals and Plants under Domestication. By Charles Darwin, M.A., F.R.S. 2 vols. 8vo. *With Engravings.* *Murray.*

2. Faraday as a Discoverer. By John Tyndall. With Portrait. 175 pp. Post 8vo. *Longmans & Co.*

3. A System of Medicine. Edited by J. Russell Reynolds, M.D., F.R.C.P. Lond., Professor of the Principles and Practice of Medicine in University College. Vol. II., containing Local Diseases. 1,000 pp. 8vo. *Macmillan & Co.*

4. Life of Sir John Richardson, C.B., LL.D., F.R.S., Inspector of Naval Hospitals and Fleets. By the Rev. John McIlraith, Minister of the English Reformed Church, Amsterdam. 290 pp. Fcap. 8vo. *Longmans.*

5. British Social Wasps: an Introduction to their Anatomy and Physiology, Architecture and General Natural History. By Edward Latham Ormerod, M.D., Caius College, Cambridge, Physician to the Sussex County Hospital. 280 pp. Post 8vo. 14 *Plates.* *Longmans.*

6. The Mineralogist's Directory: A Guide to the Principal Mineral Localities of Great Britain and Ireland. By Townshend M. Hall, F.G.S. 180 pp. Post 8vo. *E. Stanford.*

7. Chemical Notes for the Lecture Room on Heat, Laws of Chemical Combination, and Chemistry of the Non-Metallic Elements. By Thomas Wood, Ph.D., F.C.S., Chemical Lecturer at the Brighton College. Second Edition. Post 8vo. 120 pp. *Longmans & Co.*

8. The Primitive Inhabitants of Scandinavia. By Sven Nilsson. Third Edition. Edited by Sir John Lubbock, Bart., F.R.S. 16 *Plates.* 350 pp. 8vo. *Longmans & Co.*

9. The World as Dynamical and Immaterial; and, the Nature of Perception. By R. S. Wyld, F.R.S.E. 235 pp. Post 8vo. *Edinburgh: Oliver & Boyd.*

10. **A Manual of Inorganic Chemistry, arranged to facilitate the Experimental Demonstration of the Facts and Principles of the Science. By Charles W. Eliot and Frank H. Storer, Massachusetts Institute of Technology. Second Edition. 660 pp. Crown 8vo.** ***With Engravings.*** ***Van Voorst.***

11. **First Principles of Modern Chemistry. A Manual of Inorganic Chemistry, for Students and for Use in Schools and Science Classes. By W. J. Kay-Shuttleworth. 220 pp. Crown 8vo.** ***Churchill & Sons.***

12. A Treatise on Frictional Electricity, in Theory and Practice. By Sir William Snow Harris, F.R.S. Edited, with a Memoir of the Author, by Charles Tomlinson, F.R.S. 119 *Wood Engravings.* 320 pp. 8vo. *Virtue & Co.*

13. On the Pathology and Treatment of Albuminuria. By Wm. H. Dickinson, M.D., Cantab. Assistant-Physician to St. George's Hospital and to the Hospital for Sick Children. 10 *Plates.* 290 pp. 8vo. *Longmans & Co.*

14. Jerrold, Tennyson, and Macaulay; with other Critical Essays. By James Hutchison Stirling, LL.D. 245 pp. Post 8vo. *Edmonston & Douglas.*

15. Principles of Geology. By Sir Charles Lyell, Bart., M.A., F.R.S. Tenth Edition. Vol. II. 660 pp. 8vo. *Murray.*

16. A Sketch of a Philosophy. Part II., Matter and Molecular Morphology. 75 *Diagrams.* 116 pp. 8vo. *Williams & Norgate.*

PAMPHLETS, PERIODICALS, AND PROCEEDINGS OF SOCIETIES.

Guinea Worm, or Dracunculus: its Symptoms and Progress, Causes, Pathological Anatomy, Results, and Radical Cure. By James Africanus B. Horton, M.D. Edin., Staff Assistant-Surgeon of H.M. Forces in West Africa. 50 pp. 8vo. *John Churchill & Sons.*

On certain Moral Aspects of Money-Getting. By W. T. Gairdner, M.D. 47 pp. 8vo.

Experimental Investigations connected with the Supply of Water to Calcutta. 38 pp. 8vo. By D. Waldie, F.G.S.

On the Spectrum of the Bessemer Flame. By W. M. Watts, D.Sc. *Plate.* 4 pp. 8vo.

The Present Position of Opinion respecting the Geology of Devonshire. By W. Pengelly, F.R.S. 37 pp. 8vo.

The Antiquity of Man in the South-west of England. By the same Author.

On the Distribution of the Devonian Brachiopoda of Devonshire and Cornwall. Same Author.

The Raised Beaches in Barnstaple Bay. Same Author.

On the Deposits occupying the Valley between the Braddons and Haldon Hills, Torquay. Same Author.

On the Floatation of Clouds, and the Fall of Rain. Same Author.

Notes on the Meteoric Shower of November, 1866, with Speculations suggested by it. Same Author.

On a Thermometer unaffected by Radiation. By Dr. J. P. Joule, F.R.S.

Hints to Certifying Surgeons under the Factory Acts. By George Greaves, M.R.C.S. *Knight & Co.*

Harvesting in Wet Weather. By W. A. Gibbs.

On an Improved Method of dividing Alcohol and other Thermometers. By William Ackland. 4 pp. 8vo.

The Annual Meeting of the Miners' Association of Cornwall and Devonshire. *With Engravings.*

Proceedings of the Essex Institute. (Salem, Massachusetts.)

Transactions of the Geological Society of Glasgow.

The Medical Record. (New York.)

The Mining Gazette. (Halifax, Nova Scotia.)

Le Mouvement Médical.

The American Naturalist.

The Geological Magazine.

The Westminster Review.

Proceedings of the Royal Society.

" " Royal Astronomical Society.

" " Chemical Society of London.

" " Royal Geographical Society.

" " Zoological Society of London.

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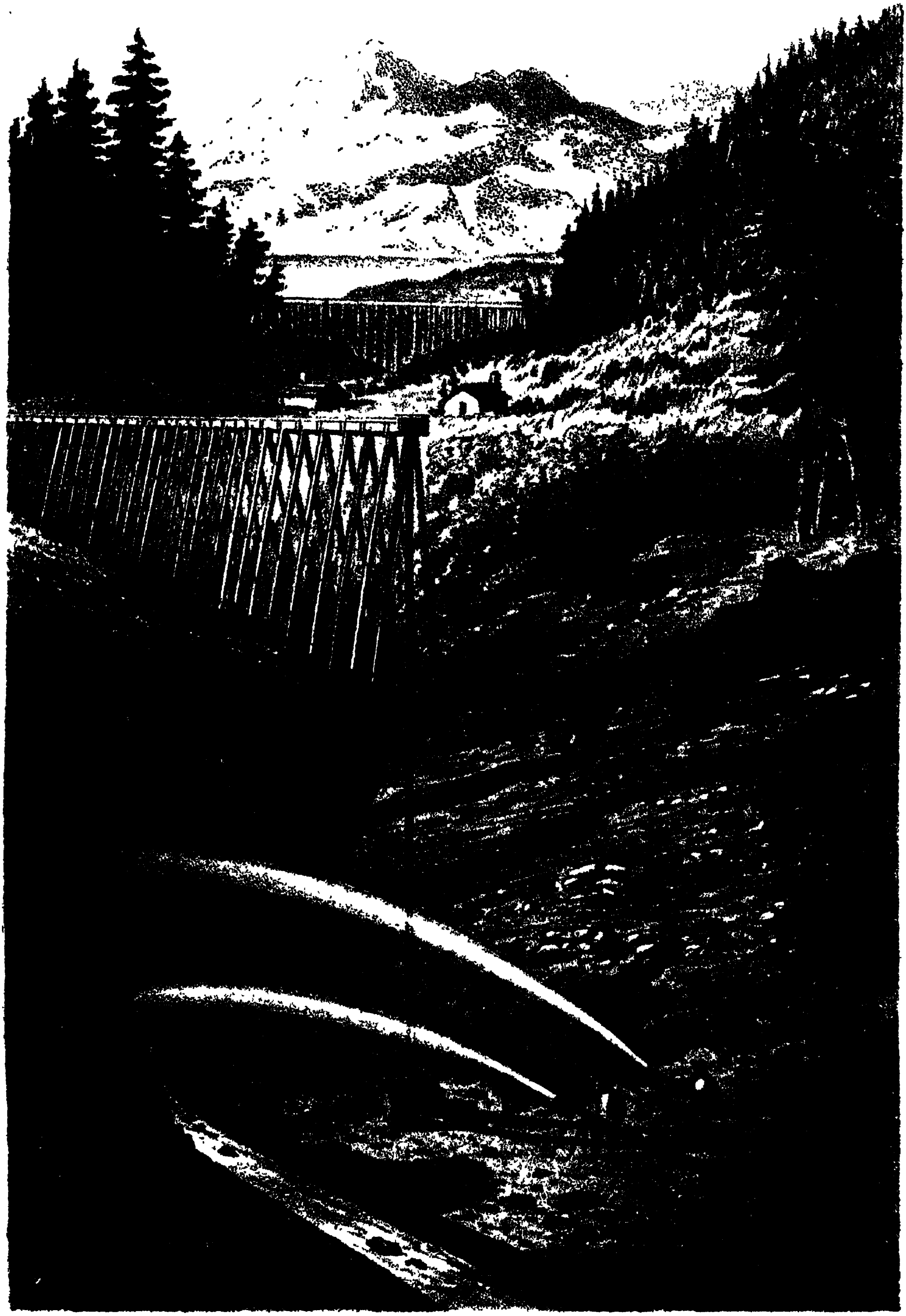

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HYDRAULIC MINING IN CALIFORNIA

THE QUARTERLY

JOURNAL OF SCIENCE.

JULY, 1868.

I. DARWIN AND PANGENESIS.

It is nearly ten years since the most important work on biological science which has ever been published, namely, the 'Origin of Species,' issued from the press; and during the long interval, interrupted, we regret to say, by bodily illness, the well-known author of that work has been accumulating further evidence in favour of his theory, which he now gives to the world. So far, his detailed information relates almost entirely to animals and plants under domestication;* and although the work in which it is contained forms a continuation of the argument in favour of the derivative origin of species, it does not conclude the consideration of the subject; and we are promised, first, a work upon the variability of organic beings in a state of nature; secondly, one upon the difficulties opposed to the theory of natural selection; and, finally, one in which it is apparently intended by the author to give a *résumé* of the whole subject, and wherein he will "try the principle of natural selection, by seeing how far it will give a fair explanation of the several classes of facts alluded to."† We confess that these announcements have taken us a little by surprise; for seeing that the esteemed author of these works, extant and promised, is already about sixty years of age, and that ten years have elapsed between the appearance of his introductory treatise and the one now before us, which is by no means the most important of the series, he must have sufficient faith in his own theory of the "survival of the fittest" to anticipate the extension of his brilliant career to at least the age of ninety. All we can say is, that we hope his expectations may be realized, and that the accumulation of knowledge and thought in the meantime may enable

* 'The Variation of Animals and Plants under Domestication.' By Charles Darwin, M.A., F.R.S., &c. In two vols., with illustrations. Murray, 1868.

† Ibid., vol. i., p. 9.

him to bequeath to mankind a biological theory which shall bear the test of future ages, and firmly secure the pedestal of fame upon which the reputation of its author is already elevated.

It may be within the memory of some of our readers, that about six years after the appearance of the 'Origin of Species'—when, therefore, sufficient time had elapsed to enable all classes of thinkers to express their views upon the Darwinian theory—we ventured to review the state of scientific opinion upon the subject, and to add such original thoughts as that review had suggested to us; * and as we find in the work before us many attempts to explain difficulties which at that time appeared to us to militate against the unqualified acceptance of the Darwinian doctrine, we may be pardoned for once more touching upon them, with a view to consider whether those obstacles have been removed in the present work, or whether they still impart to the hypothesis an imperfection which needs to be supplied before it can be converted into a well-acknowledged biological guide for all ages.

It appeared to us at that time, as it has to many others, that the author claimed for what he terms "natural selection," powers to modify old species as well as render permanent the character of new ones,—thus implying intelligence and every other attribute requisite for that purpose; and we sought to show that the author himself had not formed a clear conception of what "natural selection" is able to accomplish. We quoted one of his remarks, that "it" (natural selection) "can modify the egg, seed, or young, as easily as the adult;" † but endeavoured to show, by collateral quotations, that the author rather considered the "conditions of life" as the causes which *induce* variability, and that then "natural selection" accumulates those variations when they are profitable for the animal. Now, as by "natural selection" the author meant the part played by nature (the conditions of existence by which the living form is surrounded) analogous to man's operations in selecting and training animals under domestication; so, just as we might say of any change in the nature of an animal, "fattening" or "crossing" has effected it, instead of "the breeder has effected it by fattening or crossing;" we must not be too nice in our distinction of terms, and we must regard "Nature," the "conditions of existence," "natural selection," as in so far one and the same great power favouring the continued existence of certain types, and even in some degree modifying those types, just as the breeder modifies his domesticated animals. But even granting to the author the utmost licence in the use of terms, we could not then, and cannot now, help being drawn insensibly to the conclusion that the *departure* from any existing type results in the

* "Darwin and his Teachings:" 'Quarterly Journal of Science,' April, 1866.
† 'Origin of Species,' 3rd edition (1861), p. 144, par. 2.

main from a change in the reproductive organs of the animal; and it appears to us that whilst in his earlier work the author laid too little stress upon this obscure phase of his subject, it has haunted him throughout the present work; and though he still attributes to the external conditions of existence the chief influence in modifying species (or even varieties), we find his expressions much more clear concerning the agency which immediately operates to bring about this modification, for he says:—"The causes which induce variability act on the mature organism, on the embryo, and, as we have good reason to believe, on both sexual elements before impregnation has been effected." *

Now this is what may be called a much clearer declaration of principle than we have hitherto had from the author; and, leaving out of sight the question of the amount of variability which can by any means be brought about, we find that virtually, according to his views, the nature of the living form is decided at its very conception. For, whether the most widely diverging characters have been secured, as in the author's favourite illustration, the pigeon, or some "spontaneous" variation has sprung up, or some peculiarity has been lost sight of for one or more generations and has suddenly reappeared, in every case, and especially in the latter, the reproductive elements, or one of them, must, according to the author's views, have been the acting or perpetuating agency. In order to account for this marvellous property of the germ, the author has supplied us with a provisional hypothesis, "pangenesis," and has sought to explain how the sexual elements operate upon the fabric of which they serve as the basis. But there still remains a wide subject untouched; and that is, whether and in what degree the reproductive organs are affected by certain psychical causes, with which neither "conditions of existence" nor yet "natural selection" have any immediate relation.

This phase of the question must, however, be left for a moment unconsidered; and having referred to the crucial difficulty upon which we stumble when we regard the mode in which variation *begins*, we must next touch upon that other perplexing problem, hybridism, which is considered by the author's opponents to denote its limits, and to stand as an insuperable obstacle in the way of the acceptance of his theory. In our former notice of the author's works referred to above, we ventured to express the view that the phenomenon of hybridism should be regarded in the light of an occasional check placed by Providence upon the too rapid tendency to vary, which might arise even under the author's slow process, and might cause a reversion to the original stock, or a confusion of forms, totally subversive of all order in animated

* 'Animals and Plants under Domestication,' vol. ii., p. 270.

nature; and although such a view may be seized upon by the opponents of the theory as an admission that there *is* a limit to variation, and that therefore no new species can thus have been brought into existence (a corollary which by no means results from our proposition), yet we find that in the work before us the author quite concurs with our views, excepting that he seeks to explain how hybridism is affected by nature, whilst we contented ourselves with suggesting that Providence does bring about such results, without as yet seeing clearly by what means they are effected. He first compares the phenomena relating to this subject in domesticated animals with those in a state of nature:—"On the principle which makes it necessary for man, whilst he is selecting and improving his domestic varieties, to keep them separate, it would clearly be advantageous to varieties in a state of nature, that is, to incipient species, if they could be kept from blending, either through sexual aversion or by becoming mutually sterile. Hence it at one time appeared to me probable, as it has to others, that this sterility might have been acquired through natural selection. On this point we must suppose that a shade of lessened fertility first *spontaneously appeared*, like any other modification, in certain individuals of a species when crossed with other individuals of the same species, and that successive degrees of infertility, from being advantageous, were slowly accumulated." *

The words italicized by us show that the author had thus only removed the difficulty a little farther from view than before, but he has now come to the conclusion that "species have not been rendered mutually infertile through the accumulative action of natural selection;" . . . "that they have not been endowed through an act of creation with this quality;" but that "it has arisen incidentally during their slow formation in connection with other and *unknown* changes in their organization." † The word (again underlined by us) would lead one to think that the difficulty remains to the author pretty much where it was; but the context shows that he attributes the changes in the reproductive system leading to hybridism to a correlative variation in the whole living form, that is, that when the whole fabric changes, that portion of it which perpetuates the animal changes also, and the ultimate agency is again "pangenesis;" but then again he says, "Pangenesis does not throw much light on hybridism." ‡

There is another view taken by the author, of the occurrence and effect of hybridism in nature, which deserves mention. He finds that when wild animals are at first domesticated, the sudden change in the surrounding conditions of their life renders them for a time infertile: "numerous facts," he says, "have been given,

* 'Animals and Plants under Domestication,' vol. ii., p. 185.
† Ibid., p. 188. ‡ Ibid., p. 385.

showing that when animals are first subjected to captivity, even in their native land, and although allowed much liberty, their reproductive functions are often greatly impaired or quite annulled;" * but, on the other hand, crosses between varieties slightly modified render the offspring rather more fertile than otherwise. Now he believes that what occurs under domestication by a leap, is slowly proceeding in nature; for *natura non facit saltum*, and that infertility has been gra..ually proceeding from changed conditions of existence, extending over long ages, but resulting at length in as marked a difference as when the conditions have been suddenly changed from freedom to captivity.

But here, again, whilst the author's results appear to be correctly stated, the parallel by which he seeks to explain the cause is unfortunate and inapplicable; for in the case of domestication a male and female *of the same variety* (or one of them) are suddenly rendered quite infertile, their "fertility becomes at once quite annulled;" whereas in nature the individuals of the same species remain quite fertile, *inter se*, whilst it is only when they come to be crossed with other species that the union is barren.

But there is still another aspect of the question, in which a simple statement of facts alone gives to the theory of modification a large amount of weight.

In seeking to show that the barrier of hybridism is not so formidable as his antagonists would make it appear, the author says:

"The sterility of distinct species when first united, and that of their hybrid offspring, graduates by an almost infinite number of steps, from zero, when the ovule is never impregnated and a seed capsule is never formed, up to complete fertility. We can only escape the conclusion that some species are fully fertile when crossed, by determining to designate as varieties all the forms which are quite fertile. This high degree of fertility is, however, rare. Nevertheless, plants which have been exposed to unnatural conditions sometimes become modified in so peculiar a manner that they are much more fertile when crossed by a distinct species than when fertilized by their own pollen. Success in effecting a first union between species and the fertility of their hybrids depends in an eminent degree on the conditions of life being favourable. The innate sterility of hybrids of the same parentage and raised from the same seed-capsule often differs much in degree."†

In our notice of the author's former work we charged him with making light of the difficulties of hybridism. The fact is, he was already in possession of a mass of information which justified his giving less weight to that phase of the question than we were disposed to do, for, in common with many other critics, we had been

* 'Animals and Plants under Domestication,' vol. ii., p. 176.
† Ibid., p. 179.

taught to believe that "species" means two distinct types whose union is infertile. But whatever may be urged against the author's speculations upon the *causes* of certain natural phenomena, no one who knows anything of his character as an observer and writer will receive his statements of facts otherwise than with the most implicit confidence.

And now in regard to this apparently insurmountable difficulty of hybridism, the author tells us that, as a rule, "species," that is, widely diverging types, are infertile with each other, but that there are not only cases where they are fertile, but as we descend in the scale of nature, the crossing of species under certain conditions actually increases fertility, and that the only escape from making this admission in many cases, is by reasoning in a circle and calling species varieties because they *are* fertile. Well, as we do believe the author's statements of facts, and as we consider the terms "variety," "species," "genus," &c., to have been introduced into natural history by man for the guidance of his own limited intellect, and to have no actual existence in nature, we are unable to find any rational objection to the broad principle laid down by the author and his predecessors holding similar views, that all new forms of life are and have been modified descendants of pre-existing ones. Nor have we ever been able to see any other rational mode of accounting for the progression of nature. It is, indeed, quite proper at all times that new philosophical theories should be received with "philosophical caution;" it is perfectly just that persons who hold opinions which have been accepted as truths in the past, should require of those who desire to convert them to a new philosophical faith, a large amount of trustworthy evidence in its favour, and should insist upon the clearing away of patent obstacles to its acceptance; but, adopting one of the ordinary principles of jurisprudence, when such an amount of evidence *has* been advanced, and when obstacles which were previously deemed insurmountable have been shown not to be so, the onus of proof then falls upon those who have held the original faith, which may have been conceived in ignorance, and perpetuated by unreasoning philosophical conservatism.

The facts contained in the work before us already show that great modifications in osteological and external structure, and great divergences in habit, may in a brief period be brought about by the changed conditions and artificial selection practised under domestication. These modifications are so great, that were it not for the fertility of the varieties when crossed, no naturalist would hesitate to class them as distinct species. It is also proved almost to a certainty that many domesticated "breeds" which are fertile when intercrossed have descended from ancestors of different species.

Again, a glance at the history of the past shows us that step by step new and more completely organized forms have been superseding old and (in one sense) less perfect ones. Where links have been missing one day, they have been discovered the next. Gaps which appeared insurmountable are constantly being bridged over by the discovery of organic remains, notwithstanding that a great portion of these are still concealed from human research. The growth of the individual is completely typical of what the advocates of descent by modification maintain to have been the history of animated nature.

All these facts are strongly in favour of the theory of the formation of new species by modified descent, and what evidence have the advocates of the opposite theory to advance in its favour? Indeed, it is difficult to find out what their theory really is, or rather what their theories are, for it would hardly be possible to find half-a-dozen anti-Darwinians who, if they think at all, think alike.

Leaving out of the question the means by which the modifications have been brought about, but not doubting for an instant that it has been by slow gradation and natural agencies, and without any derangement of the laws of nature as generally accepted by mankind, we conceive that at least sufficient valid evidence has now been laid before the scientific world to justify its acceptance, pure and simple, of the law of descent by modification, from the operation of which law there is no reason whatever to exclude Man; and all unbiassed thinkers will now expect from the opponents of that theory that they will desist from attacking the new and rational doctrine with absurd theological denunciations, or with quibbles concerning the precise nature of the zoological term "species," but that they will put forward a clear defence of some definite doctrine of their own; will explain with ordinary clearness how they believe new types really have been introduced, and will support their defence by well-established scientific data.

We all know how easy and convenient it is to dash off an article upon such a work as the one before us, in which the world is informed in two or three columns of pompous common-places, that the reviewer sees no new proof of the author's theory, and that until such proofs are forthcoming, it must continue to be regarded as "purely hypothetical;" in other words, that persons who have no inclination to believe it, may reject it until the critic does see some convincing proof of its validity; and of course it is much easier, and, in a reviewing sense, pays much better to make such an announcement a week after the volumes have appeared (which have employed ten years of the author's life), than if the criticism be reserved for even a fortnight's perusal and consideration. It is equally facile, in these days of free-thought, for a person whose biological doctrines have been imbibed from the first chapter of Genesis, and some elementary work on Natural History, to triumph over an unfortunate "Darwinian" by daring him to admit that he believes a Christian and a bull to have had the same ancestry!

But with the exception of a few thinking observers—the measure of whose information is only exceeded by their caution, which prevents them from accepting the new theory—the large majority of its opponents are really such reasoners as we have described; and it appears to us that the acceptance of the theory will depend more upon the decline of superstition than upon the ascendancy of knowledge.

To return, however, to our difficulties. Another feature in the theory of modification of species which presents evidence for as well as against the doctrine of "natural selection" is he inheritance of peculiarities.

In his 'Origin of Species'* the author said:—"The laws governing inheritance are quite unknown: no one can say why a peculiarity in different individuals of the same species, or in individuals of different species, is sometimes inherited and sometimes not so, why the child often reverts in certain characters to its grandfather or grandmother, or more remote ancestor." But as we stated in our criticism already referred to, this very ignorance of the causes of inheritance presents a grave obstacle to acceptance of the doctrine of modification through the external conditions of life; for what can that power have effected "where the deceased *father* is resembled by a posthumous child?" † Had such inherited peculiarities been mental only, they might have resulted from early training; but if we take a case which is not unusual, that the grandchild by a *daughter* of the grandfather resembles the latter both in features and character, then we have the mental and physical peculiarities of a male transmitted through two females, the mother and daughter.

The mode in which we sought to explain such a wonderful phenomenon, and one, as it appeared to us, then at variance with the author's views, was that "from the very commencement of life up to the present hour there are evidences of an *immediate* designing power"—or, to use a term which is looked upon with disfavour by many Darwinians, an *ordaining* power—an occult influence in the production and modification of the sexual elements, and consequently of the beings springing from them, totally distinct from the "conditions of existence," "natural selection," or whatever the force may be called which influences the embryo and the born creature.‡ The justification we have for quoting these few expressions of our own, is that to a large extent the author seems to have

* P. 13, 8th edition.
† "Darwin and his Teachings:" 'Journal of Science,' vol. iii., p. 174.
‡ Ibid., p. 174.

adopted the suggestions we then made; and he seeks now to show what that "occult influence" is which modifies the male and female elements of reproduction. Without losing his hold upon the "conditions of existence" which, as we have shown, he considers to be one of the main causes of change in the organs of reproduction, he finds in "pangenesis" the solution of the problem and the immediate means by which the change is effected.

And now for his provisional hypothesis of "pangenesis." To explain it in his own words, it "implies that the whole organization in the sense of every atom or unit reproduces itself. Hence ovules and pollen-grains—the fertilized seed or egg, as well as buds—include and consist of a multitude of germs thrown off from each separate atom of the organism."

In short, it is the application of the atomic theory to living forms; is in perfect conformity with all the teachings of correlation between vital and physical forces, and as a *provisional hypothesis*, is well worthy of the consideration which the author and others have bestowed upon it.*

The author believes (at least as far as we can judge from his remarks on such an obscure subject) that all changes in the various organisms which result from the contact of the spermatozoon and ovum, as well as those which are derived from gemmation or budding, have their origin in the nature of the *cells* which constitute the elements or materials in operation. The cells or units which constitute all living bodies, from the simplest to the most complex, are themselves organized, and consist of lesser cells or atoms having various natures, and according to the author they give off those constituent atoms as "gemmules," and the nature of those atoms or "gemmules" fixes the future character of the organism into which they enter.

In this manner he seeks to account for the first variation in living types; for the transmission of inherited peculiarities from a grandfather, say, through a daughter to a grandchild; for hybridism. Let us endeavour to explain briefly and as popularly as possible, how the author believes that pangenesis acts in these cases. It must be presumed, first, that the male and female elements each contain a due proportion of cells composed of "gemmules." If there is a preponderance of certain gemmules in the paternal element of reproduction over those of the female, then the offspring may either resemble the father in the next generation, or the effect, being one of quantity, may be latent in that generation and only appear in the succeeding one—the peculiarity being transmitted through the reproductive organs of the intermediate generation which showed no such peculiarity. If the preponderance (the

* An able article on the subject, called "Cell *Life*," by Dr. Fick, of Zurich, will be found in this Journal, April, 1866.

"prepotency," as he terms it) be with the mother or female parent, then her or, if a plant, its likeness will be transmitted.

Now, if we once admit, what is of course quite a matter of speculation, namely, that the male and female elements are built up of atoms possessing different properties, bone-forming atoms, flesh-forming atoms, fat-forming atoms, to speak popularly, it is natural to suppose that these atoms when they are distributed through the organism may have an attraction for their kind, and this the author also assumes, and as a consequence that if there be a variation in the constitution of the reproductive elements, there will be a *tendency to vary* in the whole organism, and thus new varieties may arise.

But, finally, if one or both of the sexual elements should be deficient in those gemmules, or in the kind of gemmules necessary for fertilization of some particular form, so that one or both, instead of being "prepotent," should be "impotent," then hybridity is the result—that is, the male of one may be impotent with the female of another species, or *vice versâ*; or they may be mutually infertile.

Some of our readers will probably have felt a little difficulty in following us through this intricate "provisional hypothesis," for it removes still farther from the reach of our senses the agencies by which vital changes are supposed by the author to be brought about in animated nature. That naturalists will have to devote their attention to this obscure question is, however, quite certain; but the large majority of readers, even those tolerably well acquainted with biological phenomena, will only see in the "provisional hypothesis" a means of solving a difficult problem by another still more difficult of solution.

First, let us confine ourselves to the physical aspect of the question. Perhaps the simplest form of cell known to us is the *Amœba.* This consists of cell-contents probably enclosed in a highly elastic cell-wall. The cell-contents comprise a nucleus or germ, a nucleolus within the nucleus, and a number of granules floating in a semi-fluid substance often called "sarcode." This simple cell is already believed to possess in its nucleus and nucleolus some kind of organs of reproduction; but according to the author, it must contain a vast number of gemmules of different natures, for it is from such cells as these, in all probability, that many higher organisms have been built up. It does not necessarily follow that such a cell should contain "gemmules" of all kinds needful for the assimilation of the various organic and inorganic substances with which higher organisms that will proceed from it "by descent" are to be nourished; but what the cell must at some time or other have (according to the author's views) is a tendency to vary, else we should come to a standstill at the very threshold of "nature's progression," and all the beautiful varieties of infusoria, even, would have remained still in the conception of the Maker.

Now what perplexes us is, how in this humble form the surrounding conditions of external nature can operate to bring about a "tendency to vary." To say that we are unable to understand this, and the less therefore we say about it the better—as the author occasionally does wher he comes to a dead-lock in some mystery of nature—is taking refuge behind even less defensible breastworks than those of his opponents; for they have at least a Divine force and Will to appeal to on all such occasions. The author says, at the conclusion of his chapter on "pangenesis:"—"Finally, the power of propagation possessed by each separate cell, using the term in its largest sense, determines the reproduction, the variability, the development, and renovation of each living organism." (But, we would ask parenthetically, how does that cell itself begin to vary?) "No other attempt has been made, imperfect as this confessedly is, to connect under one point of view these several grand classes of facts. We cannot fathom the marvellous complexity of an organic being; but, on the hypothesis here advanced, this complexity is much increased. Each living creature must be looked at as a microcosm—a little universe formed of a host of self-propagating organisms, inconceivably minute, and as numerous as the stars in the heaven."

In regard to the latter portion of this paragraph, we cordially award to the able author the credit of having exhibited and illustrated the theory of cell-life, in a manner so novel and interesting as to take it out of the mere province of speculation, and to present it as one well deserving of the earnest consideration of biologists. The application of its principles to the phenomena of the hereditary transmission of peculiarities, whether they be normal or abnormal, such as the inheritance of peculiar features or of special diseases, opens out a wide field for research, and ere long the physical aspect of many of those phenomena may be made clear; but when he treats living "gemmules" as he would atoms of inorganic matter which go to form crystals, and seeks to clear up the difficulties accompanying the first tendency to vary by resorting to this almost unconsidered theory to account for the defects in his own well-founded hypothesis, we have an exhibition of weakness rather than an addition of strength.

Just let us examine one or two of his examples of the operation of pangenesis.

The author finds that when animals are suddenly brought under domestication, they are for a time infertile, and, as it has already been shown, this infertility is compared with that which gradually supervenes as varieties become more divergent in Nature.

Now, it is quite possible that in both these cases the number of the hypothetical "gemmules" in the spermatozoon or ovule may be deficient or their nature defective; but has it yet been shown that in the instance first named there is any spermatozoon at all in existence? Would it not be more philosophical to ascertain first whether the material element is present or absent (we of course refer to the higher animals, in which the phenomenon of hybridism comes out most prominently) before we attempt to discuss the number or nature of its constituents, of which we at present know nothing?

Or in these same cases of hybridism induced by sudden captivity, or by divergence in nature, we would ask the author, Are the periodical movements and the affinities of the sexual elements already so well understood that it should be safe to pass them by and descend to the consideration of the probable effect of their hypothetical invisible constituents?

But, on the other hand, there can be no doubt that when the male and female elements are perfect and perform their proper functions, they do possess powers which exceed in strangeness anything that the most fertile imagination has yet invented. Just imagine a man with a finger wanting on one hand, and one or more of his children being born with the same defect! It is just within the range of possibility that the state of mind of the mother may by some mysterious influence have caused that defect to be reproduced; but looking at all similar phenomena, it is far more probable that the defect has been communicated by the paternal male element to the ovum, and thus perpetuated in the embryo.

Let us now, however, turn for a moment to the psychical phenomena which present themselves when we consider the tendency of living types to vary, and the occasional checks which are put upon their divergence, and we shall find the cell-theory as little able to account for those as we should find a musical instrument capable of conveying an explanation of the passions which its notes inspire in the human breast, and which nerve the arm of the warrior, exhausted by a weary march, or lull to rest the spirit of a fretful child.

The author, as we have seen, admits that the reproductive elements constitute that portion of the organism in or through which the tendency to vary probably first manifests itself, but (if we understand him correctly) he attributes the change in those elements to altered physical conditions alone. Now, if we pass in review before our mind's eye the various types of animals which must have succeeded each other through modified descent, we find that amongst the lower forms it is just possible to conceive that the tendency to variation in the reproductive elements might be the result of external physical influences alone; but this admission would of itself be fatal to the application of the same theory to the higher animals, whose tendency to vary (we do not speak of any special organs) depends palpably to a large extent upon the action of mental influences. An *Actinia may* find itself surrounded by natural conditions over which it has no control, as changed food, deficiency or superabundance of light, or any other physical cause, and which may bring about a change in its reproductive elements, and thus give rise to a new variety. But would it be either natural or rational to apply this rule to the higher animals, especially to Man? Is it not certain that there we have psychical forces inducing actions, and those actions bringing about new varieties, and in a manner independently of those material influences which operate lower down in the animal scale.

A union may be brought about between two human beings solely from the attractions of the mind; and let us suppose some marked *mental* quality to be inherited. Now, we are apt to use the term "inherited" somewhat arbitrarily; for what appears to be thus communicated might, after all, be the result of mental training or example, which would have operated in a foster-child as well as in true offspring, and in that case the illustration would cease to hold good. But assuming that there is a "prepotency" on the side of the father to transmit his likeness, and that therefore some slight cerebral characteristic descends to the son, upon whom training and example are brought to bear, so that the mental quality, whatever it may be, comes to be developed in a higher degree in the son than in the father.

Here we have two distinct states of facts and two forces: the one physical, the other psychical; the one material, and explicable only upon a "provisional hypothesis," the other metaphysical, and yet as clear and patent as any such matters can be to the human mind.

In the parents, love or respect operating, it is true, through the senses, but uninfluenced by the "sense" in a lower acceptation of the term, brings about a union which is to lead to a new variation both in the physical and psychical nature of man. In the offspring, solicitude evinced in training or teaching, that is, mental intercommunication, and *later on the unfettered will of the offspring*, develop and perpetuate the mental quality, and almost certainly mould the brain and physical frame in conformity to the new condition: the immaterial, impalpable soul acts, invisibly to us, upon the brain, just as we develop the muscles through physical exercise; but prominent before all other phenomena we find the *will*, the *soul*, the active, guiding, moving force at work, and at work upon willing, passive materials.

Now look at the materialistic hypothesis. We will admit that it is possible a "prepotency" in the father may have given his likeness to the son: that the supposed order, number, nature, and disposition of the supposed gemmules in the male organ may have been the first cause of this transmission. We admit that surrounding physical conditions, such as like food, climate, and habits, may have had some share in moulding the physical frame as it became developed. We will even, for argument's sake, admit the cellular hypothesis in its most materialistic form, and suppose that the little, hypothetical, invisible, vitalized atoms are themselves the *seat* of all those qualities which accumulate as they (the atoms) accumulate; and that they are the motive power instead of the mere instruments upon which the psychical forces act. But are not these very admissions,—does not this very process of reasoning, with all its hypotheses and its uncertainties, sink back into ridiculous improbability before the clear, unmistakable operation of the psychical forces upon the subservient vegetative system—a system complex, indeed, as the author declares it to be, but complex only in the same sense as a musical instrument is so whilst it stands silently and unconsciously awaiting the touch of the master-hand, impelled by the master-spirit?

Nor is the comparison between Nature and Art in this case so entirely figurative as it would appear at first sight. The musical instrument has no power of growth, but the most we can say of nature, or "Natural Selection," in moulding man, is that it is the unconscious agent, like the artizan who collects and selects the materials and builds them up, little dreaming of the heavenly music which will be extracted from them. Then comes the skilful tuner, Man, who, under the tuition of his Creator, brings the mental chords into harmony; and finally the freed Soul, acting independently, wakes the fabric into active life, as the inspired musician wakes the mute instrument into melodious strains; but, in every case, in nature as in art, who doubts that an intelligent designing Mind is in constant operation?

That the author doubts the constant interposition of a designing Mind in nature is clear from his concluding remarks; and in order to render him justice, we will extract those remarks in full, for it will be seen how thoroughly ungenerous, or how utterly ignorant are those who brand his theory as Atheistical, and him as an Atheist, whilst at the same time it will exhibit the feebleness of that reasoning which has led him and some few of his disciples to disbelieve in the immediate and constant interposition of Providence in the development of the universe.

"Some authors have declared that Natural Selection explains nothing, unless the precise cause of each individual difference be made clear. Now, if it were explained to a savage utterly ignorant of the art of building, how the edifice had been raised stone upon stone, and why wedge-formed fragments were used for the arches, flat stones for the roofs, &c.; and if the use of each part and of the whole building were pointed out, it would be unreasonable if he declared that nothing had been made clear to him, because the precise cause of the shape of each fragment could not be given. But this is a nearly parallel case with the objection that selection explains nothing because we know not the cause of each individual difference in the structure of each being.

"The shape of the fragments of stone at the base of our precipice may be called accidental, but this is not strictly correct; for the shape of each depends on a long sequence of events, all obeying natural laws; on the nature of the rock, on the lines of deposition or cleavage, on the form of the mountain, which depends on its upheaval and subsequent denudation, and lastly on the storm or earthquake which threw down the fragments. But in regard to the use to which the fragments may be put, their shape may be strictly said to be accidental. And here we are led to face a great difficulty, in alluding to which I am aware that I am travelling beyond my proper province. An omniscient Creator must have foreseen every consequence which results from the laws imposed by Him. But can it be reasonably maintained that the Creator intentionally ordered, if we use the words in an ordinary sense, that certain fragments of rock should assume certain shapes so that the builder might erect his edifice? If the various laws which have determined the shape of each fragment were not predetermined for the builder's sake, can it with any greater probability be maintained that He specially ordained for the sake of the breeder each of the innumerable variations in our domestic animals and plants;—many of these variations being of no service to man, and not beneficial—far more often injurious—to the creatures themselves? Did He ordain that the crop and tail-feathers of the pigeon should vary in order that the fancier might make his grotesque pouter and fantail breeds? Did He cause the frame and mental qualities of the dog to vary in order that a breed might be formed of indomitable ferocity, with jaws fitted to pin down the bull for man's brutal sport? But if we give up the principle in one case,—if we do not admit that the variations of the primeval dog were intentionally guided, in order that the greyhound, for instance, that perfect image of symmetry and vigour, might be formed,—no shadow of reason can be assigned for the belief that variations alike in nature and the result of the same general laws, which have been the groundwork through natural selection of the formation of the most perfectly adapted animals in the world, man included, were intentionally and specially guided. However much we may wish it, we can hardly follow Professor Asa Gray in his belief that 'variation has been led along certain beneficial lines,' like a stream 'along definite and useful lines of irrigation.' If we assume that each particular variation was from the beginning of all time pre-ordained, the plasticity of organization, which leads to many injurious deviations of structure, as well as that redundant power of reproduction which inevitably leads to a struggle for existence, and as a consequence to the natural selection or survival of the fittest, must appear to us superfluous laws of nature. On the other hand, an omnipotent and omniscient Creator ordains everything and foresees everything. Thus we are brought face to face with a difficulty as insoluble as is that of free-will and predestination."*

Here we have an illustrated confession of faith (if it can be so called), which is well deserving of consideration.

Truly, those who say that "natural selection" explains nothing, because the author of the theory does not attempt to "make clear the precise cause of each individual difference," are unreasonable; but were we to accept the simile of the temple built of stones which have fallen from the heights, "natural selection" would avail nothing for the author of the '*Origin* of Species.' If, conforming to his wish expressed here, but certainly not elsewhere in his works, we simply accept the law of selection as accounting for the uses to which the stones have been applied in the building of the temple, what have we gained in knowledge of the causes or forces which led to the shape of the stones? In other words, "natural selection" has been in operation for the purpose of *preserving* the fittest varieties, whether new "species" arose through modified descent or whether they were special creations. All the author shows by his simile is that an intelligent mind has selected and preserved the most fitting varieties or types, as the builder selected the stones best adapted for his purpose, a proposition which, we need hardly tell our readers, we are quite prepared to admit. But the author is not satisfied with attributing to physical causes the selection and retention of fitting types; he tries to find in those causes alone the springs of variation.†

And, to pass on now to the remaining portion of the paragraphs which we have extracted: he believes furthermore that, popularly and generally speaking, all those variations have been accidental, and not pre-ordained; although, in conclusion, he confesses that the omnipotence and omniscience of the Creator "ordains everything and foresees everything;" and so the author does not exactly know what to believe. But his grounds for not believing that variations were pre-ordained and pre-designed, if we may use the term, are the strangest we have ever read.

"Do you imagine," he says, "that God made the wild dog plastic

* 'Animals and Plants under Domestication,' vol. ii., pp. 430–2.

† See 'Animals and Plants under Domestication,' chap. xxii. (especially the Summary on "Causes of Variability," and the whole chapter on "Pangenesis").

and variable in its nature, that man might select and perpetuate a ferocious type to pander to his cruel taste of bull-fighting?"

"Certainly not," is supposed to be our answer.

"Then," says the author triumphantly, "you must at the same time admit that this plasticity and law of natural selection could not have been pre-ordained for the purpose of producing the most symmetrical and perfect of dogs, the greyhound; and now, if the law did not contemplate the formation of the ugly and useless, nor yet that of the symmetrical and vigorous, it could not have contemplated anything at all, and all the results found in nature are accidental, so to speak!"

Does the author forget that Man has a free-will and the power to control nature as well as God? and that in his folly, fancy, or caprice, he often misapplies materials and misdirects natural forces for his own selfish ends? And are we on that account to close our eyes to every manifestation of design, arrangement, and co-ordination which presents itself in nature, and to say that the abuse shall explain the use, the exception shall constitute the rule? Shall we measure God's wisdom by our folly? His knowledge by our ignorance?

But the author has sufficiently pointed out elsewhere in his work, that "nature" has modified living types with purposes widely different from those of man, namely, for the benefit of the creature itself. "What does the breeder care," he says,* "about any slight change in the molar teeth of his pigs, or for an additional molar tooth in the dog, or for any change in the intestinal canal, or other internal organ? The breeder cares for the flesh of his cattle being well marbled with fat, and for an accumulation of fat within the abdomen of his sheep, and this he has effected." "Natural species, on the other hand, have been modified exclusively for their own good, to fit them for infinitely diversified conditions of life," &c.†

What would the author say if we adopted his method of reasoning thus:—"The plasticity of the ox was not designed with a view to its being fattened for man's use: this application was an accidental one. In like manner, and with still greater force, it may be added that the refuse of oil seeds, known as cattle-cake, has been accidentally applied to the fattening of the ox, for the husk and exhausted tissue were designed for a different purpose." And so the whole scheme of Providence would vanish, and natural forces, divinely and designedly guided, would give place to a beautiful, well-regulated, co-ordinated *chapter of accidents!!*

All he proves by his reasoning is that whilst our knowledge and power over nature are limited, those of God are unlimited; that whilst God operates for the benefit of all his living creatures,

* See 'Animals and Plants under Domestication,' p. 412. † Ibid., p. 413.

we are too apt to apply our power and knowledge to selfish purposes; and in all probability that, whilst our powers of modifying varieties so as to form new species are limited by restricted information and the brief duration of life, those of the Almighty know no such bounds. Nature is his handiwork; natural forces are his servants; and to Him there is no time, but an eternal "now" for the execution of his wise and infinitely varied schemes.

The author's illustration of the temple built by human hands out of the rough stones of nature, is susceptible of another application besides the one he has given to it. The explanation of the mode in which the stones have been selected is not to be found in the atoms of which they are constituted, nor on the physical forces which have given them their imperfect forms. They have to be made perfect for the end designed, by the intelligently guided hand of the artizan, and to be raised up into a useful and ornamental structure upon the pre-existing plan of the designing architect.

But whilst we are unable to agree with the author in his views as to the first causes of variability, and the operation of that mysterious influence which binds us to nature, and both to God; and whilst we feel that it is for the interest of scientific truth, after which no man seeks more earnestly than the author himself, that we should exhibit the fallacy and unhesitatingly express our disapproval of the line of argument which he adopts in these speculative matters, still we find in the mass of evidence already advanced by him, both designedly, with a view to establish his theory, and unconsciously in his descriptions of natural phenomena, such ample proofs of the production of new species by modified descent, that we are surprised any thinking person should still adhere to a doctrine which has only theological prejudices and long-established ignorance to support it. And as to the provisional hypothesis of "pangenesis," it is theoretically and *materially* consistent with all else that has been recently ascertained in other departments of physical science. Those who have studied natural phenomena with the aid of the microscope must have been satisfied that what we have been in the habit of calling the lowest forms of life are not so in reality; and coupling the appearances revealed by that instrument with the facts disclosed in the animated discussions which have from time to time taken place on the so-called "spontaneous generation," we see in "pangenesis" a probable solution of the difficulty.

But on the other hand, whether these supposed vital atoms vary in their constitution, or whether, resembling each other, they have yet varied powers of assimilating inorganic substances, is a secret which neither the indefatigable and all-observant author, nor any one else, can at present decide; and we must await the perfection of our instruments before we are able even to hazard an opinion in that respect. And furthermore, instead of enabling us to dispense with the theory of an immediate, constant, and designing Providence, this minute subdivision of vitality, so to speak, adds, in our humble opinion, to the necessity for a still more immediate and constant association between the invisible Spirit and his visible Universe. We can conceive of *Man* being entrusted with powers of selecting small differences, and by wise adaptation creating new types; we can conceive of "Nature" influencing the plastic forms of the lower animals, and causing the fittest to survive; but when we descend to cells and gemmules, the very atoms which constitute the unconscious elements of reproduction, we can conceive of no force except the Prime Force which shall determine their nature and operations, and decide what great results shall spring from such insignificant causes.

Of the author's rare merits as an observer; of his undeviating adherence to the truth so far as he can perceive it, and at whatever cost to his feelings; of his bold avowal of his tenets, without regarding the spirit in which they are likely to be received by a half-educated and theologically-prejudiced public, it is unnecessary for us to speak; his works answer for themselves.

Darwin stands side by side with Galileo; he is not only figuratively, but actually, as great a philosopher. Happily in our day retractations can no longer be enforced; and no such mental or bodily sacrifices to the cause of truth are required now as formerly. There may be thousands who, reading by proxy or thinking by substitute, would like to see him incarcerated for blasphemy; but there are myriads of intelligent men, lay as well as clerical, who look forward anxiously to each new revelation of his mind and pen, and love and admire the bold pioneer of truth as though they were his intimate friends and associates. But though Darwin has once more told the world that Nature moves, as Galileo proclaimed that the earth moves, yet he has only partially discovered the secret of its motion; and judging from the persistency with which he seeks in nature only the causes of nature's change (a feeling resulting no doubt from too close observation of details), we believe it is left for some other eye to see the apple fall, and solve the great mystery of vital gravitation. Some day the mind will no doubt visit us which can grasp the whole range of vital phenomena, and at a glance comprehend the action of those mysterious forces which cause physical atoms of like constitution to seek each other amid varying external conditions; the opening flower to follow the sun in its course; which produce the wonderful affinity between the unconscious elements of reproduction; which lead the bird to seek its mate; the weaker mind to lean upon the stronger; the soul to search for, to expand, and to change its own nature by association with its God.

II. GOLD IN CALIFORNIA.

By J. Arthur Phillips.

The principal gold-producing portion of California extends, on the western slope of the Sierra Nevada, from the Téjon Pass to the northern extremity of the state.

The slates of which it is mostly composed have been shown by the officers of the Geological Survey to belong chiefly to the Jurassic period, although the occurrence of Triassic fossils in the auriferous rocks of certain sections of the belt renders it probable that some of the slates in the heart of the gold region belong to that age.

These sedimentary rocks for the most part consist of various slates and schists, more or less metamorphosed, and sometimes containing nodules of feldspar; sandstones are also frequently met with, and these are often transformed into quartzites. Black talcose schists with slates, exhibiting a well-defined cleavage, together with bands of more or less crystalline limestone, also occur.

Lying between the band of metamorphic slates and the great granitic mass of which the Sierra Nevada principally consists, are found various crystalline rocks, such as syenites and porphyries. All of these rocks in the vicinity of the sedimentary deposits enclose numerous veins of quartz which contain, in addition to gold, iron pyrites, and other metallic sulphides. The quartz veins of the crystalline rocks are comprised within a narrow zone, extending from south to north, along the western flank of the Sierra, above the band of auriferous slates, and are found, in the vicinity of the line of junction, throughout nearly its whole extent.

The veins of the metamorphosed slates occupy a lower position on the western slope of the range, and are exceedingly numerous and important. They are not, however, by any means equally distributed throughout the region of slates, but are, for the most part, concentrated in a belt having a width, from east to west, of about fifteen miles, and extending from south to north throughout the length of the formation. They in general follow the direction of the strata in which they are enclosed, but this parallelism is seldom absolute; besides which they frequently throw off branches and offsets, cutting through the bedding of the slates at very considerable angles.

It is also to be remarked that wherever the slates have been tilted so that the bedding has become almost perpendicular, and where they have generally been subjected to the largest amount of metamorphic action, the veins are usually most productive. In fact, although there are exceptions to the rule, gold veins enclosed in stratified rocks are generally productive in proportion to the amount of metamorphic action to which the enclosing strata have been subjected.

The matrix of the auriferous veins of California is invariably quartz, which is usually crystalline, and, in the majority of cases, is ribboned in such a way as to form a succession of layers parallel with the enclosing walls. In some cases these parellel bands are separated from each other by a layer of quartz, differing slightly, either in colour or structure, from that forming the seams themselves; whilst in others they can only be distinguished by the difference of colour of two adjoining members of the series.

In many instances, however, laminæ of the enclosing slates divide the vein into distinct bands, and in such cases the thickness of the interposed fragments is often not greater than that of writing-paper.

In addition to ordinary quartz, amorphous silica, or semi-opal, and chalcedony are sometimes met with; and this opal, which is interfoliated between the layers of true quartz, occasionally contains iron pyrites and metallic gold. The walls are in most instances smooth, and often afford evidence of a considerable amount of mechanical action, whilst between them and the vein itself a thin stratum of clay or *flucan* is sometimes interposed.

In some of the detrital deposits of the gold regions distinctly marked quartz veins are observed cutting through the gravels, and are evidently formed by the action of water holding silica in solution. In certain localities also bands of silicious slates are found to contain small quantities of gold.

Analysis has shown that the quartz constituting the matrix of the auriferous veins of California almost invariably gives off, on being heated to redness, a certain amount of water which is not eliminated by a prolonged exposure to a temperature of 212° F., and that, in addition to alumina, oxide of iron, and other impurities, it always contains minute quantities of potash. On being reduced to the state of thin sections, for the purpose of examination under the microscope, the quartz is found to contain numerous small cavities partially filled with a liquid in which vacuities or gas-bubbles are seen to move about with great facility.

Boiling and hot springs are exceedingly numerous throughout California and the adjoining state of Nevada; and in Steamboat Valley, about seven miles from Virginia city, a large quartz vein appears to be now in process of formation by hydrothermal agencies. The hot springs of this locality are situated at a height of 5,000 feet above the level of the sea, on the eastern declivity of the Sierra, and the granitic rock here presents several straight and parallel fissures, either giving exit to heated water, or simply ejecting steam. The first group of openings comprises five longitudinal crevices extending in a straight line, and parallel to each other, for a distance of over 3,000 feet. These fissures are separated from one another by intervals of from 40 to 60 feet, have each a width of about 12 inches, and are connected with each other by lesser openings, intersecting the first nearly at right angles to their direction. All these crevices are usually full of boiling water, which overflows and escapes in the form of a rivulet; at other times it does not flow over, although violent ebullition may be heard to be taking place at a short distance below the surface. All these fissures have become partially filled by a silicious deposit which is being constantly increased by the formation of new layers on the sides, whilst a longitudinal central crevice allows of the escape of boiling water and steam. On the most western of these lines of fracture are several centres of active eruption, from which boiling water is sometimes ejected, by the action of steam, to a height of from 8 to 10 feet. These waters are alkaline, and contain, in addition to carbonate of soda, the sulphate of that base, and chloride of sodium. There is also a considerable escape of carbonic acid and sulphuretted hydrogen; these products give rise to the deposition, near the surface, of sulphur and anhydrous oxide of iron.

To the west of those above described, another fissure, having the same origin, is observed, but this is no longer traversed by currents of hot water, although at various points throughout its extent it still gives off steam and carbonic acid. At its northern extremity a central fissure remains open, but in other localities it is, for the most part, closed by an accumulation of silicious concretions.

The total distance over which this deposit can be traced is considerably more than a mile. The deposits of Steamboat Springs are, to a certain extent, metalliferous, and, in addition to oxide of iron, they contain oxide of manganese, together with iron and copper pyrites. M. Laur, a French mining engineer, deputed by the Imperial Government to examine and report on the mineral resources of the Pacific coast, states that they also contain gold.

Another remarkable example of the recent deposition of minerals is to be found in the vicinity of the celebrated Borax Lake, where solfatara action is still vigorous, and a large amount of sulphur has accumulated. This deposit is known as the "Sulphur Bank," and covers an area of some six or seven acres in extent. It consists of a much decomposed volcanic rock, traversed by innumerable fissures, through which steam and various gases are continually issuing, and over and through which large quantities of sulphur have been deposited, in such a way that at first sight the whole appears to consist of a mass of this substance. This sulphur is being constantly deposited, its deposition being attended by the evolution of aqueous vapour and carbonic and boracic acids, but it apparently takes place without the emission of sulphuretted hydrogen. The gaseous matters issuing from the crevices in the rock have usually a temperature of about 95° F., and appears to have been the agency by which the various mineral substances formed in the cavities were brought to the surface. Sulphur is being constantly deposited on the surfaces of the various fissures, and is sometimes mixed with cinnabar, although more frequently with pulverulent silica, often blackened by the presence of a tarry hydro-carbon. With these traces of gold and silver are stated to sometimes occur.

On the sides of the various fissures, gelatinous silica is found coating chalcedony, in various stages of induration, from a pasty condition, to that of the hardest opal: cinnabar is also found in thin bands, and occasionally even in veins of considerable thickness. Where the bituminous matter before referred to occurs in the largest quantities, the mass becomes black and friable, the cinnabar in such cases being replaced by metallic mercury.

In another locality of the same character, about ten miles distant, a vein of compact silicious rock, about ten inches in thickness and evidently of very recent origin, yielded by assay silver to the value of nearly three pounds per ton, together with traces of gold.

The above and other similar facts appear to lead to the conclusion that auriferous quartz veins are the result of aqueous agencies, and that their mineral and metallic constituents have, as well as their silicious matrix, been deposited from solution.

The extraction of auriferous quartz from the veins in which it occurs is conducted in precisely the same way that the mining of tin and copper ores is carried on in this and other European countries, and some of the workings have already reached considerable depths. Among the deepest mines in the state is Hayward's, in Amador County. This has now reached a depth of more than 1,300 feet on the inclination of the vein, and is, at the present time, more profitable to the proprietors than at any former period. The amount of veinstone annually raised is usually about 90,000 tons, and the yield of gold, on an average, from fourteen to eighteen pennyweights per ton. It may be here remarked that the productiveness of the quartz veins of California has not been found, as was at one time prognosticated, to decrease in depth; but that, on the contrary, many mines which were, near the surface, comparatively unproductive, have materially improved as lower levels are attained. It is also a fact worthy of notice, that all remuneratively auriferous gold veins contain notable quantities of iron pyrites and other metallic sulphides, and that the association of these minerals with gold is so constant, and so remarkable, as to be, in all probability, the result of some chemical action regulating the distribution of the precious metal.

The constant presence of iron pyrites in auriferous veins, and, whenever so occurring, its invariably enclosing a certain amount of gold, suggest the probability of this sulphide being, in some way, necessarily connected with the solvent by which the precious metal was held in solution. In the present state of our knowledge of this subject, it would be impossible to explain the exact process by which the solution of gold was effected. It has, however, been shown by Wurtz, that finely divided gold is soluble in sesquichloride of iron, and, more sparingly, in the sesquisulphate of that metal. It is also well known that iron pyrites, sometimes at least, result from the action of reducing agents on the sulphates of that metal. If therefore a sulphate of iron, in a solution containing gold, should become transformed by the action of a reducing agent into pyrites, the gold, at the same time, being reduced to the metallic state, would probably be found enclosed in the resulting crystals of that mineral.

On being brought to the surface the auriferous rock is first passed through a Blake's crusher, or is broken into fragments of a suitable weight, by the use of heavy hammers, and then reduced to the state of a very fine sand, under the pestles of a stamping mill. This machine differs from that employed in Cornwall for the treatment of tin ores, in so much as the heads and lifters, or "stems," are both invariably of iron, and of a cylindrical form, whilst the cams are arranged around a heavy wrought-iron shaft in such a way as to cause them to be raised in regular succession, giving to each, at the same time, a rotary motion. The "battery boxes," or "cofers," are also formed of a single iron casting, and movable "dies" are so placed along its bottom as to correspond with the "shoes" which form the wearing surfaces of the pestles. These *shoes* and *dies* possess the advantage of being readily changed when worn out, and the motion of rotation before referred to has the effect of keeping the faces constantly even. These machines, which instead of being driven by toothed gearing are worked by means of broad indiarubber belts, are fed by a shovel through a long slot at the back of each battery box.

In some cases a little quicksilver is, at regular intervals, dropped into the battery, but in others no mercury is used under the pestles, and the pulverized rock is simply washed by a stream of water, which is admitted into the arrangement by ordinary gas-pipes, through fine gratings in front of each cofer, and over a series of blankets covering the inside surfaces of wooden troughs inclined at a slight angle with the horizon.

These blankets are frequently removed for the purpose of being washed in large tanks, in which the auriferous matter accumulates, and from whence it is subsequently removed to be passed through an amalgamator. In order that there should be no interruption in the continuous action of the machinery, two of these blanket-troughs are laid down before each battery, so that when the blankets from one of them are being washed, the stream of water and sand issuing from the mill is conducted over the other.

Beyond the blankets are troughs lined with amalgamated sheet-copper, to retain any light particles of gold that might otherwise escape; these again terminate in settling-pits, or tyes, in which a portion of the sand and the greater part of the auriferous pyrites are collected.

The gold and other heavy materials collected in the vats in which the blanket-washing is carried on, are afterwards passed through the amalgamator. This machine consists of two wooden rollers, about eight inches in diameter and two feet in length, furnished, on their circumference, with knife-bladed pieces of iron arranged around them with their edges at right angles to the cylinders, and working in cisterns containing mercury. Above these rollers, which are set in motion by belts, both in the same direction, but contrary to the course of the water flowing through the apparatus, is a hopper for receiving the sand to be washed. Below the cylinder is a "riffle-board," having an inclination of about seven degrees from the horizontal, and generally covered by plates of amalgamated copper, which can be readily slipped out for the purpose of having the gold amalgam which may have become attached to them scraped off. When copper plates are not employed for this purpose, the transverse grooves of the riffles are charged with mercury. To use this apparatus some of the sand, taken from the cisterns in which the blankets have been washed, is placed in the hopper, and a small stream of slightly warm water allowed to play on it, in such a way as to gradually wash it under the revolving spiked cylinders, and from thence over the amalgamated riffles. The riffle-board is usually nine feet in length, is divided by ribs into several channels, and has, at its lower extremity, a cistern for retaining the pyrites, which, not combining with mercury, escapes amalgamation.

The sulphides thus collected are sometimes ground with mercury in a small arrastre, or edge-mill, and, after extracting from them as much gold as can be thus obtained, they may, if they still retain a sufficient amount of the precious metal, be drawn off, and, after settling, be collected and sold for treatment by chlorination, or smelting with lead ore.

The quicksilver drawn off from the amalgamator is first strained, either through close canvas or buckskin, the solid amalgam is distilled in a cast-iron retort, and the gold fused in blacklead crucibles, and then cast into ingots.

The auriferous pyrites is concentrated by washing, and when the chlorination process is employed, it is subsequently roasted "dead" in a reverberatory furnace, and afterwards subjected, in a moist state, to the action of chlorine gas. Chloride of gold is subsequently washed out with hot water, the gold precipitated by sulphate of iron, and then run into bars in the usual way.

The present average cost of treating gold quartz in California is estimated to be about as follows—

	s.	d.
In Water Mills, water free, per ton of 2,000 lbs.	4	10
„ „ „ water purchased	6	6
„ Steam „ „ „	8	7

Although a very large amount of the gold annually collected in California was doubtless originally derived from the disintegration of auriferous veins, not more than one-third of the precious metal now annually brought into the market is procured from that source. The other two-thirds is derived from alluvial diggings, in which it is separated by washing from the clay, sand, and gravel with which it is associated.

These gold-bearing drifts belong to at least two distinct geological epochs, both comparatively modern, although the later period is distinctly separated from the former; its materials being chiefly derived from the recent disintegration and re-distribution of the materials of the older.

The more ancient deposits are in all probability referable to a river-system different from that which now exists, flowing at a higher level, or over a less elevated continent and not unfrequently nearly at right angles to the main valleys of the present period. In many localities the older deposits, or "deep placers," are covered by a thick capping of lava, and in some places this eruptive matter occurs in the form of basaltic columns, beneath which are found the layers of sand, gravel, and boulders with which gold is associated.

In many localities, and particularly between the middle and south forks of the Yuba river, these auriferous gravels have, where exposed to denudation, a thickness of 120 feet; and of more than 250 feet where they have been protected by a volcanic capping. These vast auriferous beds are composed of rounded masses of all the crystalline and metamorphic rocks which occur above them in the Sierra. As a general rule, the lower portions are composed of larger boulders than the upper, although large rounded water-worn masses of rock occasionally make their appearance among the middle and upper members of the series; water-worn gold is more or less disseminated throughout the whole mass of these deposits, although not with equal uniformity, but always in greater abundance in the immediate vicinity of the "bed-rock." The materials of which these deep deposits are composed are frequently consolidated into a sort of hard concrete, by being firmly bound together by crystalline iron pyrites, and sometimes this cementing material partially consists of carbonate of lime and amorphous silica. The wood which occurs in these deep gravel beds is either beautifully silicified or is replaced by iron pyrites. In such localities a piece of wood will frequently be met with, of which one end had been converted into lignite, whilst the other remained unaltered, but the whole having subsequently become silicified, now presents the appearance of a combination of alabaster and black marble, each portion distinctly retaining the structure of the original wood.

The assay of specimens of the cementing pyrites shows that it invariably contains small, but very variable quantities of gold. In order to ascertain whether this exists in the form of water-worn grains, mechanically enclosed within the crystals of sulphide, or in the shape of crystals or spongy and filamentary particles, similar to those met with in the pyrites of auriferous veins, numerous fragments were attacked by nitric acid, and the residue subsequently subjected to microscopical examination.

In this way granules of the precious metal were detected which had evidently been worn by the action of running water, whilst others appeared not to have been subjected to such attrition. With regard to similar deposits in Australia, Mr. Ulrich* remarks, "In the gold-drifts (Ballarat, Daylesford, Clunes leads, Loddon River, alluvium near Vaughan, &c.) pyrites is often found encrusting or entirely replacing roots and driftwood; such specimens very quickly decompose on exposure to the atmosphere, and samples have, on assay by Messrs. Daintree, Latta, and Newbery, likewise yielded from a few pennyweights to several ounces of gold per ton. According to Mr. H. A. Thompson, a beautiful specimen of crystallized iron pyrites deposited on a piece of wood taken from the drift immediately below the basalt, at Ballarat, gave, by assay, 40 ounces of gold per ton, and in another case, where only the pyrites from the centre of an old tree-trunk was examined, the yield was over 30 dwts. of gold per ton. Some of the fine dust obtained by washing out the gold at the Royal Saxon claim, Ballarat, yielded, by assay, over 15 oz. of gold per ton. When placed under the microscope, this dust was seen to be composed of minute crystals of pyrites aggregated into round pellets, from 1-300th to 1-100th of an inch in diameter, the surface being roughened by the projecting angles of the crystals and un-water-worn."

The amount of skill and capital necessary for the successful prosecution of gold washing or placer mining is usually less than is requisite for carrying on quartz mining on a remunerative scale. Water is the great agent, by the aid of which placer mining is carried on; with a large supply the operations of the miner can be cheaply and rapidly conducted, but without it, or with only a limited supply, a claim that would otherwise have been highly remunerative, may either become valueless, or be only capable of affording very irregular returns.

Placer mines are of two distinct kinds, shallow and deep; shallow or surface diggings are generally found in the beds of ravines or

* 'Notes on the Physical Geography, Geology, and Mineralogy of Victoria.' By Alfred R. C. Selwyn and George H. T. Ulrich, p. 56. Melbourne: 1866.

gullies, on the bars and in the beds of modern rivers, and in shallow flats; in the latter, as before stated, the pay-dirt is often at great depths from the surface, and not unfrequently covered by thick beds of lava or volcanic ash.

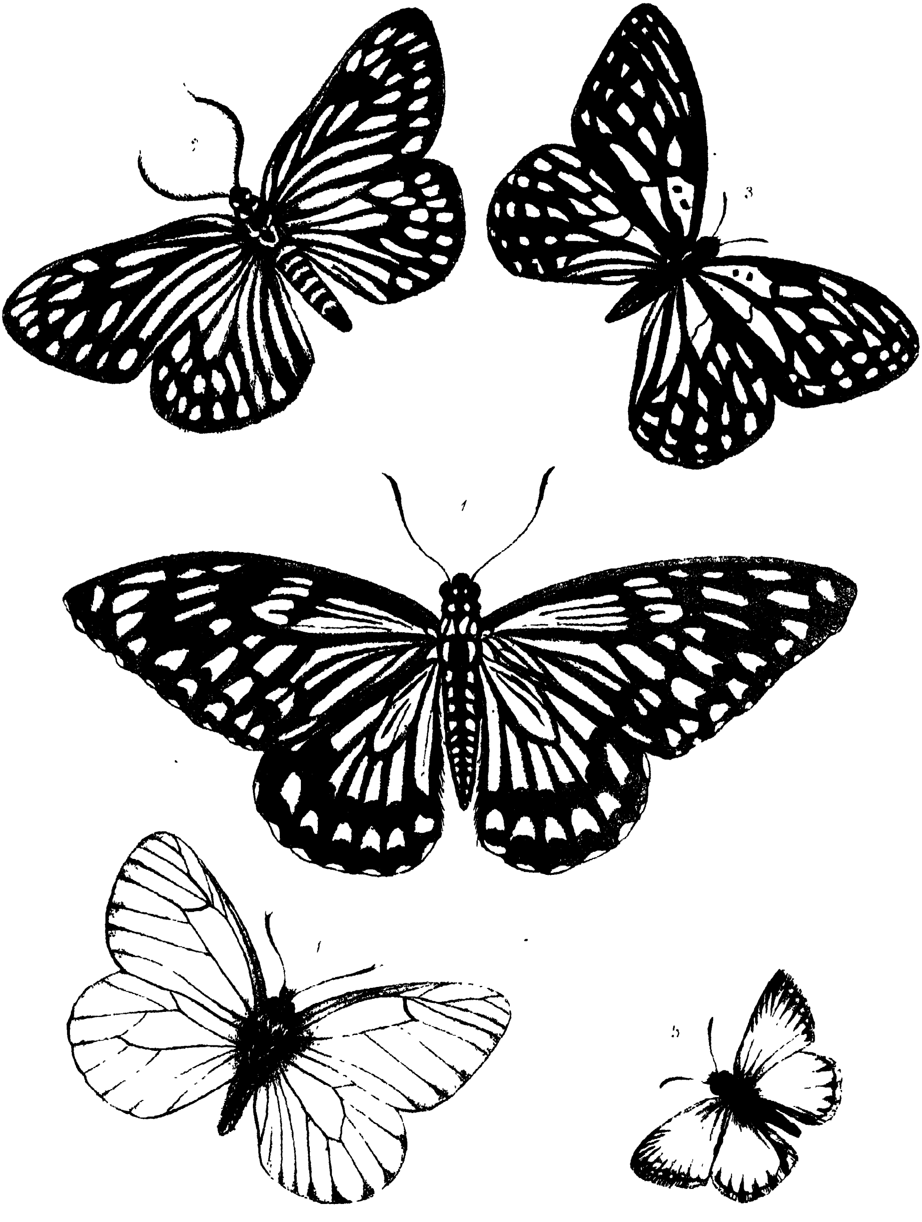
The appliances made use of in the shallow diggings are usually very simple, such as the pan, rocker, long-tom, and sluice, whilst for the deeper deposits hydraulic mining is now generally resorted to.

Among the most remarkable objects that first strike the attention of the visitor to the mining regions of California, are the lofty aqueducts constructed of trestle work for conveying water across valleys and ravines. These, and the various canals with which they are connected, are usually the property of companies who supply the miners, whose claims lie along their course, with the amount of water they may require, charging for it at rates varying from a shilling to five pence per miner's inch. The miner's inch is usually reckoned as the amount of water which will flow through a hole of an inch square, under a mean head of six inches, during ten hours.

In hydraulic mining the water from a canal is brought, by side flumes or aqueducts, to the head of the ground, with an elevation of from 120 to 150 feet, where it is conducted into a wooden box into which it constantly flows. This is provided with a valve, and from it the water is conveyed to the bottom of the claim by means of a strong sheet-iron pipe. At the lower extremity of this is a thick cast-iron chamber, in the sides of which are apertures, provided with slide-valves, to which flexible hose, terminating in bronze nozzles, can be attached by means of union joints. Jets of water are directed from these against the bank, by which means it becomes rapidly disintegrated and washed down through a sluice, in which are wooden or stone riffles charged with mercury, with which the gold becomes amalgamated and is thus retained.

The illustration shows the method of conducting the operations of hydraulic mining. Some tail-sluices employed for this purpose are as much as from fifteen to twenty feet in width, and several hundred yards in length. The more ordinary width of a hydraulic sluice is, however, from four to eight feet. When it is desired to collect the gold, the sluice is cleaned up, the mercury strained, and the amalgam retorted. To give an idea of the amount of work done in a hydraulic claim in the course of twenty-four hours, it may be mentioned that 350 miner's inches of water, with a head of 160 feet, will remove and wash above 4,000 tons of gravel per diem, leaving a small profit on the working of stuff affording gold to the value of only three half-pence per ton. Some of the aqueducts are carried across valleys at a height of 125 feet, and the aggregate length of the different ditches belonging to the Eureka Company alone exceeds 200 miles.

The largest yield of gold during any one year was in 1853,



J. Erxleben lith. M & N. Hanhart imp.

1. PAPILIO Zacreus? PAPILIONIDÆ. | 2. CYCLOSIA Papilionaris, HETEROCERA
3. ORINOMA Damaris, SATYRIDÆ. | 4. PIERIS Cratægi, PIERIDÆ
5. PYRGUS Absaite HESPERIIDÆ

when it amounted to 15,000,000*l*. sterling, since which period the production of California has steadily declined, and the present annual return of the precious metal does not much exceed 5,300,000*l*.

The total value of the gold produced in the state, from the time of the discovery of that metal in 1848 to the close of 1866, is estimated at 167,260,000*l*.

III. ON THE COLOUR-PATTERNS OF BUTTERFLIES.

By Rev. H. H. Higgins, M.A.

The petals of flowers, the plumage of birds, the surfaces of shells, the hides of quadrupeds, the integuments of polyps, and the wings of insects, are some of the chief objects distinguished by a great variety of natural colour-patterns.

All that I propose to attempt in the present instance is to offer a few remarks on the proximate origin and general configuration of the patches, bands, and spots of colour which adorn the wings of the Rhopalocera.

By the use of the term "proximate origin," the inquiry is limited to the appliances immediately engaged in producing the results under consideration; an inquiry which cannot conveniently be separated from the question, whether amidst the apparently capricious and endless varieties of colour-patterns on the wings of butterflies, may be recognized the elements of a prevailing arrangement.

An example of the kind of agency contemplated may be found in the serrated edge of the leaf of a Potentilla, which, it is said, is the result of a certain configuration of organs discernible in the leaf-bud; or, again, the spines on the shell of a Murex, which may be shown to be the result of tentacular appendages periodically developed in the mollusc.

The physical conditions which have preceded so delicate a result as the shading of the colours on the wing of a butterfly, require a kind of investigation which must be attended with corresponding difficulties. But it will be admitted that in no case is a spot or a band added or obliterated except through the instrumentality of antecedents sufficient to produce the result in question. How far these antecedents are capable of being investigated has yet to be determined.

The rudiments of wings, according to Burmeister, may be observed when the caterpillar has completed its third moulting and has attained its full size. "They at first present themselves as short viscous leaves, the substance of which greatly resembles that of the mucous tunic, and to which many delicate tracheæ pass which distribute themselves throughout them."

The wings in an imperfect condition, whilst still enclosed by the shell of the chrysalis, are closely folded together with many plications. Can any clue to the subsequent arrangement of the colours be found in the manner in which the wings are folded in the pupa state? If a scrawl of any kind be made on paper with a pen, and if the paper be folded, the ink being inside and still wet, a symmetrical pattern is produced, the sides of which, like the markings on the wings of a butterfly, exactly correspond. And it is manifest that under certain conditions of folding, colouring matter of any kind might, by a comparatively simple process of arrangement, produce patterns remarkable for symmetry and regularity.

In the limited number of instances in which I have been able to examine the sufficiently advanced chrysalis of a butterfly, nothing of this kind has been indicated: the like spots on the right and left wings do not, in the pupa state, coincide; the folds do not bisect the markings; that which becomes a beautifully formed band, begins as a mere line, or a shapeless spot; and this stage of the metamorphosis, if watched, conveys a decided impression that the resulting colour-pattern is not dependent on the folding of the wings in the immature condition.

The perfect wing of a Lepidopterous insect consists of a delicate double membrane, traversed between the folds by nerves or veins ramifying from the base. The wings are covered with minute scales of various shapes and colours, which, in combination, form a pattern much after the manner of the materials used by an artist in constructing a piece of mosaic work.

Three elements then are essential to the wing, the double membrane, the veins, and the scales covering both.

The simplest type of colour presents itself in the plain uniform tint, exhibited when the scales are all exactly alike. Examples of this are rare in nature. A variety of *Pieris rapæ* is almost wholly white; *Gonepteryx rhamni* is almost wholly yellow.

It seems probable, however, that the scales growing on the membrane upon or near the veins would be distinguished from the scales growing on other parts of the membrane by a freer development of pigmentary matter, and that in this manner would arise a kind of primary or fundamental pattern, namely, a pale ground with darker linear markings following the course of the veins, *e. g. Pieris cratægi.*

For the present we shall notice only the upper surface of the wings, in which the prevalence of the primary pattern is more clearly indicated.

Most butterflies exhibit some traces of the *black-veined white* pattern; and the pattern itself, with slight modifications, is found in species belonging to eight of the fourteen families into which the butterflies are divided.* (See Plate.)

The fundamental character of this dark-veined pattern is confirmed by the closeness of the gradations connecting it with others apparently altogether distinct. For example, *Pieris brassicæ*, and some other insects of the same family, which are wholly white with the exception of a broad black tip at the apex of the fore-wing. Now several exotic species of *Pieris* present the dark veins expanded at the outer margin of the fore-wing into a deeply scalloped black border; others show the gradual fading of the lower portions of the border, together with attenuation of the venous markings in the disc of the wing, till the passage from the pattern of *P. cratægi* to that of *P. brassicæ* is made by almost imperceptible steps.

In the genus *Hestia*, the primary pattern is diversified by a great variety of black spots and blotches, which are all evidently dependent on the venation: the spots occupy a central position between the veins, or they are bisected by a false vein, or they are in pairs contiguous to a vein. In one fine species there is a broad, black band across the wing; but here (as in almost every other instance) the outlines of the black markings are strongly affected by the veins. We shall see, presently, that this is not the case with the brighter colours; but the black markings are very generally thrown nearer to or farther from the base by the passage of a vein, as geological strata are disturbed by the occurrence of a fault. Even where, as in *Euplæa Treitschkei*, only a small spot or two of white is shown on the wings, it is pretty plain that the ground-colour of the wings is white, almost wholly obscured by a greater development of the dark scales belonging to the veins.

The scalloped border has been referred to; and as the scalloped band, nearer to or farther from the margin of the wing, is one of the most prevalent kinds of markings, it may be well to see how readily it may arise from the primary pattern. Let it be supposed that at a given distance from the base a portion of the dark scales begin to diverge on each side from the veins. The dark lines thus formed will meet in the middle of the areas between the veins, producing a band of scallops having their concavities towards the base of the wing. If the divergence takes place towards the base, scallops are formed having their convexities in the same direction. If the latter mode of divergence be quickly followed by the former, a row of annular markings between the veins is the result. In this manner may be obtained the simplest and most elementary form of the annular or ocellate spot, which in the higher stages of development becomes distinguished for its variety and exquisite beauty. Of this, more hereafter.

* Even in the less likely families, *Nymphalidæ* and *Satyridæ*, it occurs in *Penthema Lisarda*, *Orinoma Damaris*, and other species.

Before leaving the subject of the dark vein scales, it may be desirable again to refer to the folding of the wings in the pupa state; for although the pattern is not supposed to be the result of the plications, yet the compressed condition of every part of the wing, whilst in the chrysalis, must be borne in mind. The divergence of a portion of the vein scales to form scallops is difficult to be conceived if we regard the process as wrought in the fully expanded wing; but the whole scallop is a microscopic speck, and the direction of the divergence quite indistinguishable in the pupa state. Yet in this state, whilst the vessels are soft and permeable, the scheme of the future pattern is, no doubt, fully organized, so that the most minute extension this way or that from the incipient vein, of the dark pigment bearing germs of scales, when inflated, expanded, dried and hardened in the wing of the imago, becomes a band, or a scallop, or a ring, according to the original construction and direction.

From the vein scales, then, are supposed to arise all the darker markings which limit and sometimes enclose the areas occupied by the paler ground-tint; frequently, in fact, extending over the greater portion of the surface of the wing. These darker markings are manifestly affected by the passage of the veins, and very commonly, though not always, are distinguished by an outline more or less sharp and distinct.

We come now to inquire into the modifications observable in the paler ground-colour, proper to the scales growing on the spaces between the veins, and often extending over the veins themselves. The first and most obvious modification is the deepening or intensifying of the colour in certain parts of the wing: thus, yellow becomes bright orange; white becomes yellow or scarlet; a pale buff becomes bright testaceous, &c. The transition is generally gradual, the richer being shaded off at its edges into the paler colour. Indeed, so characteristic of the ground-pattern is this kind of shading, that I propose to call the area occupied by the brighter and more intense hue, the "blush." A very satisfactory example of the blush is seen in *Gonepteryx Cleopatra*.

Belonging essentially to the membranous portions of the wing, the blush should not in its contour be affected by the veins, and for the most part it seems to be remarkably independent of them. It occurs in all parts of the wing, at the tip or in the disc, at the margin or, less frequently, near the base, often at the anal angle of the hind wing; but wherever it occurs, it seems to be neither limited nor extended by the veins. It is of course liable, like the ground-colour to which it belongs, to be parted into bands or spots by the dark vein scales; in fact, the whole area of the blush is seldom seen, and more frequently than otherwise the junction of the blush with the pale tint, or rather the space where the junction might have been, is occupied by expanded parts of the black venous pattern.

The blush is not always shaded at its junction with the paler tint, especially where it takes the form of a patch or a spot; as in the tip of the fore-wing of the male of *Anthocharis Cardamines*, the spot in the fore-wing of *Gonepteryx Rhamni*, and that on the anal angle of the hind-wing of *Papilio Machaon*.

In *Vanessa Cardui* the blush is suffused over the greater part of the fore and hind wings, the pale ground colour appearing in spots towards the tip of the fore-wing, on the under side of which the "blush" character of the rose-tint is more plainly exhibited.

In *Vanessa Atalanta* a similar disposition of colours is observable, but the black vein-scales cover a larger portion of the wings, the bright scarlet of the blush being shown in a band on the fore-wing and on the margin of the hind-wing.*

The shading of the paler into the brighter hue is well seen in *Vanessa Urticæ*.

The testaceous colour of the *Fritillaries* I am inclined to regard as a blush, uniformly suffused over the whole area of the wings. The dependence of the black scales on the veins is seen throughout the tribe.

In *Papilio Hector* the blush is exhibited in the crimson spots on the hind wings.

In *Thais Rumina* the blush is broken up into spots, but it will be observed that the crimson spots have black edges, and are rarely bordered by the yellow ground-colour.

We have now observed three important elements in the colour patterns of butterflies: the pale ground-colour; the dark markings due to the vein scales; and the more or less richly-tinted blush; a fourth remains to be noticed.

Hitherto, the scales themselves have presented no very marked distinctions; the black scales, colour excepted, are in appearance exactly similar to the adjacent white or red ones. Under a magnifying power and by transmitted light, all are found to contain appropriate colouring matter; thus, an orange band is made up of orange-coloured scales, and a black marking of dark and nearly opaque scales.

But conspicuous on the wings of butterflies are certain other hues, and these the most splendid of any, which when examined by transmitted light are found to be produced by scales not of corresponding colours. *Lycæna Adonis*, the most brilliant of the British "Blues," has scales altogether colourless; the deep purple on the wings of *Apatura Iris* is produced by scales the colouring matter of

* That the scarlet band is a blush, shown as it were through an opening in the black scales, appears from the under-side of the fore-wing. This is seen still more plainly in the allied species *Pyrameis Gonerilla* from New Zealand.

which is brownish black. A similar hue on *Thecla Quercus* is formed by scales the colour of a dark cloud. The brightest scales on *Lycæna Phleas* are of a watery burnt-sienna hue. Far more striking discrepancies between the transmitted and reflected hues of scales might be quoted from exotic butterflies: I have selected these because the insects are more familiarly known. Viewed as opaque objects, even under a moderately high magnifying power, at the proper angle the reflected hue comes out superbly, but when the light is sent through the scales, a pale, or dull dark tint is all that is observable.

These scales therefore exhibit the phenomena of iridescence, and their hues are derived, not from the colouring matter present in them, but from striations upon their surfaces; not, however, from the striæ which under a microscope may be seen on all Lepidopterous scales, but from others far more minute, surpassing, probably, in delicacy and uniformity, anything elsewhere to be found in nature. The surfaces of iridescent bodies, such as mother-of-pearl and some of the ores of iron and copper are often very gorgeously tinted, but their hues are mixed and irregular, whereas nothing can exceed the purity of colour exhibited by patches of these iridescent scales, indicating a wondrous exactness in the intervals between the striæ.

For convenience, I shall call the feature produced in the colour-pattern by these iridescent scales, the "gloss."

The gloss seems to have towards the dark vein scales the same kind of relation which the blush has towards the pale ground-colour, except that it seems to be rather charged upon, than shaded off into, the venous scales, being sometimes, as it were, sprinkled or dusted upon them, as in *Papilio Paris* and *Teinopalpus imperialis*.

The gloss is rarely seen to form sharply-defined bands or patches, nor does it often come in contact with the ground-colour or the blush, being almost always surrounded by a black border: it frequently suffuses the whole wing,* and is often pierced by the black vein scales, which show themselves as spots in the midst of it.

In rare instances, highly-coloured scales, belonging to the blush, exhibit iridescence; when this occurs the result is exquisitely beautiful. Thus, in *Papilio Vertumnus*, a patch of carmine scales on the hind-wing is glossed so as to show an amethystine hue when seen obliquely; and in one rare species of *Ornithoptera* the yellow patch on the hind-wing has similar reflections. In these butterflies the carmine and yellow hues are the results of corresponding pigment granules; the amethystine gloss arising from iridescent striæ on the surfaces of the scales which contain the pigment grains.

It is a source of much gratification in all branches of natural history, to observe the modifications of an organ through a series of

* As in some *Morphos* and many of the *Lycænidæ*.

species, in one or other of which it may become so changed in appearance, that its identification is possible only by a close comparison between the many links which connect its most abnormal forms with those in which it is ordinarily found.

I have often felt the want of a *rationale* of this kind, in admiring the colour-patterns of butterflies, and have endeavoured to trace a kind of homology between their respective constituents.

For a long time the case seemed hopeless; but opportunities having been afforded me of examining a moderately large number of *Rhopalocera* from most parts of the world where they abound, many apparent anomalies were found to be so only because intermediate forms had not previously been known to me. Thus, for instance, I have ventured to speak of the red spot at the anal angle of the hind-wing of our British Swallow-tailed Butterfly as a form of the "blush." British butterflies alone considered, this must appear to be simply fanciful; but any one who will examine even a limited number of species of the large genus *Papilio* will, I think, be satisfied that the red spot on the hind wing of *P. Machaon* is a modification of the richer tinting of the pale ground-colour, such as may be seen in its more ordinary form in *P. Zagreus* (Doubleday), and in a striking intermediate form in *P. Iswara* (White).

I have only touched on the elementary portion of the subject; more minute details must be reserved for another occasion; but I venture to hope that the present very imperfect account of an attempt to classify the colour-patterns of butterflies may not be uninteresting to their admirers, and may lead to further investigations by more able observers.

IV. THE MODERN ASPECTS OF PHYSICAL SCIENCE.

If we examine with thoughtful deliberation the aspects of Physical Science as they are now presented to our mental vision, we arrive at the conclusion that much uncertainty surrounds them, and we feel that with the advance of knowledge we shall have to modify many a pet hypothesis and, possibly, to abandon some favourite theories which have held their position by the weight of the great names by which they have been supported.

We have before us ten works, each one of them excellent in its class,* and in their entirety fairly representing the conditions of the

* 1. 'The Elements of Natural Philosophy; or, an Introduction to the Study of the Physical Sciences.' By Charles Brooke, M.A., M.B., F.R.S. Churchill.
2. 'Heat considered as a Mode of Motion.' By John Tyndall, F.R.S. Longmans.
3. 'Faraday as a Discoverer.' By John Tyndall. Longmans.

Physical Science of the present day; and it is from a careful study of those, that we arrive at the conclusion that the present is a transition period. We have included in our list some recent works on Chemistry. When the reader reflects on the phenomena connected with the so-called molecular forces—embracing especially those of capillary attraction, of exosmose and endosmose, of epipolic action or surface force, of all that belongs to the allotropic state, and of the facts connected with diffusion and transpiration—he will feel that Physics claims a large portion of the domain of Chemistry as its own. The influences of Light, Heat, and Electricity, in producing chemical changes, and again the development of those energies by chemical action, prove the close alliance of Physical and Chemical Science in all that relates to the properties of molecules and masses. It is on this account—although we may not, in this article, make any further reference to them—that we have included Watts's admirable 'Dictionary of Chemistry' and Dr. Hofmann's excellent little volume, as the exponents of the principles—it might be better to write—the philosophy—of this science. Our desire is to stimulate inquiry, to invite search, and to show that amongst the authorities in science there exist great differences of opinion upon some most important questions. Therefore we have selected those works which most fully and satisfactorily set forth the philosophy of modern Physical Science as the basis of our remarks.

It is universally admitted that we live in a transition period. Old things are being roughly examined, and in many cases subverted, while the New is only, as yet, upon trial. As the political atmosphere exhibits unmistakable tendencies towards a storm, all the elements of which are surely gathering upon the horizon, so the philosophical atmosphere is disturbed by the conflict of opposing currents of thought, which threaten a cyclonic movement likely to carry destruction as it passes, through many a favoured field. Some of our social organizations, stamped with the approval of centuries, and which have hitherto been, through the sanctifying powers of age, regarded with feelings of superstitious reverence, are being rudely shaken. It is clear that many of them will perish in the storm; but it is not so clear that those systems which will occupy the ground they filled are destined to endure so long, or to serve

4. 'The Reign of Law.' By the Duke of Argyll. Strachan.
5. 'A Treatise on Frictional Electricity.' By the late Sir Wm. Snow Harris; edited by Charles Tomlinson, F.R.S. Virtue.
6. 'Researches on Solar Physics.' By Warren De la Rue, F.R.S.; Balfour Stewart, F.R.S.; and Benjamin Loewy. Printed for private circulation.
7. 'A Dictionary of Chemistry.' By Henry Watts, F.R.S., &c. Longmans.
8. 'Introduction to Modern Chemistry, &c.' By A. W. Hofmann, LL.D., F.R.S. Walton & Maberley.
9. 'Reports of the British Association.'
10. 'Philosophical Transactions of the Royal Society.'

so well the purposes for which they are designed—the happiness and peace of men—as those which we are now impulsively rejecting as of an ancient type.

Thus it is, too, in the purer regions of thought. There is an ominous trembling amongst those trees of knowledge which were planted by our truth-seeking forefathers, and which have borne fruit to science. The rustling of the leaves is all that is heard at present; but this indicates tc truly a passing undulation of great power, the precursor of a sweeping force, before which all the trees of knowledge must bend, and those which are not securely planted, and of vigorous growth, must fall to rise no more.

Whether the tendencies of the present time are favourable to the production of Truths is a question to which it is not easy to give a satisfactory answer. That throbbing of the brain and pulsation of the heart which mark the movements of the men of to-day, and which manifest themselves in impulsive action and sensational thought, are, we fear, extending themselves with dangerous influences to the philosophers. In many an essay in which questions of pure science are discussed, in books professedly enunciating some high philosophy, and in lectures professing to teach the simple truths which experiments have brought to light, may be discovered the symptoms of that prevailing mental epidemic which is mainly distinguished by a straining after effect, a desire to surprise, and a resolve to be, in one way or another, sensational.

The worth of scientific knowledge is far too commonly estimated according as the men of to-day have fixed upon one or the other of two standards: the first being its money-worth—the commercial value of science in some practical application; and the second, its sensational value—its worth as a surprise to the public mind, or its influence as a lecture experiment which shall, in theatrical phrase, bring down the house.

To borrow the thought—it is not our purpose to quote the exact words—of a living philosopher; man appeared to us a few years since as beginning to consider himself not merely as the denizen but as the interpreter of Nature, and inspired by the noble prospects opening to him, he exhibited a tendency to become a humble but diligent seeker of the means by which to unravel some of the lowest of her mysteries, and catch a dim, because a distant, glimpse of the designs of the Creator. "The cherub Contemplation" appeared to find a genial atmosphere amongst us. With a religious calmness, men asked for more light to guide them in their pursuit of truth. There were many who—regardless of external sympathy, caring but little for applause, unrepressed by difficulty and undisturbed by the excitements of the world—pursued their tranquil paths, earnestly seeking for some development of Nature's mysteries, regarding the discovery of a truth its own exceeding great reward. These men became each the centre of a circle, to the extremity of which they diffused the influences by which they were themselves inspired; and as the Magnet induces in every neighbouring particle of iron its own powers, so the master-minds induced in other minds that love of truth and that desire to know by which they were themselves so nobly stirred.

It is certain that this period of the awakening of the popular mind, which, with human pride, was spoken of as the "March of Intellect" age, was of but brief duration. Either from a want of reality in the professors of this intellectual religion, or from external influences which are so complicated that they almost escape detection, the desire *to learn* was repressed, and in its place appeared the animal craving *to enjoy*.

"And thus it has happened that in so many cases the impulse of intellectual activity even when given has failed of propagation. The ball has not been caught up at the rebound, and urged forward by emulous hands. The march of progress, in place of quickening to a race, has halted in tardy and intermitted steps, and soon ceased altogether." *

It will appear to many that the talk which we have lately heard respecting Technical Education, and the establishment of Science schools, indicates a consciousness of the value of science. It indicates that science has made itself felt as a power in the land; that there is an awakening to the fact that labour may be saved, and the result of labour improved, or, in other words, that money may be made out of it, but nothing more. The teachers of science may become many, and through even imperfect instruments a considerable amount of knowledge may be diffused among the people; but we fear that in all this there is but little prospect of producing cultivators of science. Whenever there has been an increase of schools, there has been a decay of the sciences or arts to which they have been dedicated. The Past tells us this; let us hope that the Future will not find in the Present another example of this. Having indicated the condition of the Sciences (as it appears to us) as an element of knowledge diffused amongst the so-called thinking classes of Europe, we must proceed to our examination of the actual state of scientific knowledge amongst us.

It ever has been, and for a long period of time it must continue to be, that the popular notion of things runs in grooves which have been cut out by some original minds. In the history of the sciences this is seen to have been the case from the earliest recorded period unto the present day. We smile now at the phlogistic theory—a principle of levity is regarded as the unsatisfactory dream of men imperfectly instructed; yet a careful examination of the hypotheses of the present day will convince the examiner that, although they

* Herschel, "Whewell on the Inductive Sciences:" 'Quarterly Review,' No. 135.

assist us to climb, they are but stepping-stones which will be kicked away as we advance. A careful writer, whose work is now before us, says he cannot doubt that ere long all physical phenomena will be acknowledged to be *the results or effects of various, but interchangeable modifications of Energy;* that is, that Motion, Light, Heat, and Electricity (and, with many, Life) are but the developments of Energy—manifestations of Force. "The term *energy* meaning simply the power of doing work; *force*, meaning the power of producing energy." Let us endeavour to give a faithful example as an illustration of the meaning of this; for the metaphysical refinement which involves this hypothesis hides it, as by a veil, from vulgar intelligences. A mass of gunpowder is a store of *force*, but the force is *potential* only; it is placed in a cannon, with a shot—an inert mass—in front of it, in the tube. A spark is applied, it matters not how, and the force becoming *actual*, imparts energy to the shot, which flies through space and strikes an iron target. The primary Energy—shown in motion—is checked, and we find it is converted into Heat and Light at the moment the blow is given, and, there is but little doubt, also into Electricity.

The *force* which was *potential* in the gunpowder, and which was developed, or made *actual*, by the explosion—producing Motion, Heat, Light, and Electricity—is not destroyed; it exists as an Eternal Energy, or, in the poetic phrase of a writer of note, the flash of the pistol fired by a murderer years long ago is being repeated in space, flashing from star to star; and the sigh of the drowning slave will undulate for ever, until, at the last day, it becomes the damning evidence against the slave-dealer.

"The principle of the 'Conservation of Energy' implies that when once actual energy has been developed in matter, it cannot be annihilated; it can only be transferred in some form to other matter. So universal is the truth and practical application of this principle of conservation, that it may almost be taken as an axiom that it is no more the narrowly-bounded power of man to create or annihilate *force* or *energy* than it is to create matter itself: energy may be variously transmuted and directed, and matter may be variously combined and modified in form and physical properties, but that is all."—*Brooke.*

In passing, it is but justice to state that, although we differ widely from Mr. Brooke in many of his conclusions, and fail to see the cogency of several of his arguments, we know of no other work which more clearly places 'The Elements of Natural Philosophy' before the student; and therefore we recommend it to the attention of every one who is desirous of learning the present state of the Physical Sciences, and, indeed, of studying the main features of the philosophy of the inductive sciences,—except chemistry,—in their more important generalities.

We have spoken of the *energy*, or power of doing work, as developed by or from a *force* dormant in the gunpowder. Let us examine this a little further. This combustible substance is a compound of carbon, sulphur, and nitre; and it owes its power (*force*) to the collision of the molecules of the carbon with those of the oxygen concentrated in the nitre. Without involving ourselves in the mysteries of combustion—for we must call them so—we admit that the molecules of carbon and those of oxygen being forced into union, Heat and Light are the result. Did these physical forces exist as positive entities in the carbon or in the nitre, or were they created from the molecules of matter by the act of union? The answer is before us:—"In long bygone ages the energies of solar light and heat were occupied in the development of woody tissue;" and every molecule of wood is such by virtue of the energy which has been expended in producing it. A cube of wood represents an equivalent of solar force, which, as the energies in sunshine, did the work of producing it (*i. e.* of establishing *grouth*), and they were "used up" in doing the work. The solar energies were not destroyed, but from an active they changed into a passive state; and the wood is a reservoir of sleeping—dormant power. Thus probably it is with the oxygen of the nitre; but we are not yet in a position to trace out satisfactorily the process of the absorption of solar energy by any inorganic mass. If the magic and the beauty of photographic phenomena had not led men away from the study of the science of the chemical energy of the sun (Actinism) to the production of heliographic pictures, we might possibly have advanced our knowledge in this direction.

In the process of converting the wood into charcoal, there does not appear to be any appreciable loss of its solar energy; therefore the grains of charcoal in the gunpowder are cells of sunshine, and by combustion this is suddenly developed. There is, of course, some solar energy—Heat and Light—lost in the flash of light seen at the mouth of the cannon, but much of it has given motion—energy—to the shot, and sent it forth to do its work of destruction, in which, by the sudden suspension of its *motion*, Heat and Light are again seen ready to do some work somewhere: but we can trace force and energy no further.

To give one other example in illustration of the great prevailing doctrine of our modern philosophers—coal is but changed vegetable matter which grew under the influences of sunshine, myriads of ages ere yet man had being. This substance holds its equivalent of solar energy. It is placed under the boiler of a steam-engine, and combustion is established. The heat passes into the water and it becomes steam. This water-vapour, full of solar energy, produces, by ingenious mechanical contrivances, motion, which is applied in doing work of various kinds. If, however, it is employed in driving round the armatures of electro-magnets, it is *converted*, according to the prevailing hypothesis, into magnetic, and this again into electric energy. "This being transmitted between carbon electrodes, an immense amount of light and heat is produced by molecular friction at the point of great resistance to the passage of the current; and these are produced at the expense of electric energy, as proved by the loss of current. Here, then, we have the final transmutation of electric into thermic and photic energy, the latter being so intense as to have thrown a shadow across the brightest sunbeam, and to produce an amount of illumination unattainable by any other known means."—*Brooke.*

By the "undulatory theory" we believe we explain not only the phenomena of Light but those of Heat and Electricity. With some misgivings we venture to ask, Have we not been advanced to this by a system of reasoning from analogy, and are analogies always to be trusted? Sound, we know, is developed by the vibration of material atoms; where there is matter in a state of extreme attenuation, it is scarcely possible to convey through it any audible sound, and silence reigns supreme in even the imperfect vacuum which we can produce. Since, then, sound is proved to require a medium through which its waves may be propagated, what kind of medium can we imagine to be all diffusive and all penetrating, in which the waves of Light, Heat, and Electricity can be generated, and through which they can be propagated across the immensities of space and amidst the interstices of a material body? The wave motions of Light and Heat are supposed to take place in an infinitely elastic, imperceptible, imponderable medium, which pervades space and fills the interstices between the atoms of matter. This is the "*Ether*" of modern philosophers. Some evidence of the existence of an attenuated medium of some kind, in the stellar regions, is obtained by the observations of the periodic retardation of Encke's comet. Although this has been the received idea since the general adoption of the wave theory, it is now giving place to the hypothesis of the vibratory disturbances of the material atoms themselves; the kind of vibration—motion—determining the kind of physical energy which becomes the object of sensuous perception. This hypothesis is very strongly put before us in "Heat considered as a Mode of Motion;" and in the numerous essays which have within the last few years been given to the world by the philosophers of the metaphysical school, especially such as are tinctured with the German modes of thought. It is not our purpose to accept or reject either hypothesis—they have been, and they may continue to be, useful as hypotheses; but we would not have them advanced to the dignity of theories until all that now appears contradictory or inadequate in them is removed, or by extension placed in a more satisfactory position. That all the physical energies become sensible only when in motion, is an established fact. That Heat may require one mode of motion, and Light another, can scarcely be denied. But we have still to inquire what is it that is moved, and where is the Mover. It is not enough to say it is the Ether that is put into undulation; we cannot rest satisfied with the idea, in many cases much too dogmatically put, that the vibration of material atoms produces, according to its degree, one or the other kind of physical energy. However positively these scientific dogmas may be asserted, it should never be forgotten that they are but hypotheses, and that notwithstanding the appeal which is constantly made to mathematical analysis in support of them, the evidence is yet wanting to establish their first principles. Faraday long since showed us that a dew-drop held within it a quantity of Electricity which would, if suddenly liberated, be sufficient to destroy the life of a small animal. He also proved that this great quantity of electricity was necessary to the combination of the gases, oxygen and hydrogen, into that drop of water. Beyond this, we know that water is the fluid which we find it, by virtue of a given equivalent of heat, and by the simple process of chemical decomposition we may burn this water—strictly, its elements—and produce heat and light of the highest intensity. Are those phenomena explained in any way by the dynamical theory? We think not.

At the same time that we are advancing to those metaphysical conclusions, we find ourselves in blind ignorance respecting the most simple conditions which rule the molecular condition of matter, whether inorganic or organic. We have firmly established the Law of Gravitation; but we know not what force it is that pushes or pulls mass towards mass. We speak of Cohesion, but we can only speculate on the power which compels molecule to cohere to molecule. We have supposed ourselves familiar with capillarity; but since M. E. Becquerel has shown us that the surface-attraction which compels the rise of fluids within a tube is sufficient to separate metals from their combinations with acids, and deposit them in films upon the attracting surface,* we discover that we have to study the indications of some occult power. The Osmose forces, again, have been so fully investigated by Professor Graham, that we begin to see that they involve all the phenomena of condensation which are exhibited by porous bodies, and that solution, diffusion, transpiration, and probably chemical attraction are but modified manifestations of some undeveloped force capable of producing new forms of energy.

Residing upon the surface of material atoms there is a power equal, if not superior, to the known physical forces, probably

* As long since as the Meeting of the British Association at Southampton, Professor Oersted called attention to phenomena of this class.

controlling, certainly modifying, their actual energies. This molecular power cannot be regarded as a mode of motion—it is a statical, rather than a dynamical force, yet it is the cause of actual energy.

The study of those powers which appear to act at insensible distances only, is gradually leading us to a knowledge of new conditions, which, probably, determine those dissimilar states under which we find matter of the same kind presenting itself, such as carbon and the diamond, oxygen and ozone, yellow and red phosphorus, and other elements. The relations existing between those molecular forces and the physical forces—Heat, Light, and Electricity—are at present too obscure to admit of the formation of any hypothesis. At the same time there are facts which inform us of some evident relations; and the careful study of these promises to place the inquirer upon new lands in the unexplored sea over which Newton looked from the shore on which he laboured, rich with the fruits of the trees of knowledge.

Everything, however, points to the establishment of the great fact that the sun is the reservoir of force; and it is constantly diffusing to all the worlds revolving around it, those energies which, at the beginning, converted a chaotic mass into a globe beautiful in its order, organization, and life. Matter changing its form in the sun develops an accurately-determined quantity of power, which, passing without loss through space, falls upon another mass of matter, and transmutes its atoms into a thousand forms, some brilliant as gems, others beautiful as flowers. The fine old fable of the Memnonian Statue, bursting into music at the first touch of the morning sunbeam, was but the outshadowing of a philosophic truth. Piercing through the darkness of night, the sunbeam touches the dormant earth, and establishes a series of undulations, which move onward in harmony and awaken the brute atoms into the divinest music. Touched by influences which can only be derived from the solar energies falling on the surface of the earth, the inorganic atoms, buried deep within the rocky crust, glide into geometric forms of beauty, and the crystal foretells the coming organization.

Such are the modern aspects of Physical Science; such are the wondrous truths which experimental inquiry is opening up to us. With so much to know, and with the deep consciousness of the little that we really do know, let us not indulge in the bewitching, but often bewildering labour of creating hypotheses; but, above all things, let us be careful to avoid advancing our hypothetical deductions from our inductive investigations into the importance of theories until they have been subjected to the severest tests.

When we have a theory which, like that of Gravitation, aids us in reaching far into space and feeling out a world which had never yet been detected by the eye of man, assisted even with his wonderful instrumental appliances—then may we accept it without a lingering doubt, and rely upon its power to advance us in the great task committed by his Creator to intellectual Man, of subduing the earth and holding dominion over it.

V. ON MUSICAL SCALES.

By Sir J. F. W. Herschel, Bart., F.R.S.

Having had my attention recently drawn to an ingenious attempt, by Mr. Jackson, to explain the relations between the Major and Minor scales in music, on the principle of the maximum of simplicity in the ratios of the vibrations of the several notes employed, I could not help being strongly impressed with the want of clearness introduced into the discussion of this subject by the employment of the fractions expressing the ratios of the vibrations, or of the lengths of the vibrating strings, and their multiplication or division one by another, to explain the relations of musical intervals. The elementary fractions concerned, $\frac{1}{2}$, $\frac{1}{3}$, and $\frac{1}{5}$, are, it is true, of the simplest kind; but their combinations, formed by multiplication and division, by whole numbers and by each other, present sufficient complexity to throw a kind of haziness over the perception of their magnitudes which distract attention. We have not quite so clear a perception of the magnitude of a fraction as of an integer number; and this indistinctness increases with the numerical increase of the numerator and denominator. Thus, to say which of two proposed fractions is the greater, if their numerators and denominators exceed a few units, often requires some consideration, and reduction to a common denominator; as for instance in the case of $\frac{7}{9}$ and $\frac{10}{13}$. The great majority too of those who study music do it as a subject *sui generis*, and not as a branch of mechanics. Their thoughts are directed to musical intervals and not to the vibrations which give rise to the sounds, or to the lengths of the strings which vibrate; and accordingly they find it far easier to conceive the interval (say) from C to E as the sum of the intervals from C to D and from D to E, than as a ratio compounded of two ratios expressive of these intervals severally. The use of logarithms, by the intervention of which musical intervals are treated as magnitudes susceptible of addition and substraction, and, like feet and inches, measurable on a scale (that scale being the finger-board of an imaginary pianoforte capable of yielding every gradation of audible tone from the lowest to the highest; the same interval corresponding to the same distance of the finger in every part of the scale and in every octave, higher or lower)—gets over this difficulty, and is accordingly often resorted to in treatises on music. In this, however, as in most other things, the proper choice of a unit is a matter of much importance. Every subject of mensuration has its natural unit: in angular measure, the circumference of the circle; in geodesy, the earth's polar axis; in time, the length of the day; and in music, the octave. The ordinary tabular logarithms, however, which give 0·30103, or (striking off the last two figures as unimportant, and multiplying by 1,000) 301 as the logarithm of 2, labour under two great disadvantages, *viz.* 1st, that of assuming an awkward incommensurable or prime number as the measure and representative of this natural unit; and 2ndly, that, in different octaves, the same note (by name) will come to be represented by a totally different and unrecognizable set of figures. Thus, for instance, taking the key-note *Do* as 0 and its octave *do* as 301, *Sol** will be expressed by 176; while *sol* (the same note in the next higher octave) will be expressed by 477 (176 + 301), in the next by 778 (176 + 602), and so on—figures which no way recall or suggest one another, and serve only uselessly to burden the memory. The same objection applies to the division of the octave into 1,200 equal parts, which, on the system of what is called "mean temperament," would assign 100 as the representative of a mean semitone; or into 600 (*temptingly near to* 2 × 301), which would give 100 for the expression of a mean tone.

Both these disadvantages are avoided by altering all the logarithms proportionally, so as to make 1,000 the logarithm of 2; or, speaking practically and without reference to any theory or to any mathematical phraseology, to regard the octave as divided into 1,000 equal intervals, each singly denoting a difference of tone so small as to be undistinguishable by the nicest ear, as the thousandth part of an inch would be to any ordinary eyesight. On this convention the numbers of such minute equal intervals, contained respectively in a Fifth (Vth), a Fourth (IVth), a Major Third (IIIrd), a Minor Third (3rd); a Major and a Minor tone, a Limma, and a Comma, are 585, 415, 322, 263, 170, 152, 93, and 18. The two first together make up an exact octave (585 + 415 = 1000), and are therefore complementary to each other, while the last is the difference between a Major and a Minor tone, the smallest interval recognized as such in musical language, and one which it requires a nice ear to discriminate. The way in which

* I adhere throughout to the good old system of representing by *Do, Re, Mi, Fa,* &c., the scale of natural notes *in any key whatever*, taking *Do* for the key-note, whatever that may be, in opposition to the practice lately introduced (and soon, I hope, to be exploded) of taking *Do* to express one fixed tone C—the greatest retrograde step, in my opinion, ever taken in teaching music, or any other branch of knowledge.

these numbers stand connected with each other is as follows:— the Octave being 1,000, the Fifth, V. = 585, and the Third,* III. = 322; then, denoting the Major tone by T, the Minor by *t*, the Limma by *l*, and the Comma by *c*, the IVth will be expressed by 1,000 − V., the Minor Third (263) by V. − III.; while T, *t*, *l*, and *c* will be respectively expressed by T = 2V. − 1,000, *t*=1,000 + III. − 2V., *l*=1,000 − V. − III., and *c* = 4V. − III. − 2,000; equations which, musically interpreted, express that the Minor Third is obtained from the fundamental or key note, by tuning upwards a Fifth, and thence, downwards, a Major Third; a Major tone, by tuning upwards two Fifths, and thence, downwards, an octave; and so of the rest.

As regards the numerical values of notes in higher or lower octaves, they are formed by adding in the former case, or subtracting in the latter, 1,000, 2,000, 3,000, &c., according to the number of octaves. Thus *Sol* being represented by 585, its representative numbers in the higher octaves will be 1,585, 2,585, &c., and in the lower by 585 − 1,000, 585 − 2000, &c., which, in order to preserve the same terminal figures 585, may be written (in analogy with what is usually done in ordinary logarithmic calculation) $\bar{1}$,585, $\bar{2}$,585, &c., the superscript negative sign applying only to the index figures 1, 2, &c., and the three terminal figures being regarded as always positive.

To those who study music simply *as* music, without troubling themselves with ratios, logarithms, or vibrations, it will save some trouble and bewilderment to accept these numbers as they stand, and to regard the interval called the Octave as made up of the seven successive intervals, T, *t*, *l*, T, *t*, T, *l*, constituting what is called the Diatonic Scale in its ordinary acceptation (though, as will be presently shown, the order T, *t*, of the two first intervals may be reversed, so as to give the scale *t*, T, *l*, T, *t*, T, *l*, without materially altering its character). It is thus that we accept the division of the year into twelve months of unequal lengths, and of these again into four weeks of seven days in each, with a greater or less number of supernumerary days. There is this difference, however, *viz.:* that the latter division is purely arbitrary, whereas the former is founded in the nature of harmony; and it will therefore not be amiss, before proceeding farther, to explain the *rationale* on which the scale is thus, as it were, built up, and how its elements come to succeed each other in this manner. It is recognized, then, as a matter of experience, that the intervals designated as an Octave, a Fifth, and a Major Third (1,000, 585, 322), and also the com-

* Whenever a "Third," without any adjunct, is spoken of, a *Major* Third is hereafter understood.

plement of the two latter to the Octave (1,000 − 585 = 415 and 1,000 − 322 = 678), and those formed by the addition to them of one or more octaves (as 1,000 + 585 = 1,585, and 2,000 + 322 = 2,322) are *perfectly* harmonious, and the only intervals in music which are so: for the Minor Third (263), though not unpleasing, or in any way *discordant*, leaves the ear in some degree unsatisfied, giving that melancholy expression to the Minor key which conveys the impression of something wanting to perfect happiness. Assigning, then, to each note in the scale *Do, Re, Mi, Fa, Sol, La, Si, do,* constituting the Octave, a numerical value expressing its interval or distance from the fundamental note *Do,* we have the two extremes *Do, do* designated respectively by 0 and 1,000, and three of the intermediate ones (*Mi* = 322; *Fa* = 415; and *Sol* = 585) will claim admission as perfect harmonics with the fundamental note or its octave. On the same ground also might 678 claim a place in the scale; but as it differs only by 93, or less than the tenth part of the octave from *Sol* already fixed, its admission would go to break up the octave into too small subdivisions; so that although an excellent candidate for admission into a chromatic scale of twelve semitones, as an intermediate between *Sol* and *La* it cannot be received into the scale of the *natural* notes. Regarding it, then, as an open question how to break the intervals between 0 and 322 on the one hand, and between 585 and 1,000 on the other, by introducing three more natural notes *Re, La,* and *Si;* it is evident that they ought to be determined (since they cannot harmonize with *Do* or *do*) by the condition of forming, each, if possible, perfectly harmonious combinations with one or more of the other three already fixed. This condition is satisfied by assigning to *Re* the number 170, which thus forms a IVth (585 − 170 = 415) with *Sol;* by 737 assigned to *La,* which thus affords a IVth (737 − 322 = 415) with *Mi,* and a IIIrd (737 − 415 = 322) with *Fa;* and by 907 assigned to *Si,* giving a Vth (907 − 322 = 585) with *Mi,* and a IIIrd (907 − 585 = 322) with *Sol.*

Thus, then, the natural scale is filled up. But here already occurs an alternative, and a choice of difficulties. As respects the positions of *La* and *Si* there can be no doubt. *La* besides standing in perfect harmony with *Mi* and *Fa* gives a minor Third (1,000 − 737 = 263) with the upper octave *Do,* an interval though somewhat less than harmonious (as already observed), yet indispensable in music, and without which a large region of human emotion would lack its musical expression; and *La* being thus fixed, *Si* can no otherwise be determined. As regards *Re,* however, it may equally well be determined by making it form a Vth with *La* (giving 737 − 585 = 152 for its value) as a IVth with *Sol,* which, as we have seen, gives 170. This latter, however, makes the interval between

Re and *La* $(737-170)=567$, differing from a Vth by a comma, while the former, which makes this interval a good Vth, gives with *Sol* a IVth $(585-172=433)$ equally erroneous. Again, 170 assumed for *Re* gives a good Minor Third $(1{,}170-907=263)$ with *Si* below it, but a defective one $(415-170=245=263-18)$ with the *Fa* above it, while if 152 be used the result is simply reversed. Thus it appears that for *Re* two distinct values, 170 and 152, are equally eligible, thus originating two distinct diatonic scales. The former is that commonly received: the latter, by way of distinction, we shall speak of as the *Co-diatonic* Scale, as if complementary or correlative to the other.

If music were always played in one key, there would be no occasion for intermediate notes; but the change of key necessitates their introduction, and moreover introduces the further question of temperament, arising from the fact that no mere repetition, ascending or descending, of perfect Fifths or Thirds will lead to an exact Octave or Octaves of the note we set out from. The nearest approach in the case of Fifths is that of twelve Fifths $(12\times585=7{,}020=7{,}000+20)$, which exceed seven Octaves by 20, or rather more than a Comma.* The Thirds, whether major or minor, are still more rebellious, as appears from the equations $3\times322=966=1000-34$, and $4\times263=1052=1000+52$. By combining Fifths and Thirds, however, a much nearer approach may be made. Thus $2\times585+15\times322$ $(2\text{V}+15\text{III})=6{,}000$, which shows that tuning upwards from *Re* (in the ordinary diatonic scale, where *Re* $=170$), fifteen perfect Thirds will lead up precisely to the sixth Octave above *Do*. Again, we have $322+8\times585$ $(\text{III}+8\text{V})=5{,}002=5{,}000+2$, which shows that tuning upwards from *Mi* eight perfect Fifths brings us within the ninth part of a Comma to an Octave of *Do*—a difference perfectly inappretiable. The former of these coincidences is of no value in musical theory; the latter, however, as will appear hereafter, affords the basis of a chromatic scale (*i. e.* a scale in which the Octave is divided into twelve intervals, designated, whether equal or unequal, as "semitones") so very slightly tempered that, practically speaking, it may be regarded as perfect in every key but one.

Dismissing, however, the subject of temperament, we shall now proceed to inquire (for the first time, I believe, on any distinct general principle) how the sharps and flats of the scale can be inserted on an instrument like the pianoforte admitting only of twelve keys on its finger-board within the compass of an Octave, so as to allow of transposition into *all* keys, both natural and sharp or flat, with the least possible deviation from a perfect scale in any one key, and with the greatest number of attainable perfect harmonics

* This interval is sometimes called a Pythagorean comma.

in the *ensemble* of all the twelve; bearing in mind, however, that the Fifth is a far more important harmonic than the Third.*

With this object, setting out, we will suppose, with the key of C on the pianoforte as our fundamental scale, let us denote by C, D, E, F, G, A, B, C′, the respective numbers above assigned as expressing the intervals from C of the natural notes so named, taking, in the first instance, 170 for the value of *Re*; or, let C=0; D=170; E=322; F=415; G=585; A=737; B=907; C′=1000: and let α, β, γ, δ, ϵ be taken to represent the numbers, at present unknown, to be assigned to the intermediate notes C♯=D♭, D♯=E♭, F♯=G♭, G♯=A♭, and A♯=B♭; so that

$$C\ \alpha\ D\ \beta\ E\ F\ \gamma\ G\ \delta\ A\ \epsilon\ B\ C'$$

shall form the complete chromatic scale within the compass of an octave. Now, if we assume, for our fundamental or key note, each, in succession, of the twelve elements C, α, D, ... B, of the scale, the derivative scale will be formed by taking that note for our *Do*, the third from it in succession (counting the fundamental note as the first) for *Re*, the fifth in order for *Mi*, the sixth for *Fa*, the eighth for *Sol*, and so on: so that our aim must be to make as many of such derivative intervals (*Mi* − *Do*) as possible, perfect Thirds, as many from *Do* to *Fa* perfect Fourths, and from *Do* to *Sol* perfect Fifths as possible. These last conditions are identical; a Fourth ascending being equivalent to a Fifth descending. And it is evident that by proceeding thus through the whole scale, we shall get as many Thirds and Fifths as it is possible to make by combining its notes two and two. Our object then is, in effect, to assign such numerical values to our unknown symbols, α, β, γ, δ, ϵ, as shall satisfy as many as possible of the following equations.

(I.)

$E-C=322$, $F-\alpha=322$, $\gamma-D=322$, $G-\beta=322$, $\delta-E=322$, $A-F=322$, $\epsilon-\gamma=322$, $B-G=322$, $\delta-C\ (=1000-322)=678$, $A-\alpha=678$, $\epsilon-D=678$, $B-\beta=678$.

And (II.)

$F-C=415$, $\gamma-\alpha=415$, $G-D=415$, $\delta-\beta=415$, $A-E=415$, $\epsilon-F=415$, $B-\gamma=415$, $G-C\ (=1000-415)=585$, $\delta-\alpha=585$, $A-D=585$, $\epsilon-\beta=585$, $B-E=585$.

Of these 24 equations, eight, *viz.*: $E-C=322$, $A-F=322$, $B-G=322$, $F-C=415$, $G-D=415$, $A-E=415$, $G-C=585$, and $B-E=585$, are satisfied by the numerical values already assigned to these several letters; but the value of D so assigned (170) renders the equation $A-D=585$ self-contradictory, and this equation must be left unsatisfied, giving, as we have already observed, an imperfect Fifth.

* I believe this is the general opinion among musicians; and it is justified by the important part it plays as the dominant of the scale, and as giving fullness and roundness to the harmony of the common chord.

The remaining 15 equations, when for C, D, E, &c., we substitute their assigned numerical values, divide themselves into two classes; those which give explicit values to the unknown quantities α, β, γ, &c., and those which give differential relations between them, thus:—

(III.)—Explicit Values.

$\alpha=59$; $\alpha=93$; $\beta=229$; $\beta=263$; $\gamma=492$; $\delta=644$; $\delta=678$; $\epsilon=848$.

Differential Relations.

$\epsilon-\gamma=322$.

(IV.)—Explicit Values.

$\gamma=492$; $\epsilon=830$.

Differential Relations.

$\gamma-\alpha=415$; $\delta-\alpha=585$; $\delta-\beta=415$; $\epsilon-\beta=585$;

of which the system (III.) contains those whose fulfilment secures perfect Thirds, and (IV.) those which secure perfect Fifths. And on them both we have to remark—1st. That not more than five distinct Thirds, in addition to the three which the natural notes afford, can be secured by *any* choice of α, β, γ, &c., by employing the equations (III.) 2ndly. That the same is true of Fifths *as secured by the equations* (IV.). And 3rdly. That these Thirds and Fifths are mutually exclusive, with the exception that the adoption of 492 as the value of γ, secures at once both a Fifth and a Third. To show this, it suffices to compare the values assigned by each set of equations separately, which are—

(V.), those deduced from (III.), *viz.*:—

$\alpha=59$ *or* 93

$\beta=229$ *or* 263

$\delta=644$ *or* 678

$$\left\{\begin{matrix}\gamma=492\\ \text{and}\\ \epsilon=448\end{matrix}\right\} \text{ or } \left\{\begin{matrix}\gamma=492\\ \text{and}\\ \epsilon=814\end{matrix}\right\} \text{ or } \left\{\begin{matrix}\gamma=526\\ \text{and}\\ \epsilon=848\end{matrix}\right\}$$

And (VI.), those derived from (IV.), being Six Distinct Systems of Values obtained:

1st,	by excluding	$\gamma=492$;	*viz.*	$\alpha=75$,	$\beta=245$,	$\gamma=490$,	$\delta=660$,	$\epsilon=830$
2nd,	„	$\epsilon=830$;	„	$\alpha=77$,	$\beta=247$,	$\gamma=492$,	$\delta=662$,	$\epsilon=832$
3rd,	„	$\gamma-\alpha=415$;	„	$\alpha=75$,	$\beta=245$,	$\gamma=492$,	$\delta=660$,	$\epsilon=830$
4th,	„	$\delta-\alpha=585$;	„	$\alpha=77$,	$\beta=245$,	$\gamma=492$,	$\delta=660$,	$\epsilon=830$
5th,	„	$\delta-\beta=415$;	„	$\alpha=77$,	$\beta=245$,	$\gamma=492$,	$\delta=662$,	$\epsilon=830$
6th,	„	$\epsilon-\beta=585$;	„	$\alpha=77$,	$\beta=247$,	$\gamma=492$,	$\delta=662$,	$\epsilon=830$

These, however, are not the only Fifths obtainable; for among the value of α, β, γ, &c., given in (V.), there are six pairs which satisfy one or other of the differential relations in (IV.), *viz.* ($\alpha=59$, $\delta=644$), and ($\alpha=93$, $\delta=678$), either of which pairs satisfies $\delta-\alpha=585$. And again, ($\beta=229$, $\delta=644$), and ($\beta=263$,

$\delta = 678$) which satisfy $\delta - \beta = 415$. And lastly, ($\beta = 229$, $\epsilon = 814$) and ($\beta = 263$, $\epsilon = 848$): so that either of the two systems—

(VII.)

$$\alpha = 59,\ \beta = 229,\ \gamma = 492,\ \delta = 644,\ \epsilon = 814$$
$$\alpha = 93,\ \beta = 263,\ \gamma = 492,\ \delta = 678,\ \epsilon = 848$$

will satisfy the differential relations $\delta - \alpha = 585$, $\delta - \beta = 415$, and $\epsilon - \beta = 585$, and will thus give us three more implied Fifths, without sacrificing either of the five Thirds which they imply, or the independent Fifth secured by taking $\gamma = 492$.

On the other hand, any one of the systems of values in (VI.) will give us five Fifths, but their adoption necessarily sacrifices four out of the five Thirds given by (V.); that dependent on $\gamma = 492$ being the only one retained. Here, however, our attention is naturally drawn to the singularly close coincidence of all the six values of α, β, γ, &c., in these systems (the direct consequence, be it observed, of that remarkable relation III. + 8 V. = 5000 + 2 we have already pointed out). And it will not fail to strike us that if we consent to overlook so very minute a deviation from absolute perfection in the value of ϵ as a single unit (a thousandth part of an octave, or 1-18th part of a comma, an interval no human ear is nice enough to distinguish), and adopt the series of values,

$$\alpha = 77,\ \beta = 247,\ \gamma = 492,\ \delta = 662,\ \epsilon = 831,$$

we shall obtain *six* Fifths, four of which are perfect, and two defective only by the infinitesimal error above mentioned.

Thus, then, we have arrived at three scales, or chromatic subdivisions of the octave, which alone can be considered as having any distinct claim to preference among the innumerable systems which might be proposed, *viz.* :—

	Do		*Re*		*Mi*	*Fa*		*Sol*		*La*		*Si*	*do*
(A)	0,	93,	170,	263,	322,	415,	492,	585,	678,	737,	848,	907,	1000.
(B)	0,	59,	170,	229,	322,	415,	492,	585,	644,	737,	814,	907,	1000.
(C)	0,	77,	170,	247,	322,	415,	492,	585,	662,	737,	831,	907,	1000.

The first of these (A), when translated into the language of ratios and fractions, will be found to coincide with that given by Cavallo (Phil. Trans., vol. lxxviii., p. 239) as the then received harmonic subdivision of the octave into twelve intervals. The second (B) is one proposed by Euler; * while the third (C) coincides very nearly, so far as the accidental notes (the sharps or flats) are concerned, with either of the two *tempered* scales propounded by Dr.

* I derive my knowledge of it from the Abbé Moigno's Journal, 'Annuaire du Cosmos,' 1859, part ii., p. 200. As there given, however, it is full of misprints. The fractions expressing the ratios of vibrations, evidently intended by Euler, are—

$$1,\ \tfrac{25}{24},\ \tfrac{9}{8},\ \tfrac{75}{64},\ \tfrac{5}{4},\ \tfrac{4}{3},\ \tfrac{45}{32},\ \tfrac{3}{2},\ \tfrac{25}{16},\ \tfrac{5}{3},\ \tfrac{225}{128},\ \tfrac{15}{8},\ 2.$$

Young in his 'Lectures on Natural Philosophy' (Lect. 33), which, translated into our language, are respectively—

	Do		Re		Mi	Fa		Sol		La		Si	do
	0,	75,	163,	245,	327,	415,	490,	583,	660,	745,	830,	908,	1000;
And	0,	75,	164,	245,	322,	415,	490,	585,	660,	743,	830,	905,	1000;

in the latter of which it will be seen that with the exception of the single interval of 583 instead of 585, between *Mi* and *Si*, the semitones are all inserted by eight successive additions of 585 from *Mi* upwards: thus $323+583=905$; $905+585=1{,}490$; $1{,}490+585=2{,}075$; $2{,}075+585=2{,}660$; $2{,}660+585=3{,}245$; $3{,}245+585=3{,}830$; $3{,}830+585=4{,}415$; $4{,}415+585=5{,}000$: from which, rejecting the entire thousands so as to bring the notes all within the compass of one octave, we have a series of accidentals identical with the second of those set down in (VI.).

Let us now examine these three scales in succession, by forming out of them—1stly, all the Fifths; 2ndly, all the Major Thirds; and 3rdly, all the Minor Thirds which can be made among them, and we shall find as follows: *viz.* 1stly, for the scale (A)—

Vths—585, 585, 567, 585, 585, 585, 601, 585, 585, 585, 567, 585;
IIIrds—322, 322, 322, 322, 356, 322, 356, 322, 322, 356, 322, 356;
3rds—263, 229, 245, 229, 263, 263, 245, 263, 229, 263, 245, 263;

showing nine good Fifths, eight Major, and six Minor Thirds. The erroneous Fifths are, two of them, deficient by a Comma, and one in excess by nearly a Comma (16). The erroneous Major Thirds are all in excess by 34, or nearly two Commas; and the erroneous Minor Thirds all deficient, three by a Comma and three by 34.

The scale (B) similarly tried, gives—

Vths—585, 585, 567, 585, 585, 585, 567, 585, 585, 585, 601, 585;
IIIrds—322, 356, 322, 356, 322, 322, 322, 322, 356, 322, 356, 322;
3rds—229, 263, 245, 263, 263, 229, 215, 229, 263, 263, 215, 263;

which singularly enough (as it seems at first sight) exhibits the same number of each harmonic as (A), and the same amount of deviation, and in the same direction for each. These two scales then are precisely on a par, nor does there seem any reason for preferring one to the other. Both are rich in perfect Thirds both Major and Minor, which is a strong recommendation; but, owing to the bad Fifths which they involve, three out of the eleven keys into which the fundamental scale may be transposed are spoiled by false dominants, and three others blemished by false sub-dominants, while the more erroneous Thirds cannot but prove objectionable wherever they may occur.

Treating our scale (C) in the same manner, we get:—

Vths—585, 585, 567, 585, 585, 585, 585, 585, 585, 585, 584, 584;
IIIrds—322, 339, 321, 339, 339, 322, 340, 322, 339, 339, 339, 339;
3rds—246, 246, 245, 245, 263, 246, 246, 246, 246, 263, 245, 263;

Of the Fifths one only errs by a Comma, all the rest may be regarded as perfect, and the defective one (as we have seen) is inevitable if we insist on starting from an untempered scale. The chief blemish of this scale is the paucity of its perfect Thirds of both kinds, but on the other hand none of them err in excess or defect beyond a Comma.

The peculiarities of these several scales will, however, be placed in a clearer light by exhibiting the several scales of natural notes resulting from their transposition into all the keys. Taking then C for an original or fundamental key, the values of the natural notes in all the keys, starting from the scale (A), will stand thus:—

(A.)	C.	D♭.	D.	E♭.	E.	F.	G♭.	G.	A♭.	A.	B♭.	B.
Do ..	0	0	0	0	0	0	0	0	0	0	0	0
Re ..	170	170	152	152	170	170	186	152	170	170	152	186
Mi ..	322	322	322	322	356	322	356	322	322	356	322	356
Fa ..	415	399	415	415	415	433	415	415	415	433	415	415
Sol ..	585	585	567	585	585	585	601	585	585	585	567	585
La ..	737	755	737	737	771	755	771	737	737	755	737	771
Si ..	907	907	923	907	941	907	923	907	907	941	889	941
do ..	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

From which it appears that—1stly, the transposition into A♭ gives us back again the pure original scale of C unaltered; and, 2ndly, the transposition into either G or into E♭, gives again the diatonic scale, with the substitution of 152 instead of 170 for *Re*, constituting what we have above designated as the Co-diatonic scale.

Operating a similar series of transpositions with (B) as a fundamental scale, we find the following system—

(B.)	C.	D♭.	D.	E♭.	E.	F.	G♭.	G.	A♭.	A.	B♭.	B.
Do ..	0	0	0	0	0	0	0	0	0	0	0	0
Re ..	170	170	152	186	170	170	152	152	170	170	186	152
Mi ..	322	356	322	356	322	322	322	322	356	322	356	322
Fa ..	415	433	415	415	415	399	415	415	415	433	415	415
Sol ..	585	585	567	585	585	585	567	585	585	585	601	585
La ..	737	755	737	771	737	755	737	737	771	755	771	737
Si ..	907	941	889	941	907	907	923	907	941	907	923	907
do ..	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Here we are again presented with a similar phænomenon. The exact original scale of C is reproduced in E♮, and the co-diatonic scale in the keys of G and B. Lastly, making the same series of transpositions in the case of our scale (C), we obtain—

(C.)	C.	D♭.	D.	E♭.	E.	F.	G♭.	G.	A♭.	A.	B♭.	B.
Do ..	0	0	0	0	0	0	0	0	0	0	0	0
Re ..	170	170	152	168	170	170	170	152	169	170	169	170
Mi ..	322	338	322	338	340	322	339	322	338	340	339	340
Fa ..	415	415	415	415	415	416	415	415	415	433	416	415
Sol ..	585	585	567	584	585	585	585	585	585	585	584	585
La ..	737	754	737	753	755	755	755	737	753	755	754	755
Si ..	907	923	907	923	925	907	923	907	923	925	906	924
do ..	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

where the co-diatonic scale appears in G, as in the case of (B). And it is sufficient to run the eye along the several horizontal lines of the table to perceive the much greater uniformity and regularity prevailing in this system than in the other two, between which it offers a sort of mean.

§ 2.

Let us now go through exactly the same set of operations, setting out from the co-diatonic scale in which *Re* $= 152$; and instead of the system of values of α, β, &c. in (VII.), we shall find ourselves conducted to the following:—

(VIII.)

$$\alpha = 59,\ \beta = 229,\ \gamma = 474,\ \delta = 644,\ \epsilon = 796;$$
$$\alpha = 93,\ \beta = 263,\ \gamma = 508,\ \delta = 678,\ \epsilon = 830;$$

while the systems of values in (VI.) remain unaltered. Here, then, the link of connection between the two sets which give a Fifth in the one and a Third in the other, is $\epsilon = 830$, instead of $\gamma = 492$; and thus, proceeding as before, we are led to three scales, (a), (b), (c), each having its own especial claims to consideration.

	Do		*Re*		*Mi*	*Fa*		*Sol*		*La*		*Si*	*do*
(a)	0,	93,	152,	263,	322,	415,	508,	585,	678,	737,	830,	907,	1000.
(b)	0,	59,	152,	229,	322,	415,	474,	585,	644,	737,	796,	907,	1000.
(c)	0,	75,	152,	245,	322,	415,	491,	585,	660,	737,	830,	907,	1000.

Examining these by the criterion afforded by their Fifths and Major and Minor Thirds, as in the cases of the former scales, (A), (B), (C), we shall find that (a) affords, just as in the case of (A), nine perfect Fifths, and three excessive or defective by a Comma; eight perfect Major Thirds, and four excessive by 34; and six perfect Minor Thirds, three deficient by a Comma, and three by 34, or nearly two Commas.

The scale (b) similarly tried affords only eight perfect Fifths, three defective by a Comma, and one excessive by 34; eight perfect Major Thirds, the other four all excessive by 34; and seven perfect Minor Thirds, the others defective—two by 18, two by 34, and one by 52. This scale, then, is decidedly inferior, and may at once be rejected.

Lastly, (c) affords eleven Fifths (two defective by a single unit, and therefore to be received as perfect), and one defective by a Comma; the Major and Minor Thirds also as in the case of (C).

Rejecting, then, (b), the transpositions of (a) and (c) will give the following systems:—

(a.)	C.	D♭.	D.	E♭.	E.	F.	G♭.	G.	A♭.	A.	B♭.	B.
Do ..	0	0	0	0	0	0	0	0	0	0	0	0
Re ..	152	170	170	152	186	170	170	152	152	170	170	186
Mi ..	322	322	356	322	356	322	322	322	322	356	322	356
Fa ..	415	415	433	415	415	415	399	415	415	415	433	415
Sol ..	585	585	585	567	585	585	585	567	585	585	585	601
La ..	737	737	755	737	771	737	755	737	737	771	755	771
Si ..	907	907	941	889	941	907	907	923	907	941	907	923
do ..	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

And,

(c.)	C.	D♭.	D.	E♭.	E.	F.	G♭.	G.	A♭.	A.	B♭.	B.
Do ..	0	0	0	0	0	0	0	0	0	0	0	0
Re ..	152	170	170	170	169	170	169	152	170	170	170	168
Mi ..	322	340	339	340	338	322	339	322	340	338	322	338
Fa ..	415	416	433	415	415	415	416	415	415	415	415	415
Sol ..	585	585	585	585	585	585	584	567	585	585	585	584
La ..	737	755	755	755	753	737	754	737	755	754	755	753
Si ..	907	925	923	905	923	907	924	906	925	923	907	923
do ..	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Here we see reproduced in the scale (a) the peculiarity already noticed in (A), *viz.* that it gives to A♭ the same identical scale with C and in D♭, (and with the exception of the single note *La*, also in B♮), the diatonic scale complementary to that we started from. Among the transpositions of (c), again, we find the key of F reproducing the complementary diatonic.

Except these five scales, it does not appear possible to construct any others having the smallest pretension to be received, consistently with the condition of starting from one or the other of the two *untempered* diatonics,* unless, perhaps, we regard as entitled to enter into this competition that bugbear to the musical mind, the scale which arises from tuning up directly from *Do* eleven consecutive perfect Fifths; the twelfth (which, with tempered Fifths, would lead to the seventh octave of the fundamental note), surpassing it

* The minute temperament of a single unit in the two intermediate Fifths of the scales (C) and (c), it will be observed, does not affect any of the *Natural* notes of the fundamental scale. In those proposed by Dr. Young, on the other hand, the temperament is made to fall *entirely* on those notes, the accidentals being all free from it.

by 20, or by what is called a "Pythagorean Comma," and so throwing "the wolf," as the phrase is, deliberately into one key, whose dominant, deficient by that amount, shall render it altogether unfit for use. To find the values of the notes in this scale, we have only to form the eleven first multiples of 585, reject the thousands, and arrange the results in order of magnitude, which gives the scale—.

	Do		*Re*		*Mi*	*Fa*		*Sol*		*La*		*Si*	*do*
(*d*)	0,	95,	170,	265,	340,	435,	510,	585,	680,	755,	850,	925,	1000.

This scale, tried by the same test of Fifths and Major and Minor Thirds, gives us eleven perfect Fifths, and one deficient by 20; four Major Thirds deficient only by 2, and which therefore may be received as good, and all the other eight excessive by a Comma; and four Minor Thirds excessive by 2, and therefore to be received as good, all the rest being deficient by a Comma. This scale, then, so far from meriting the unreserved condemnation with which it has been received, stands in no *very* unfavourable comparison with (C) or (c) (though certainly inferior to both), in the original key, while in its transpositions (taking C as the original key) it exhibits some remarkable peculiarities which render it otherwise worthy of attention, as the following table will show:—

(d.)	C.	D♭.	D.	E♭.	E.	F.	G♭.	G.	A♭.	A.	B♭.	B.
Do ..	0	0	0	0	0	0	0	0	0	0	0	0
Re ..	170	170	170	170	170	150	170	170	170	170	150	170
Mi ..	340	340	340	320	340	320	340	340	320	340	320	340
Fa ..	435	415	415	415	415	415	415	415	415	415	415	415
Sol ..	585	585	585	585	585	565	585	585	585	585	585	585
La ..	755	755	755	735	755	735	755	755	755	755	735	755
Si ..	925	905	925	905	925	905	925	925	905	925	905	925
do ..	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
(e)	A.	B♭.	B.	C.	D♭.	D.	E♭.	E.	F.	G♭.	G.	A♭.
(f.)	D.	E♭.	E.	F.	G♭.	G.	A♭.	A.	B♭.	B.	C.	D♭.

This table, as it stands, with the headings of the columns as on the upper horizontal line marked (d), exhibits the transpositions of the scale (d), starting with C as a fundamental note. It affords two very good scales, *viz.* a good, almost a perfect, diatonic scale in E♭, and an equally good co-diatonic in B♭; so that in those keys it will afford excellent harmony. What seems to condemn it is, that it throws "the wolf" into F, one of the most useful keys, and what may be called "the counter-wolf" (that which results from a faulty IVth—*for every faulty Fifth in one key necessitates an equally faulty Fourth in the key a fourth below it*) into the original key C itself. This unlucky defect, however, it is evident, will be evaded by starting, and beginning to tune our Fifths upwards, not from C but from E♭ or B♭, which will simply transfer the letters in the heading (d) into the order (e) in the upper of the two lines below the table in the former case, and into the order (f) in the latter case; and will give us for the values of the notes in the two scales as under—

	Do		*Re*		*Mi*	*Fa*		*Sol*		*La*		*Si*	*do*
(e)	0,	75,	170,	245,	320,	415,	490,	585,	660,	735,	830,	905,	1000;
(f)	0,	75,	150,	245,	320,	415,	490,	585,	660,	735,	830,	905,	1000;

whose approximation to our scales (C) and (c) is very close.

Exactly in the same manner, if we set out with either of the scales (A), (B), and, instead of commencing with C as a fundamental note, commence with A♭, as *Do*, and tune upwards thence by the successive intervals *of the other scale* in their order, from the beginning to the end of the octave. we shall complete the scale—thus, commencing with 678, which corresponds to A♭ in the scale (A), and adding to it in succession each of the numbers 59, 170, 229, 322, &c., belonging to the scale (B), we produce the numbers 737; 848; 907; 1,000; 1,093; 1,170, 1,263; 1,322; 1,415; 1,492; 1,585; 1,678; and *vice versâ*. This places in evidence the musical relation of those two scales, and shows that in fact each of them is only a transposition of the other.

The scale of equal temperament results from tuning upwards from *Do* twelve successive Fifths, each defective by $\frac{2}{12}$, or each = $583\frac{1}{3}$; or, which comes to the same, dividing the octave into equal intervals of $83\frac{1}{3}$ each, thus giving the scale (to the nearest unit in each note)—

	Do		*Re*		*Mi*	*Fa*		*Sol*		*La*		*Si*	*do*
(g)	0,	83,	167,	250,	333,	417,	500,	583,	667,	750,	833,	917,	1000.

This scale, of course, reproduces itself in all its transpositions, and is therefore exceedingly well adapted to the purposes of the mere Pianiste as affording him an unbounded range of modulation, and (by the free use of the equivocal chord, or diminished Seventh, and other similar artifices of modulation) allowing him, within the compass of the same piece of music, to pass into any, or if he please, all the keys, without fear of encountering "the wolf," or any other musical monster but those of his own making. Its chief defect is that it does not afford a single good Third, either Major or Minor; *all* the former being two-thirds of a Comma in excess, and *all* the latter as much in defect of their legitimate values. This is little felt in modern pianoforte music, in which brilliancy and rapidity of passages and startling turns of modulation, by the introduction of all sorts of extraneous notes into the discords, stand in the place of delicate and sustained harmony; to which, besides, the instrument itself is little adapted, owing to the rapid degradation in the intensity of sound in its notes when once struck. As an accompaniment, however, to instruments without a fixed scale, and more especially to vocal music in parts, where the performers, if they have any ear, will naturally endeavour to keep their Thirds perfect in those passages in which many of them follow in succession, on which so much of the beauty of vocal music depends, the advantage of a scale abounding in *perfect* Thirds is evident; especially if the composer, aware of the existence of faulty ones in the scale, should avoid their introduction, or avoid, at least, dwelling long on them.

To show the composition of the several numbers which occur in the foregoing scales, or what musical intervals they represent, we subjoin the following table, in which it is to be remembered that the entire thousands (expressive of octaves), whether + or −, are rejected; or in other terms, that − V (a Fifth tuned downwards) is to be considered as equivalent to + IV = 415, a Fourth tuned upwards; and − III., a descending Third, to = 678, its complement to the octave, ascending; and in which it must also be borne in mind that though these equations may be added to or substracted from one another or multiplied by any whole number, they must not be halved, quartered, or otherwise divided.

Table of Musical Equivalents in the foregoing pages, the Octave being 1000.

1 = − 2 III. + 37 V.	247 = + III. + 5 V.	644 = + 2 III.
2 = + III. + 8 V.	263 = − III. + V.	660 = − 4 V.
16 = − 2 III. − 4 V.	265 = + 9 V.	662 = + III. + 4 V.
18 = − III. + 4 V.	320 = − 8 V.	678 = − III.
20 = + 12 V.	322 = + III.	680 = + 8 V.
34 = − 3 III.	338 = − III. − 4 V.	735 = − 9 V.
36 = − 2 III. + 8 V.	340 = + 4 V.	737 = + III. − V.
52 = − 4 III. + 4 V.	415 = − V.	753 = − III. − 5 V.
59 = + 2 III. − V.	433 = − III. + 3 V.	755 = + 3 V.
75 = − 5 V.	435 = + 11 V.	771 = − 2 III. − V.
77 = + III. + 3 V.	474 = + 2 III. − 2 V.	796 = + 3 III. − 2 V.
93 = − III. − V.	490 = − 6 V.	814 = + 2 III. + 2 V.
95 = + 7 V.	492 = + III. + 2 V.	830 = − 2 V.
111 = − 2 III. + 3 V.	508 = − III. − 2 V.	832 = + III. + 6 V.
150 = − 10 V.	510 = − 6 V.	850 = + 10 V.
152 = + III. − 2 V.	526 = − 2 III. + 2 V.	889 = + 2 III. − 3 V.
168 = − III. − 6 V.	565 = − 11 V.	905 = − 7 V.
170 = + 2 V.	567 = + III. − 3 V.	907 = + III. + V.
186 = − 2 III. − 2 V.	583 = − III. − 7 V.	923 = − III. − 3 V.
229 = + 2 III. + V.	585 = + V.	925 = + 5 V.
245 = − 3 V.	601 = − 2 III. − 3 V.	941 = − 2 III. + V.

VI. ON THE MEASUREMENT OF THE LUMINOUS INTENSITY OF LIGHT.

By William Crookes, F.R.S., &c.

The measurement of the intensity of a ray of light is a problem the solution of which has been repeatedly attempted, but with less satisfactory results than the endeavours to measure the other radiant forces. The problem is susceptible of two divisions:—the absolute and the relative measurement of light.

I. Given a luminous beam, we may require to express its intensity by some absolute term having reference to a standard obtained at some previous time, and capable of being reproduced with accuracy at any time in any part of the globe. Possibly two such standards would be necessary, differing greatly in value, so that the space between them might be subdivided into a definite number of equal parts; or the same result might perhaps be obtained by the well-known device of varying the apparent intensity of the standard light by increasing and diminishing its distance from the instrument.

II. The standard of comparison, instead of being obtained once for all, like the zero and boiling-points of a thermometer, may be compared separately at each observation; and the problem then becomes somewhat simplified into the determination of the relative intensities of two sources of light.

The *absolute* method is of course the most desirable; but as the preliminary researches and discoveries are yet to be made before a photometer, analogous to a thermometer in fixity of standard and facility of observation, could be devised, the realization of an absolute light-measuring method appears somewhat distant. The path to be pursued towards the attainment of this desirable object appears to be indicated in the observations which from time to time have been made by Becquerel, Herschel, Hunt, and others on the chemical action of the solar rays, and the production thereby of a galvanic current, capable of measurement on a delicate galvanometer, by appropriate arrangements of metallic plates and chemical baths connected with the ends of the galvanometer wires.

Many so-called photometers have been devised, by which the chemical action of the rays at the most refrangible end of the spectrum have been measured, and the chemical intensity of light tabulated by appropriate methods; and within the last few years Professors Bunsen and Roscoe have contrived a perfect chemical photometer, based upon the action of the chemical rays of light on a gaseous mixture of chlorine and hydrogen, causing them to combine with formation of hydrochloric acid.

But the measurement of the chemical action of a beam of light, is as distinct from photometry proper as is the thermometric registration of the heat rays constituting the other end of the spectrum. What we want is a method of measuring the intensity of those rays which are situated at the intermediate parts of the spectrum, and produce in the eye the sensation of light and colour; and, as previously suggested, there is a reasonable presumption that further researches may place us in possession of a photometric method based upon the chemical action of the *luminous* rays of light.

The rays which affect an ordinary photographic sensitive surface, are so constantly spoken of and thought about as the ultra-violet invisible rays, that it is apt to be forgotten that some of the highly luminous rays of light are capable of exerting chemical action. Fifteen years ago the writer was engaged in some investigations on the chemical action of light, and he succeeded in producing all the ordinary phenomena of photography, even to the production of good photographs in the camera, by purely luminous rays of light free from any admixture with the violet and invisible rays. When the solar spectrum, of sufficient purity to show the principal fixed lines, is projected for a few seconds on to a sensitive film of iodide of silver, and the latent image then developed, the action is seen to extend from about the fixed line G to a considerable distance into the ultra-violet invisible rays. When the same experiment was repeated with a sensitive surface of bromide of silver instead of iodide of silver, the result of the development of the latent image showed that in this case the action commenced at about the fixed line *b*, and extended, as in the case of the iodide of silver, far beyond the violet. A transparent cell, with parallel glass sides one inch across, was filled with a solution of twenty-five parts of sulphate of quinine to one hundred parts of dilute sulphuric acid; this was placed across the path of the rays of light, and photographs of the spectrum were again taken on iodide of silver and on bromide of silver, the arrangements in all cases being identical with those in the first cited experiments, with the exception of the interposition of the quinine screen. The action of the sulphate of quinine upon a ray of light is peculiar; to the eye it scarcely appears to have any action at all, but it is absolutely opaque to the ultra-violet, so called chemical, rays, and thus limits the photographic action on the bromide and iodide of silver to the purely luminous rays. On developing the latent images, it was now found that the action on iodide of silver was confined to a very narrow line of rays, close to the fixed line G, and in the case of bromide of silver to the space between *b* and G. Designating the spaces of action by colours instead of fixed lines, it was thus proved that, behind a screen of sulphate of quinine, iodide of silver was affected only by the luminous rays about the centre of the indigo portion of the spectrum, whilst bromide of silver was affected by the green, blue, and some of the indigo rays.

It is very likely that a continuance of these experiments would lead to the construction of a photometer capable of measuring the luminous rays; for although bromide of silver behind quinine is not affected by the red or yellow rays, still it is by the green and blue; and as the proportion of red, yellow, green, and blue rays is always invariable in white light (or the light would not be white but coloured), a method of measuring the intensity of one set of the components of white light would give all the information we want; just as, in an analysis of a definite chemical compound, the chemist is satisfied with an estimation of one or two constituents only, and calculates the others.

Method based upon the foregoing considerations would supply us with what may be termed an *absolute* photometer, the indication of which would be always the same for the same amount of illumination, requiring no standard light for comparison; and pending the development of experiments which the writer is prosecuting in this direction, he has been led to devise a new and, as he believes, a valuable form of *relative* photometer.

A relative photometer is one in which the observer has only to determine the relative illuminating powers of two sources of light, one of which is kept as uniform as possible, the other being the light whose intensity is to be determined. It is therefore evident that the great thing to be aimed at is an absolutely uniform source of light. In the ordinary process of photometry the standard used is a candle, defined by Act of Parliament as a "sperm candle of six to the pound, burning at the rate of 120 grains per hour." This is the standard from which estimates of the value of illuminating gas are deduced, hence the terms "12-candle gas," "14-candle gas," &c. In his work on *Gas Manipulation*, Mr. Sugg gives a very good account of the difficulties which stand in the way of obtaining uniform results with the Act of Parliament candle. A true sperm candle is made from a mixture of refined sperm with a small proportion of wax, to give it a certain toughness, the pure sperm itself being extremely brittle. The wick is of the best cotton, made up into three cords and plaited. The number of strands in each of the three cords composing the wick of a six-to-the-pound candle is seventeen, although Mr. Sugg says there does not appear to be any fixed rule, some candles having more and others less, according to the quality of the sperm. Sperm candles are made to burn at the rate of one inch per hour, and the cup should be clean, smooth, and dry. The wick should be curved slightly at the top, the red tip just showing through the flame, and consuming away without requiring snuffing. To obtain these results, the tightness of the plaiting and size of the wick require careful attention; and as the quality of the sperm differs in richness or hardness, so must the plaiting and number of strands. A variety of modifying circumstances thus tend to affect the illuminating power of a standard sperm candle. These difficulties, however, are small, compared with those which have resulted from the substitution of paraffin, &c., for part of the sperm; and Mr. Sugg points out that candles can be made with such combinations of stearin, wax, or sperm, and paraffin, as to possess all the characteristics of sperm candles, and yet be superior to them in illuminating power; while, on the other hand, candles made from the same materials otherwise combined are inferior. When, in addition to this, it is found that candles containing paraffin require wicks more tightly plaited and with fewer strands than those suitable for the true sperm candle, our readers will be enabled to judge of the almost unsurmountable difficulties which beset the present system of photometry.

But assuming that the true parliamentary sperm candle is obtained, made from the proper materials and burning at the specified rate, its illuminating power will be found to vary with the temperature of the place where it has been kept, the time which has elapsed since it was made, and the temperature of the room wherein the experiment is tried.

The Rev. W. R. Bowditch, in his work on *The Analysis, Purification, &c., of Coal-gas*, enters at some length into the question of test-candles, and emphatically condemns them as light-measurers; one experiment quoted by this author showed that the same gas was reported to be 14·63 or 17·36 candle gas, according to the way the experiment was conducted.

The present writer has taken some pains to devise a source of light which should be at the same time fairly uniform in its results, would not vary by keeping, and would be capable of accurate imitation at any time and in any part of the world by mere description. The absence of these conditions seems to be one of the greatest objections to the sperm candle. It would be impossible for an observer on the continent, ten or twenty years hence, from a written description of the sperm candle now employed, to make a standard which would bring his photometric results into relation with those obtained here. Without presuming to say positively that he has satisfactorily solved all difficulties, the writer believes that he has advanced some distance in the right direction, and pointed out the road for further improvement.

Before deciding upon a standard light, experiments were made to ascertain whether the electric current could be made available. Through a coil of platinum wire, so as to render it brightly incandescent, a powerful galvanic current was passed; and its strength was kept as constant as possible by a thick wire galvanometer and rheostat. To prevent the cooling action of air-currents, the incandescent coil was surrounded with glass; and it was hoped that by employing the same kind of battery and by varying the resistance so as to keep the galvanometer needle at the same deflection, uniform results could be obtained. In practice, however, it was found that many things interfered with the uniformity of the results, and the light being much feebler than it was advisable to work with, this plan was deemed not sufficiently promising, and it was abandoned. The method ultimately decided upon is the following:— Alcohol of sp. gr. 0·805, and pure benzol boiling at 81 C., are mixed together in the proportion of 5 volumes of the former and 1 of the latter. This burning fluid can be accurately imitated from description at any future time and in any country, and if a lamp could be devised equally simple and invariable, the light which it would yield would, it is presumed, be invariable. This difficulty the writer has attempted to overcome in the following manner.

A glass lamp is taken of about two ounces capacity, the aperture in the neck being 0·25 inch diameter; another aperture at the side allows the liquid fuel to be introduced; and by a well-known laboratory device, the level of the fluid in the lamp can be kept uniform. The wick-holder consists of a platinum tube 1·81 inches long and 0·125 inch internal diameter. The bottom of this is closed with a flat plug of platinum, apertures being left in the sides to allow free access of spirit. A small platinum cup 5 inches diameter and 1 inch deep is soldered round the outside of the tube 0·5 inch from the top, answering the threefold purpose of keeping the wick-holder at a proper height in the lamp, preventing evaporation of the liquid, and keeping out dust. The wick consists of 52 pieces of hard-drawn platinum wire, each 0·01 inch in diameter and 2 inches long, perfectly straight and tightly pushed down into the platinum holder until only 0·1 inch projects above the tube. The height of the burning fluid in the lamp must be sufficient to cover the bottom of the wick-holder: it answers best to keep it always at the uniform distance of 1·75 inches from the top of the platinum wick; a slight variation of level, however, has not been found to influence the light to an extent appreciable by our present means of photometry. The lamp with reservoir of spirit thus arranged, with the platinum wires parallel and their projecting ends level, a light is applied, and the flame instantly appears, forming a perfectly-shaped cone 1·25 inches in height, the point of maximum brilliancy being 0·56 inch from the top of the wick. The extremity of the flame is perfectly sharp, without any tendency to smoke; without flicker or movement of any kind, it burns when protected from currents of air at a uniform rate of 136 grains of liquid per hour. The temperature should be about 60° F., although moderate variations on either side exert no perceptible influence.

There is no doubt that this flame is very much more uniform than that of the sperm candle sold for photometric purposes. Tested against a candle, considerable variations in relative illuminating power have been observed; but on placing two of these lamps in opposition, no such variations have been detected. The same candle has been used, and the experiments have been repeated at wide intervals, using all usual precautions to ensure uniformity. The results are thus shown to be due to variations in the candle and not in the lamp.

It is expected that whoever may be inclined to adopt the kind of lamp here suggested will find not only that its uniformity may be relied upon, but that, by following accurately the description and dimensions here laid down, each observer will possess a lamp of equivalent and convertible photometric value; so that results may not only be strictly comparable between themselves, but, within slight limits of accuracy, comparable with those obtained by other experimentalists. The dimensions of wick, &c., here laid down are not intended to fix the standard. Persons engaged in photometry as an important branch of their regular occupation will be better able to fix these data than the writer, by whom photometry is only occasionally pursued as a means of scientific research. Already many improvements suggest themselves, and several causes of variation in the light have been noticed. Future experiments may point out how these sources of error are to be overcome; but at present there is no necessity to refine our source of standard light to a greater degree of accuracy than the photometric instrument admits of.

The instrument for measuring the relative intensities of the standard and other lights, next demands attention. The contrivances in ordinary use are so well known that a short sketch of the principles on which they are based need only be given. Most of them depend on a well-known law in optics, namely, that the amount of light which falls upon a given surface varies inversely as the square of the distance between the source of light and the object illuminated. The simplest observation which can be taken is made by placing two sources of light (say a candle and gas-lamp) opposite a white screen a few feet off, and placing a stick in front of them, so that two shadows of the stick may fall on the screen. The strongest light will cast the strongest shadow; and by moving this light away from the stick, keeping the shadows side by side, a position will at last be found at which the two shadows appear of equal strength. By measuring the distance of each light from the screen, and squaring it, the product will give the relative intensities of the two sources of light.

In practice, this plan is not sufficiently accurate to be used except for the roughest approximations; and from time to time several ingenious contrivances, all founded upon the same law, have been introduced by scientific men, by which a much greater accuracy is obtained; thus, in Ritchie's photometer the lights are reflected on to a piece of oiled paper in a box, and their distances are varied until the two halves of the paper are equally illuminated. In Bunsen's photometer, which is the one now generally used, the lights shine on opposite sides of a disc of white paper, part of which has been smeared with melted spermaceti to make it more transparent. When illuminated by a front light the greased portion of the paper will look dark; but if the observer goes to the other side of the paper, the greased part looks the lighter. If therefore lights of unequal intensity are placed on opposite sides of a piece of paper so prepared, a difference will be observed; but by moving one backwards or forwards, so as to equalize the intensity, the whole surface of the paper will appear uniformly illuminated on both sides. This photometer has been modified by many observers. By some the disc of paper is moved, the lights remaining stationary; by others the whole is enclosed in a box, and various contrivances are adopted to increase the sensitiveness of the eye and to facilitate calculation: but in all these the sensitiveness is not materially augmented, as the eye cannot judge of very minute differences of illumination approximating to equality.

In 1833 Arago described a photometer in which the phenomena of polarized light were employed. This instrument is fully described, with drawings, in the tenth volume of the *Œuvres Complètes de François Arago;* but the description, although voluminous, is far from clear. The principle of its construction is founded on "the law of the square of the cosines," according to which polarized rays pass from the ordinary to the extraordinary image. The knowledge of this law, he says, will not only prove theoretically important, but will further lead to the solution of a great number of very important astronomical questions. Suppose, for example, that it is wished to compare the luminous intensity of that portion of the moon directly illuminated by the solar rays with that of the part which receives only light reflected from the earth, called the *partie cendrée.* Were the law in question known, the way to proceed would be as follows:—after having polarized the moon's light, pass it through a doubly refracting crystal, so disposed that the rays, not being able to bifurcate, may entirely undergo ordinary refraction. A lens placed behind this crystal will therefore show but one image of our satellite; but as the crystal in rotating on its axis passes from its original position, the second image will appear, and its intensity will go on augmenting. The movement of the crystal must be arrested at the moment when, in this growing extraordinary image, the segment corresponding to the part of the moon illuminated by the sun, exhibits the intensity of the ashy part shown by the ordinary image. From these data it is easy to perceive, he says, that the problem is capable of solution.

In another part of the same volume, after speaking of the polariscope which goes by his name, Arago writes:—"I have now arrived at the general principle upon which my photometric method is entirely founded. The quantity (I do not say the proportion)—the quantity of completely polarized light, which forms part of a beam partially polarized by reflection, and the quantity of light polarized rectangularly which is contained in the beam transmitted under the same angle, are exactly equal to each other. The reflected beam and the beam transmitted under the same angle by a sheet of parallel glass, have in general very dissimilar intensities; if however we examine with a doubly refracting crystal, first the reflected and then the transmitted beam, the greatest difference of intensity between the ordinary and the extraordinary images will be the same in the two cases, because this difference is precisely equal to the quantity of polarized light which is mixed with the common light."

In Arago's astronomy, the author again describes his photometer in the following words: "I have constructed an apparatus by means of which, upon operating with the polarized image of a star, we can succeed in attenuating its intensity by degrees exactly calculable after a law which I have demonstrated." It is difficult to obtain an exact idea of this instrument from the description given; but from the drawings it would appear to be exceedingly complicated, and to be different in principle and construction from the one now about to be described. The present photometer has this in common with that of Arago as well as with those described in 1853 by Bernard,* and in 1854 by Babinet,† that the phenomena of polarized light are used for effecting the desired end. But it is believed that the present arrangement is quite new, and it certainly appears to answer the purpose in a way which leaves little to be desired. The instrument will be better understood if the principles on which it is based are first described.

FIG. 1.

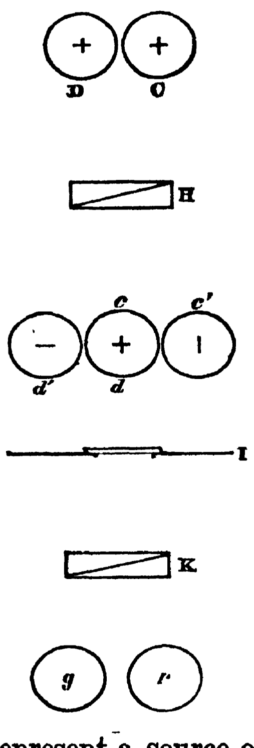


Fig. 1 shows a plan of the arrangement of parts, not drawn to scale, and only to be regarded as an outline sketch to assist in the comprehension of general principles. Let D represent a source of light. This may be a white disc of porcelain or paper illuminated by any artificial or natural light. C represents

* 'Comptes Rendus.' April 25, 1853.
† 'Proceedings of the British Association,' Liverpool Meeting, 1854.

a similar white disc likewise illuminated. It is required to compare the photometric intensities of D and C. (It is necessary that neither D nor C should contain any polarized light, but that the light coming from them, represented on each disc by the two lines at right angles to each other, forming a cross, should be entirely unpolarized.) Let H represent a double refracting achromatic prism of Iceland spar; this will resolve the disc D into two discs *d* and *d'*, polarized in opposite directions; the plane of *d* being, we will assume, vertical, and that of *d'* horizontal. The prism H will likewise give two images of the disc C; the image *c* being polarized horizontally, and *c'* vertically. The size of the discs D, C, and the separating power of the prism H are to be so arranged that the vertically polarized image *d*, and the horizontally polarized image *c*, exactly overlap each other, forming, as shown in the figure, one compound disc *c d*, built up of half the light from D and half that from C.

The measure of the amount of free polarization present in the disc *c d*, will give the relative photometric intensities of D and C.

The letter I represents a diaphragm with a circular hole in the centre, just large enough to allow the compound disc *c d* to be seen, but cutting off from view the side discs *c'*, *d'*. In front of the aperture in I is placed a piece of selenite of appropriate thickness for it to give a strongly-contrasting red and green image under the influence of polarized light. K is a doubly refracting prism, similar in all respects to H, placed at such a distance from the aperture in I that the two discs into which I appears to be split up are separated from each other, as at *g*, *r*. If the disc *c d* contains no polarized light, the images *g r* will be white, consisting of oppositely polarized rays of white light; but if there is a trace of polarized light in *c d*, the two discs *g r* will be coloured complimentarily; the contrast between the green and red being stronger in proportion to the quantity of polarized light in *c d*.

The action of this arrangement will be readily evident. Let it be supposed in the first place that the two sources of light, D and C, are exactly equal. They will each be divided by H into two discs, *d' d* and *c c'*, and the two polarized rays of which *c d* is compounded will also be absolutely equal in intensity, and will neutralize each other and form common light, no trace of free polarization being present. In this case the two discs of light *g r* will be colourless. Let it now be supposed that one source of light (D for instance) is stronger than the other (C). It follows that the two images *d' d* will be more luminous than the two images *c c'*, and that the vertically polarized ray *d* will be stronger than the horizontally polarized ray *c*. The compound disc *c d* will therefore shine with partially polarized light, the amount of polarization being in exact ratio with the photometric intensity of D over C. In this case the image of the selenite plate in front of the aperture I will be divided by K into a red and a green disc.

IG. 2.

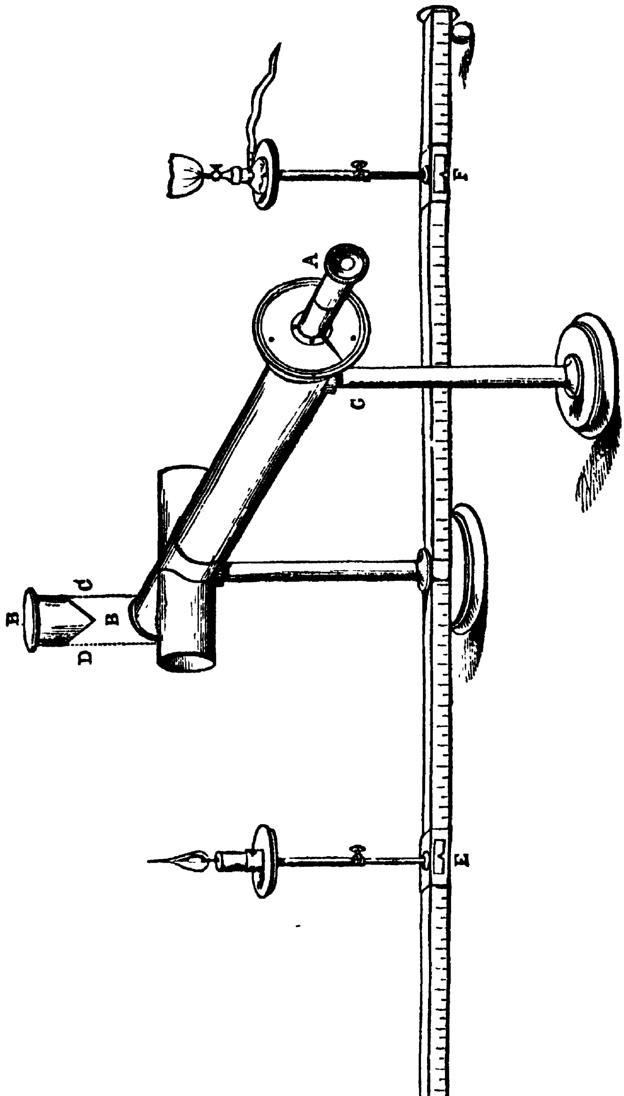
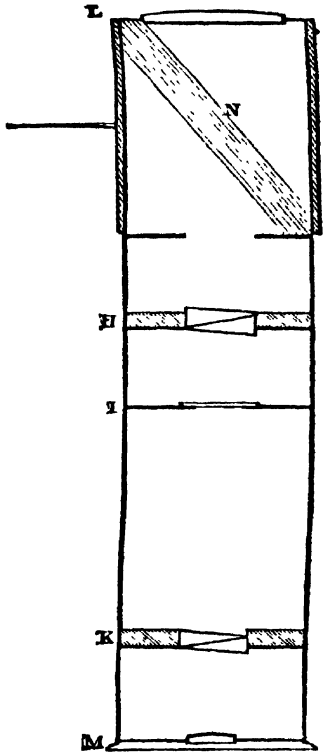


Fig. 2. shows the instrument fitted up. A is the eye-piece shown in enlarged section at Fig. 3. G B is a brass tube, blacked inside, having a piece, shown separate at D C, slipping into the end B. The sloping sides, D B, B C, are covered with a white reflect-

ing surface (white paper or finely-ground porcelain), so that when D C is pushed into the end B, one white surface D B may be illuminated (as in Fig. 2) by the candle, and the other surface B C by the lamp. If the eye-piece A is removed, the observer, looking down the tube G B, will see at the end a luminous white disc divided into two parts, one half being illuminated by the candle E, and the other half by the lamp F. By moving the candle E, for instance, along the scale, the illumination of the half D B can be varied at will, the illumination of the other half remaining stationary.

The eye-piece A (shown enlarged at Fig. 3) will be understood by reference to Fig. 1, the same letters representing similar parts. At L is a lens to collect the rays from D B C (Fig. 2), and throw the image into the proper part of the tube. At M is another lens, so adjusted as to give a sharp image of the two discs into which I is divided by the prism K. The part N is an adaptation of Arago's polarimeter, which consists of a series of thin plates of glass capable of moving round the axis of the tube, and furnished with a pointer and graduated arc (shown at A, G, Fig. 2). By means of this pile it is possible to partially polarize the rays coming from the illuminated discs in one or the other direction, and thus bring to the neutral state the partially polarized beam *c d*, (Fig. 1,) so as to get the images *g r* free from colour. It is so placed that when at the zero point it produces an equal effect on both discs.

FIG. 3.



The action of the instrument is as follows. The standard lamp being placed on one of the supporting pillars which slide along the graduated stem (Fig. 2), it is adjusted to the proper height, and moved along the bar to a convenient distance, depending on the intensity of the light to be measured: the whole length being a little over four feet, each light can be placed at a distance of twenty-four inches from the disc. The flame is then sheltered from currents of air by black screens placed round, and the light to be compared is fixed in a similar way on the other side of the instrument. The whole should be placed in a dark room, or surrounded with non-reflecting screens; and the eye must also be protected from direct rays from the two lights. On looking through the eye-piece two bright discs will be seen, probably of different colours. Supposing E represents the standard flame and F the light to be compared with it, the latter must now be slid along the scale until the two discs of light, seen through the eye-piece, are about equal in tint. It has been found most convenient not to attempt to get absolute equality in this manner, but to move the flame to the nearest inch on one side or the other of equality. The final adjustment is now effected at the eye-end, by turning the polarimeter one way or the other up to 45° until the images are seen without any trace of colour. This will be found more accurate than the plan of relying entirely on the alteration of the distance of the flame along the scale; and by a series of experimental adjustments, the value of every angle through which the bundle of plates is rotated can be ascertained once for all, when the future calculations will present no difficulty. Squaring the number of inches between the flames and the centre will give their approximate ratios; and the number of degrees the eye-piece rotates will give the number to be added or subtracted in order to obtain the necessary accuracy.

The delicacy of the instrument is very great. With two lamps, each about twenty-four inches from the centre, it is easy to distinguish a movement of one of them to the extent of $\frac{1}{10}$th of an inch to or fro; and by using the polarimeter an accuracy considerably exceeding that can be attained.

The employment of a photometer of this kind enables us to compare lights of different colours with one another, and leads to the solution of a problem which, from the nature of their construction, would be beyond the powers of the instruments in general use. So long as the observer, by the eye alone, has to compare the relative intensities of two surfaces respectively illuminated by the lights under trial, it is evident that unless they are of the same tint it is impossible to obtain that absolute equality of illumination in the instrument which is requisite for a comparison. By the unaided eye one cannot tell which is the brighter half of a paper disc illuminated on one side with a reddish and on the other with a yellowish light; but by using the above-described photometer the problem becomes practicable. For instance, on reference to Fig. 1, suppose the disc D were illuminated with light of a reddish colour and the disc C with greenish light, the polarized discs *d′ d* would be reddish and the discs *c c′* greenish, the central disc *c d* being of the tint formed by the union of the two shades. The analyzing prism K and the selenite disc T will detect free polarization in the disc *c d* if it be coloured as readily as if it were white; the only difference being that the two discs of light *g r* cannot be brought to a uniform *white* colour when the lights from D and C are equal in intensity, but will assume a tint similar to that of *c d*. When the contrasts of colour between D and C are very strong—when, for instance, one is bright green and the other scarlet—there is some difficulty in estimating the exact point of neutrality; but this only diminishes the accuracy of the comparison, and does not render it impossible, as it would be according to other systems.

No attempt has been made in these experiments to ascertain the exact value of the standard spirit-flame in terms of the parliamentary sperm candle. Difficulty was experienced in getting two lots of candles yielding light of equal intensities, and when their flames were compared between themselves and with the spirit-flame, variations of as much as 10 per cent. were sometimes observed in the light they gave. Two standard spirit-flames, on the other hand, seldom showed a variation of 1 per cent., and had they been more carefully made they would not have varied 0·1 per cent.

This plan of photometry is capable of far more accuracy than the present instrument will give. It can scarcely be expected that the first instrument of the kind, roughly made by an amateur workman, should possess equal sensitiveness with one in which all the parts have been skilfully made with special adaptation to the end in view.

CHRONICLES OF SCIENCE.

1. AGRICULTURE.

Beyond the ordinary labours of the field preceding and succeeding seed time, which have this year been carried on under favourable circumstances, the subjects principally occupying agricultural attention during the past quarter have been rather of a social, or even political, than of a practical and scientific nature; and they are the less proper for discussion, or even enumeration here. We may, however, refer to the condition of the agricultural labourer as one of them. It has been properly enough characterized as extremely unsatisfactory in many parts of the country, where the ignorance of the class is very great and their wages very low. Schools are, however, bearing fruit everywhere, and the proportion of country workmen who can read and write a letter, is every year increasing; and the wages received by them, though still various in different districts (indicating the strength of tie which still holds the labouring population to their parish), is less various than the mere money paid to them would lead one to suppose. There are many districts where the money wages are declared to be only 9*s.* or 10*s.*, or even less, a week, in which a man is better off than he would be in a town with 20*s.* to 25*s.* weekly. The real payment for services includes in the former case, cottage and garden, 5*l.* or 6*l.* for the harvest month, constant payment all the year, and the opportunity both of earning triple wages at occasional piecework and of buying cheap flour and fuel. In an instance known to us near Rochford, Essex, where the offer of a 5*l.* prize at length brought forth a properly vouched year's cash-account of the income and expenditure of an agricultural labourer who was receiving nominally 11*s.* a week, the actual receipts for the year exceeded 50*l.* Those who compare the nominal wages of the labourer in town and country, are thus contrasting things of entirely different character, and are in danger of misleading themselves and others. Good service will, nevertheless, we readily admit, be done by any one who shall set himself to help good working-men to improve their circumstances, by sending them from over-populated districts to places where labourers are more wanted, and wages accordingly are higher; and this has been done of late by the Rev. Canon Girdlestone, at Halberton, in Devonshire, to an extent which has at length excited public attention.

Returning now to our task as mere chroniclers of agricultural events, we have to mention Mr. Gülich's mode of potato growing, reported from Holstein, which has been designed with a view to escape the so-called potato disease. He grows his potato plants in hillocks, a yard apart every way, planting the tubers individually on earth over a spadeful of compost or manure in each spot, and taking care that each tuber is planted with the eye downwards. The shoots rise in a circle round the tuber, and in the course of their growth they are separated wider by additions of earth in the middle of this circle, and fall down into the intervening spaces whence the earth has been removed for this purpose. There is thus ultimately a set of hillocks of which the tops are bare and the base surrounded with foliage; and the idea is that the alleged freedom from disease which ensues must be owing to the blight fungus being washed downwards into the intervals between the plants, and away from the crop of young tubers which remain under the central hillock of bare earth.

The spring time of the year always brings round discussions of the injury done to farmers by fraud in the seed and the manure trades. It is alleged that the phrase "nett seed" is a common one among wholesale seedsmen, indicating that seed which is not "nett," and which therefore must be fraudulently mixed with dead and worthless additions, is also commonly delivered. There can be no doubt that the immense quantities of seed used in order to obtain an agricultural crop—often ten and twenty-fold the quantity which would, if all would grow, supply more than plants enough—can be explained only on the theory that a very large quantity of seed does not grow at all. Manures, in like manner, are the subject of fraudulent admixture; and sales by auction, professedly of damaged cargoes, often take-in the unwary who think to catch a bargain by cheap purchases of worthless stuff that is really dear at any price. Some service is done by repeatedly calling attention to the risks of this kind which the farmer runs; and we therefore mention the subject here.

The theory of the under-drainage of land has recently received some discussion in the agricultural journals. The policy of leaving the upper ends of pipe-drains open to the air has been defended on the ground that it facilitates the passage of water through the pipe. The idea seems to us an entire mistake. The sole agency in the drainage of land is the weight of the water in the soil, which ensures its passage downwards and outwards, as soon as any channel of escape for it is opened. If the soil be air-tight, so that an air-passage is required to the underground pipe at the upper end of it, still more must it be water-tight, and then, of course, incapable of being drained at all. But no soil is in such a plight as this. It only needs that a channel be cut three or four feet deep in any soil, and any water that is in it will begin to ooze and trickle through it, and thus establish that movement of the rain-water from the surface through the substance of the soil and subsoil which brings all the circumstances of increased fertility in its train.

Among the events of the quarter having an indirect bearing on agricultural subjects, we may mention that the University of Edinburgh has issued a programme of examinations in various branches of applied science, under which students may receive diplomas as Bachelor and Master of Agriculture. There can be no doubt that a successful passage, thus guaranteed, through well-conducted examinations on all the subjects with which a man must be familiar to mark him out as a thoroughly well-educated agriculturist, will ultimately materially affect the future professional career of individual agricultural students; and in this way it will benefit agriculture and agriculturists generally. Professor John Wilson, of the Edinburgh University, has done good service to the cause of general agricultural progress by obtaining at the hands of so distinguished an educational body this recognition of agriculture as one of the professions for which a liberal education is desirable.

We add that the subject of the beet-sugar manufacture and of the sugar-beet cultivation has continued to engage attention. Mr. Gibbs, of Gilwell Park, near Woodford, lately read a paper before the Society of Arts, advocating the use of his drying-engine for the reduction of crop-weight in the field, and the consequent reduction of the expense of carriage, which more than anything else tends to discourage the establishment of local sugar factories. And Mr. Baruchson, of Liverpool, has published a most exhaustive treatise on the agricultural, manufacturing, and commercial aspects of the subject, which ought to be read by every one who is disposed to introduce the cultivation of the sugar-beet upon his farm.

2. ARCHÆOLOGY AND ETHNOLOGY.

The interest attaching to bone-caves yielding remains of man and works of art is still kept at a high pitch by new discoveries. During the past quarter a most interesting account of some explorations in Portuguese bone-caves* has reached us; and we thus obtain evidence that in the district of Cesareda man once existed in so uncivilized a condition that he lived in caves, ate human flesh, and possessed chipped flints for his only weapons. M. Delgado describes three caves in the Jurassic limestone of Cesareda, all of which he has thoroughly explored. In one (the Casa da Moura) he obtained

* Da existencia do Homen no nosso solo em Tempos mui remotos provada pelo estudos das cavernas. Primeiro opusculo. Noticia ácerca das Grutas da Cesareda. Por J. F. D. Delgado.

evidence of the existence of two deposits, a lower, resting on the stalagmite floor, composed of sand and angular fragments of the surrounding rock; and an upper, composed of a sandy loam. The lower one yielded many flint implements and fragments of charcoal, with bones of *Felis*, *Canis*, *Cervus*, *Lupus*, &c. In its deepest part the author found a hr ıan skull and lower jaw, but these he regards as having been buried at a subsequent period. The upper deposit contained a large number of fragmentary human bones, and numerous polished stone celts, flint flakes, bone instruments, &c., and a bronze arrow-head in its lowest part, which had probably been buried there. The fragmentary condition of the human bones, which had been cut and scraped, the long bones having also been split, appears to show that the author is right in regarding the cave as a burial-place of a tribe of cannibals. Bones of the wolf, fox, a dog, horse, deer, sheep, &c., coarse pottery marked with lines or rows of dots, shells pierced for ornaments, and other objects, were also found. The other caves yielded remains similar to those obtained from this upper deposit, one of them yielding in addition a portion of the lower jar of *Ursus arctos*. If the author's determination of this relic be accurate, it is the most important animal remain which these caves have as yet yielded.

While on the subject of bone-caves we should notice the publication of the fifth part of the 'Reliquiæ Aquitanicæ.' It contains the conclusion of Professor Rupert Jones's geological sketch of the Vézère, figures and descriptions of a number of flint implements, and a most interesting essay by Mr. A. C. Anderson, "On the Resemblance of many of the Dordogne Works of Art to the Implements used by the North American Tribes, either now or at some former period." This resemblance is in many instances very striking, and suggests two questions for consideration, namely: (1), Are the uses for which the implements were made the same, or analogous, in both cases? and (2), Does the resemblance imply any affinity between the tribes? The first question will probably receive an affirmative reply from almost any antiquary; but the answers to the second would probably show great diversity of opinion. We shall only quote a sentence from Mr. Anderson, as an indication of one class of opinions:—"I believe that, under similar circumstances and conditions of things, isolated branches of the human race will arrive, in simple matters of domestic or offensive art, at nearly similar conclusions, each independently of the other."

Dr. Geinitz has given a useful summary of the objects exhibited in the Paris Exhibition of last year in relation to the Antiquity of Man, in the second number of the 'Neues Jahrbuch' for this year. The reported occurrence of traces of human work in Miocene deposits is not regarded by him as having been yet proved to the satisfaction of critical antiquaries and naturalists.

This question of the Miocene age of the human species was discussed before the Académie des Sciences on April 20th, when MM. Garrigou and Filhol requested the opening of a sealed packet which had been deposited with the Academy by them on May 16, 1864. From this it appears that at that date their observations made in the deposits of Sansan led them to regard the Miocene age of man as extremely probable. The evidence on which they relied consisted of bones split longitudinally, as they are frequently found in caverns, having been thus broken by man for the purpose of extracting the marrow. The evidence is slender; hence, in all probability, their timidity in not publishing their views four years ago; but now that other evidence, more or less questionable, pointing in the same direction, has been discovered, they have naturally regarded their own observations as equally worthy of publicity

In the last volume of the 'Proceedings' of the Asiatic Society of Bengal we notice a paper on the Ethnology of India, by Dr. J. B. Davis, in which that author strives to show that philology is not so sure a guide in Ethnology as craniology; consequently he is led to object to the Aryan hypothesis. "If Europeans and Hindoos be of the same family, why cannot the former migrate to and live in India? How is it that the people of India are celebrated for the smallness of their heads, while the inhabitants of Europe have large heads?" Again, he remarks that it is admitted that the Syro-Arabian division of mankind is physically identical with the Aryan section; still the two cannot be allied, because the languages of the two families utterly sunder them." In all probability, as Mr. Blanford remarked at the reading of the paper, a natural classification must be arrived at by the aid of a number of characters, as in Botany. Dr. Davis also objects to the hypothesis of the unity of the human race, regarding our species as, "in the main, an aggregate of families formed by the hand of the Creator, in every different locality in which it is found, and each constituted by that wise Providence for the climate and productions with which it is surrounded."

We also notice a series of admirable notes on the occurrence of chipped flakes of agate, quartzite, flint, &c., in India, followed by a table in which all the information on the subject is shown at once. The implements are divided into the three following classes:—

A. Cores and flakes of agate, flint, &c.

B. Chipped axes, &c., chiefly of quartzite.

C. Polished 'celts' of trap, chert, jade, &c.

These objects are extensively distributed, not only in India itself, but also in some of the islands of the Indian Ocean.

With respect to the antiquity of man in India, Mr. W. T. Blanford expresses his belief that there is evidence of the existence of man in India at a much earlier period than in Europe. Unfortunately the "evidence" consists of but one flake found *in situ* in the Godavery gravels by Mr. Wynne. Now the fauna of the Godavery gravels consists of animals having European or African affinities, while the recent fauna has Malay relations; therefore they differ much more widely than the Pleistocene animals of Europe do from those now existing on the continent. If, therefore, we accept the flake found by Mr. Wynne as conclusive of the existence of man in India during the deposition of the Godavery gravels, this conclusion as to the relative antiquity of the periods, though a little crude, is legitimate enough.

We should mention that, in addition to Mr. Blanford, the following gentlemen have contributed their notes to this highly interesting series, Mr. King, Mr. Wilson, and Mr. Ball.

A second supplement to the 'Recueil d'Antiquités Suisses' was published last year by the Baron de Bonstetten, and contains sixteen large folio plates of the objects recently discovered, with a few remarks in explanation of them. The list embraces almost every description of object, from implements of the Stone age found in the lake-dwelling of Greng (lake of Morat) to mosaic pavements and various relics of still later date.

In a letter to M. Lartêt, published in the 'Bibliothèque Universelle' for March, M. Favre has recorded the discovery of a human station of the Stone age, in which remains of the Reindeer have been found, in a small elevation (monticule) at Veirier, at the foot of Mont Salève, not far from Geneva. Hitherto remains of the Reindeer have been found in the terrace-alluvium in but five localities in Switzerland, namely, at three places on the Lake of Geneva, at Meilen on the borders of the Lake of Zurich, and at Windisch on the Reuss. With the Reindeer occur remains of the Horse, Ox, *Cervus elaphus*, *Lepus variabilis*, *L. cuniculus*, the Marmot, *Meles taxus*, the Ptarmigan, the Sheep or the Bouquetin, human bones (fragments of skull, &c.), small worked flints, and various other examples of human workmanship. These remains were found at a height of 42 mètres above the present level of the river Arve, and it seems clear that since the glacial period the water of the river has reached to a height of 38 or 40 mètres above its present level. M. Favre believes that the mound was inhabited by man when the water of the river was at a higher level than it now attains, though probably not when it was at its highest; and M. Lartêt expresses his opinion, in a reply to M. Favre, that the Reindeer period is probably not of the same age, but somewhat more ancient, in southern Europe than in more northern latitudes, the animal having migrated northwards.

The 'Report of the Proceedings of the Geological and Polytechnic Society of the West Riding of Yorkshire' contains a very readable and interesting paper by the Rev. Canon Greenwell, "On the Inhabitants of Yorkshire in Pre-Roman Times," which is chiefly occupied with a description of the manners and customs of "the ancient Briton," so far as they can be inferred from the implements, ornaments, tombs, monuments, &c., which the researches of archæologists have brought to light.

The same volume contains a description of a Romano-British mosaic pavement, representing Romulus and Remus, discovered at Aldborough (Isurium of the Romans), by Mr. Henry Ecroyd Smith.

The 'Reliquary' for April contains a short note by Mr F. C. Lukis, reminding us that the now well-known Stone Celt and Flint Arrow-head were formerly regarded in the north with considerable superstition, the latter being known as the Elf-Shot, while the larger examples were designated Elfin Darts. As usually happens in such cases, the same objects which in one district are highly prized as preventive of evil, are in others shunned as producers of misfortune.

Mr. Peacock gives an account, in the same number, of the opening of a Celtic grave-mound, at Cleatham, Lincolnshire; and the editor, Mr. Llewellynn Jewitt, gives a description and figures of the urns. The excavation has been chiefly interesting as showing the manner in which these barrows were made. "When a section of the hill was made, it became quite evident that the whole of this large hill had been carried where it was in baskets. Each basket-load was distinctly visible." Mr. Peacock remarks that, although antiquaries have long known that this must have been the mode of accumulation, "this is, perhaps, the first instance where ocular demonstration of the fact has been given."

Mr. T. M'Kenny Hughes has commenced in the 'Geological and Natural History Repertory and Journal of Pre-historic Archæology and Ethnology' for May, a useful paper on flint implements, in which he endeavours to define the distinctions between the natural forms of flints and those which have been produced artificially. Premising that the natural forms of flint are derived, 1st, from the original formation of flint in the chalk; 2nd, from fracture; and 3rd, from weathering; the author describes the nature of these natural appearances, and insists on the truth of Mr. Evans's canon, that the only kind of evidence of the human origin of manufactured forms which can be admitted is that of design shown in various ways. This paper will be specially useful as containing a descriptive catalogue of a collection of implements in the Museum of Practical Geology, Jermyn Street, classified in series to illustrate the several categories to which various implements may be assigned.

In the same number the editor, Mr. Mackie, describes and figures a very singular chipped flint in the shape of a flattened sphere, which was found at Willesden by Mr. Caspar Clarke. Unfortunately, the circumstances under which it occurred are not stated. Its use Mr. Mackie is uncertain about. From the drawings we should infer that it might have made a tolerable hammer.

The 'Anthropological Review' for April contains nothing that demands notice from us except a partial report of the proceedings of the Congress of Pre-historic Archæology which was held at Paris last year. Certain questions were proposed for open discussion; but of course we cannot give in this Chronicle even an outline of the facts and opinions advanced in illustration of them. With respect to caverns, however, we learn from the 'Anthropological Review' that it was agreed that they should be divided into three classes, namely, (1) those which contain the Quaternary fauna, now utterly extinct; (2) those in which the Reindeer assumes a large development; and (3) the caverns which contain only the animals now found in the country, many of which had been no doubt domesticated. We also learn that it was generally admitted that cannibalism was practised in pre-historic times down to the period of polished stone. Other questions related to the antiquity of man, the megalithic monuments and their builders, the Bronze age, the Iron age, and the anatomical characters of Pre-historic man. On the last question, apart from minor differences of opinion, there was some amount of agreement that there were two races of Pre-historic men, one brachycephalic and the other dolicocephalic. M. Pruner-Bey, however, preferred describing the former as characterized by a lozenge-shaped face and the latter by an oval-shaped face.

This year the Congress will be held at Norwich, commencing on August 20th, under the presidency of Sir John Lubbock, Bart., F.R.S.

3. ASTRONOMY.

(Including the Proceedings of the Royal Astronomical Society.)

The re-discovery of Brorsen's comet is the most interesting astronomical occurrence of the past quarter. This comet must not be confounded with another—also called Brorsen's comet—which revolves in a much more extended orbit. The comet just discovered belongs to that remarkable family of comets of which Biela's, De Vico's, and other objects are members. All the comets of this family—in other words, all the comets of short period—have the aphelia of their orbits pretty close to the orbit of Jupiter. It seems probable that the introduction of these comets within the solar system—or at least to their present position in that system—is due to the action of this great planet. This is certainly the case with Brorsen's comet; since D'Arrest has shown that before 1842 it had been moving in an orbit of very different figure. In that year it passed very near to Jupiter, and was compelled by his attractive influence to travel in its present orbit. Discovered in 1846, the comet was missed at the perihelion passage of 1851, seen in 1857, again missed in 1862, and re-discovered, by three observers almost simultaneously, in April of the present year. It will travel across the southernmost parts of the constellations Ursa Major and Bootes, remaining throughout invisible to the naked eye.

Mr. Huggins has subjected Brorsen's comet to spectroscopic analysis. The results are exceedingly interesting. It will be remembered that two former comets, examined by Mr. Huggins, exhibited, so far as the light of their *nuclei* was concerned, spectra closely resembling those of the gaseous nebulæ. Their *comæ* appeared to shine by reflected light. The spectrum of the present comet is very different. It consists of three bright bands, somewhat resembling those seen by Donati in the spectrum of the comet which bears his name. The length of the bands shows that they are not due to the steller nucleus of the comet alone, but are produced by the light of the coma, or at least of its brighter portions. In one of the bands Mr. Huggins could occasionally detect two bright lines, shorter than the band, and therefore presumably due to the nucleus alone. This view of their origin was confirmed by the circumstances that they were not visible when the middle of the comet was not upon the slit, whereas the nebulous band on which they were projected continued visible so long as any part of the comet except its extreme margin was upon the slit. A very faint continuous spectrum was also visible. The brightest band was found to lie nearly in the same position as the brightest line of the nebulæ, which is coincident with the double line in the spectrum of nitrogen.

It appears, then, that Brorsen's comet resembles the two others (and probably Donati's) in this respect, that the nucleus and part of the coma shine by their own light. But whereas only the brightest part of the comæ of the two other comets shone by their own light, it appears that nearly the whole of the coma of Brorsen's comet is self-luminous.

We have to record a most interesting application of spectroscopic analysis to a different subject of astronomical research. It is well known that what is called the proper motion of the stars, or their apparent change of place on the sidereal concave, is in reality only a portion of their true motion—the *transverse* portion. The other part—or the motion of a star directly towards or from the eye—produces no effects perceptible by the telescope. It would require thousands of years before any motion of this sort could produce an appreciable change in a star's apparent brilliancy; but by a subtle application of spectroscopic analysis, Mr. Huggins has led the way in a process of research which promises to afford us information respecting this part of the stellar motions. The law on which the inquiry proceeds may be thus illustrated:—If we imagine a powerful swimmer to urge his way rapidly against a series of advancing waves, it is evident that they will pass him more rapidly —in other words, they will seem narrower—than if he were at rest; on the contrary, if he urged his way in the same direction as the waves, they would appear broader than they really are. Since the light of the stars reaches us in a succession of minute waves, it is clear that if we are approaching a star or receding from it, whether through the earth's motion or that of the star, the light waves will appear modified in length—in other words, the light's refrangibility will be altered. Thus the lines in the star's spectrum will be altered in position, and will no longer coincide with the corresponding lines in the spectra of terrestrial substances. Our space will not permit us to enter into an account of the methods which have been devised to enable spectroscopic analysis to deal with this very delicate research. At present we must content ourselves with exhibiting the two principal results of Mr. Huggins's labours. He has succeeded in showing that the nebulæ are not approaching the earth or receding from it at a rate which is appreciable by his instruments; but he finds that the bright star Sirius—the only fixed star which he has yet had time to examine satisfactorily—is approaching the solar system at the rate of nearly 29½ miles per second.

Mr. Huggins has re-examined the spectra of several nebulæ. He finds that when the intensity of the spectrum of nitrogen is diminished by removing the induction spark in nitrogen to a sufficient distance, the whole spectrum disappears except the double line, which agrees in position with the bright line in the nebulæ. "It is obvious," he adds, "that if the spectrum of hydrogen were greatly reduced in intensity, the strong line in the blue, which corresponds to one of the lines of the nebular spectrum, would remain visible after the line in the red, and the lines more refrangible than F had become too feeble to affect the eye." We shall see presently that this view has been confirmed by an experiment made by Father Secchi. There seems reason for supposing that the light of the gaseous nebulæ is emitted by nitrogen and hydrogen.

Mr. Huggins has also been able to confirm the observations made by Mr. Lockyer on the spectra of the umbræ and penumbræ of solar spots, and to obtain some new results of interest. He found that most of the dark lines of the solar spectrum were wider in the spectrum of the umbræ. The lines F and C due to hydrogen were not stronger, however. No new lines were detected, nor were any of the lines of the normal solar spectrum wanting in the spectrum of the umbra.

We hear that Mr. Lockyer is about to renew his observations of the solar spots with a spectroscope specially prepared for the purpose by Mr. Browning.

The last-named gentleman is also preparing a powerful spectroscope for use with the great Parsonstown reflector. The Earl of Rosse, following worthily in the footsteps of his father, is about to apply the unrivalled light-gathering powers of this instrument to the spectroscopic analysis of objects too faint to be reached by smaller telescopes. Clockwork is to be so applied to the great telescope, so that it will follow stars and nebulæ as closely as a smaller equatorial would.

Our readers will be glad to hear that the instruments supplied by the Royal Society to the expedition under Lieutenant John Herschel have already been applied to useful work—six nebulæ in the southern hemisphere have been examined with the spectroscope. The great nebula in Argo is found to exhibit a spectrum of bright lines, so that, like its rival in splendour the great Orion nebula, this object is gaseous.

The great eclipse of August 17th will be well watched. Besides the expeditions sent out under Lieutenant Herschel and Major Tennant, there is to be one under the charge of Mr. Pogson, the Government astronomer at Madras; another has been sent out by France under M. Jansen; the Papal government sends out Father Secchi, and there is also to be a Prussian expedition. Mr. Huggins has sent out to Mr. Pogson a spectroscope and apparatus for observing polarization.

The Minister of Public Instruction in France has lately submitted to the Council of State the draft of a decree for the complete reorganization of the Imperial Observatory at Paris. It is stated that this establishment will be removed from its present site, which is very unfavourable for astronomical observation, owing to the vibration of the building caused by passing vehicles. The air also in the neighbourhood of the Observatory is so heavily loaded with smoke and vapour as to interfere with many of the delicate observations which have to be made by astronomers of the present day. We learn that owing to these causes it is impossible to apply a higher power than 500 to the great equatorial. It is proposed to remove the Observatory to Fontenoy-aux-Roses, south-west of Paris.

The planet Venus is now very favourably situated for observation. She has been seen several times in full day-light. Mr. Browning has observed several faint markings on the planet, resembling the grey plains on the moon. "These markings seem to be studded with white spots of various sizes." It is a pity that modern astronomers do not make an effort to learn something respecting the axial position of Venus. Large achromatics do not seem well suited to this work, on account of the extreme brilliancy of Venus.

Reflectors used with a solar eye-piece containing a simple surface-reflecting prism, seem to give the most satisfactory views.

The ninety-eighth asteriod was discovered by Mr. Peters, at Clinton, on April 18th last; it is of the twelfth magnitude.

The lunar crater Linné continues to be a subject of dispute in the astronomical world: the opinion is gaining ground that there has been no change in the crater, but that, owing to the peculiar character of the moon's surface in this neighbourhood, very slight variations in the illumination serve to produce marked variations in the appearance of the crater. At a late meeting of the Astronomical Society, Captain Noble stated that a "few hours sufficed to change a distinct ring into a *smudge*."

Saturn is now an interesting object of observation, though his southern declination is unfavourable to distinctness. His rings are well open, the outer edge very nearly coincident (in appearance) with the outline of the ball. It is to be hoped that something may be learned respecting the structure of the rings during the present and the next two oppositions, as some fourteen or fifteen years will elapse before the rings are again opened to their full extent.

Proceedings of the Royal Astronomical Society.

M. Hoek, director of the Observatory of Utrecht, remarks on the small distance which separates the intersection of the orbits of comets III. and V., 1857, from the point which he has assigned as the radiant point of cometary orbits. Comet III., 1867, unexpectedly confirms his views, since, as we have mentioned in a former Chronicle, the circle which is the intersection of its orbit-plane with the celestial sphere passes through almost the same point of the sky. Thus, he adds, "the last ten years have furnished us with two Cometary systems, each composed of three members; first, that of the years 1860 and 1863, then that of the years 1857 and 1867. It appears that it would be to mistake the principles of the theory of probabilities, if we attributed all these coincidences to mere chance."

He supplies also an elaborate memoir on the phenomena which a very extended swarm of meteors, coming from space, would present after its entry into the solar system. He takes the case of a swarm of corpuscles coming from the stellar spaces, and sufficiently extended to embrace the whole earth. It would be impossible in the space available to us to give even a sketch of the processes applied by M. Hoek, which occupy no less than eighteen pages of calculation. Some of the results at which he arrives agree closely with those lately published by M. Schiaparelli, in a memoir entitled "Note e Riflessioni intorno alla Teoria Astronomica delle stelle cadenti." M. Hoek finds that under certain circumstances, the earth's attraction may have the effect of shifting the radiant point more than 17°. In future therefore it will be necessary to note the hour and the minute of each observation made on a falling star.

Sir John Herschel has been engaged, since he sent to the Astronomical Society his synoptic catalogue of stars observed by Sir William Herschel, in forming a general digest of all the recorded measures of all known double stars—a task which "he hopes to leave in such a state of forwardness as will ensure its completion by some other hand." While engaged on this task, he has been led by the coincidence, or near coincidence, of the measures taken by Sir William with those of stars observed by others, to the identification, more or less probable, of a considerable number of these stars with those subsequently measured. He supplies a list of the objects in question, judging "that information of this kind cannot but prove interesting to observers engaged in the measurement of double stars." In the progress of the work he has been led to the detection of a somewhat formidable list of errata in the printed catalogue. We should recommend those who possess or make use of the catalogue to pay attention to these errata, some of which are important, and, if uncorrected, likely to cause the observer considerable waste of time.

Mr. Key supplies an interesting paper on the planetary nebula 45 ♊ Geminorum. This nebula was discovered by Sir W. Herschel in 1787, and is described by him as "a star of the ninth magnitude, with a pretty bright nebulosity equally dispersed all round." The younger Herschel describes it as "a star of the eighth magnitude, exactly in the centre of an exactly round bright hemisphere 25″ in diameter." Lord Rosse gives an account of the same object in the 'Philosophical Transactions,' 1850. He saw it as a nebulous star with a black patch close to it on the preceding side, a less luminous space somewhat unequal in breadth surrounding the nucleus, and a luminous ring at some distance; this ring being of less breadth on the following side. Mr. Lassell's drawing of the object, in 1862, represents a star in the centre of a planetary disc, surrounded by a non-luminous space, and, at some distance, by a luminous ring of considerable breadth. He adds that "he can see no trace of the dark patch of Lord Rosse's drawing near the bright centre." Mr. Key, using an 18-inch silvered-glass reflector 10 feet in focal length (of his own make), finds the present appearance of the object to be different. It appears as a bright but somewhat nebulous star, closely surrounded by a dark ring; this again is surrounded by a luminous ring; then comes an interval much less luminous, and finally, at some distance, an exterior luminous ring. The whole is almost exactly symmetrical, though not quite so; the dark space between the two bright rings being darker on the north following side, and the preceding side of the whole object is rather fainter than the rest. Of the two luminous rings the inner is considerably the brighter.

Mr. Key considers that there is a progressive character in the results above recorded, since the various aspects of the nebula do not appear to depend on the power employed. His own reflector is somewhat more powerful than the Herschelian 20-feet reflector, but is of incomparably inferior power to the instruments of Lord Rosse and Mr. Lassell. "One fact," he adds, "seems, at all events, abundantly evident, *viz.* that whereas at the date of the Herschels' observation, there was no appearance whatever of a ring surrounding the central star, at the present time there are two."

Mr. Simms supplies a description of a zenith telescope employed in America, and explains a method of determining the latitude which has been for several years adopted by the United States coast surveyors, and which has the advantage of being at once simple and exceedingly accurate. The instrument is further described, and figured in a later number of the Society's notices, in a paper by Mr. Davidson, of Germantown, Pennsylvania. The method of observation, known as Talcott's, is worth studying:— "Two stars are selected, one of which passes the meridian to the north, and the other at nearly the same distance to the south of the zenith. The telescope is brought into the plane of the meridian, and set for the star which first passes the meridian; when visible it is bisected by the micrometer wire, the tangent screw of the instrument being used. The telescope is then turned 180° in azimuth, and when the second star makes its appearance, should there be any difference in the zenith distances, this distance is measured by the micrometer screw." The latitude is readily deduced. For example, suppose the polar distances of the two stars are D and D′ (D less than D′), and that the former star, when on the meridian, has a zenith distance less than the corresponding zenith distance of the other by a small arc d; then a star, whose polar distance was D − d, would cross the meridian at exactly the same altitude towards the north, as the star whose polar distance is D′ has towards the south. Hence the polar distance of the zenith of the place of observation, that is, the complement of the latitude, is $\frac{1}{2}(\overline{D-d} + D')$. Mr. Davidson says that, after twenty-two years' experience in using prime vertical transits, vertical circles, and Airy's zenith sector, he can affirm confidently that the zenith sector of the coast survey, used as above described, is far better than any of them.

Father Secchi supplies an interesting paper on the great nebula in Orion. He has also sent to the Astronomical Society a drawing of the nebula, commenced several years ago, and finished last year by combined observations made by himself and Father Ferrani, his assistant. One point in Father Secchi's paper will excite surprise. He states that the nebula is much better seen in moonlight than on dark nights. He considers that this is a consequence of that optical principle, that the difference of two lights is more easily appreciated when they are weak than when both are strong. He finds that, as Mr. Huggins had anticipated, the spectrum of hydrogen may be made, by sufficiently diminishing the light, to present the middle line only, which is that visible in the nebula.

Mr. Stone supplies a valuable paper on the rejection of discordant observations. His theory is that the rejection of such observations cannot be made except upon a direct admission of carelessness on the part of the observer; and he shows how the amount of error which justifies a rejection is to be calculated from an estimate of the average number of mistakes made by the observer in a given number of observations.

Mr. Chambers supplies a catalogue of binary stars formed (in the main) by reducing to the year 1870 the stars in the excellent catalogue presented by Mr. A. Brothers, to the Manchester Literary and Philosophical Society.

Mr. Proctor puts forward a proposal for a new star-atlas. The advantages of the plan appear to be the following:—The stars would be presented in a moderate number (12) of maps, uniform in size, shape, and mode of projection; with scarcely appreciable distortion and scale-variation; not too large for convenient use (about 12 inches in diameter), and yet on the sufficiently large scale of an 18-inch globe. The twelve maps would correspond to the twelve pentagonal maps of his gnomonic set, but being made circular and thus overlapping, the connection between the different maps would be conveniently exhibited.

We must leave to our next number the review of several interesting papers which appear in the latest number of the Society's Proceedings. The issue of this number having been delayed for the completion of a lithograph, illustrating Mr. Abbott's paper on certain variations in the nebula surrounding η Argûs, we have received the number too late for discussion here. But we are glad to notice that there now occurs less delay than took place some few months ago in the issue of the Society's notices.

4. BOTANY AND VEGETABLE PHYSIOLOGY.

Green Rotten Wood.—We have received the following from Mr. H. C. Sorby, F.R.S.:—"In the last number of your Journal (p. 222) you call attention to the colour of green rotten wood, and ask whether it has any relation to the Phycocyan of Cohn. I have examined it carefully, and find it is quite distinct from that or any other colouring matter with which I am acquainted. The chief constituent is a green-blue colour, insoluble in water and only sparingly soluble in alcohol or benzole, and not fluorescent; whereas Phycocyan is soluble in water and very fluorescent. The spectra are also quite different. It gives merely one absorption band very near the extreme red; whilst Phycocyan gives two, both much farther from the red end. In its general characters it is related to chlorophyll, but is quite distinct from it. The wood also contains two yellow colours, which make it more green; and also a substance of a claret colour, which seems to make it somewhat dull. This claret colour is insoluble in water, but much more soluble in alcohol than the green-blue; and is quite different from any other substance which has come under my notice. On the whole, both these colours are very interesting, since they belong to classes of colouring matters which are so rare that I only know one or two other examples out of some hundreds which I have examined and classified."

Nature of "Leaves" of Sciadopitys.—At p. 124 of the 'Report of Proceedings' of the Botanical Congress in 1866, Professor Dickson pointed out that the linear leaf-like bodies in *S. verticillata* were homologous with branches, and analagous to the phylloid shoots in Ruscus, Phyllocladus, &c. His views have been confirmed by the observations of M. Carrière, published in the 'Revue Horticole,' who has seen them bearing buds, and also branched and whorled.

Stamens of Cochliostema.—Dr. Masters has described in the 'Gardener's Chronicle' the structure of the androecium in a species (*C. Jacobinianum*, Koch and Linden) of this hitherto misunderstood genus of Commelynaceæ. On removing the leaves of the perianth, in front of the flower appear two lateral linear purple organs densely clothed with fringe-like hairs; these are considered staminodes, or abortive stamens. The perfect stamens present a very unusual appearance. A single organ arises from the posterior part of the flower, and attached to its base behind is a dense tuft of yellow hairs. The organ consists below of a flat stalk, but above of two petal-like convolute horns with long terminal points. This was formerly considered a single stamen, but is now seen to be three combined. The anthers are entirely enclosed in the cavity of the organ, and are three in number; two being vertical, attached by slender filaments to near the inner edge of the petal-like process; and the third horizontal, below the other two, its filament bent downwards: at the back of the organ, at a point corresponding to the attachment of this anther, is an oval disk surrounded by a few irregular processes. The anthers are twisted into a spiral, and dehisce by a line which follows all the curves. The theoretical nature of this androecium is considered by Dr. Masters to be nine stamens in three rows (or, if the staminodes be considered petals, six in two rows). The outer row is barren, consisting of the two lateral purple organs and the tuft of yellow hairs; of the stamens of the middle row, only the posterior two are developed, their anthers being the two vertical ones, and part of their filaments dilated into the petal-like horns; of the inner whorl only the posterior is developed as the horizontal anther.

Seeds of Juncus and Luzula.—In the 'Botanische Zeitung' is a paper by Dr. F. Buchenau, of Bremen, "On the Sculpture-markings of the Testa of the Seeds in the German Species of these Genera." An English translation appears in Seemann's 'Journal of Botany' for May. Certain points of difference connected with the seeds have long been used as sectional characters in both genera; but the peculiar mouldings of the external seed-coat do not seem to have been systematically examined by any botanist before Dr. Buchenau. At his suggestion, however, Dr. Engelmann of St. Louis looked at this point in the North American species of Juncus, and in his recently published "revision" of them * has founded three sections on the characters presented. In the present paper, Dr. Buchenau, though taking exception to some of Dr. Engelmann's terms, generally adopts his divisions. The characters of the testa of 31 species of Juncus are given as seen under a power of 50 diameters in *dried herbarium specimens* of *perfectly ripe* seeds. It appears that the testa is either *costate, i.e.* marked with prominent longitudinal ribs, connected only by few and inconspicuous ones, or *reticulate,* of which there are two kinds. In one the costæ are still prominent, but connected by equally prominent transverse ridges, in the other the costæ are inconspicuous and wavy or angular, whilst the transverse ribs appear very prominently (called *transtilla*); in both cases reticulations are formed, and are often marked with more delicate lines (*lineolæ*). The characters are said to be constant.

In Luzula there is less variety, the testa being reticulate in a more or less regular or longitudinal manner in all the species (12) examined.

Seedless Raisins.—Mr. T. Meehan, in the 'Proceedings of the Philadelphia Academy,' calls attention to the fact that the ordinary vine of Europe is frequently found in a barren state, bearing only male flowers, and he suggests that the seedless raisins and currants so much prized may be the fruit of purely female plants, ripened, though never fertilized. It appears, however, that as yet purely female plants have never been observed by botanists.

Discoloration of the Sea.—Some interesting facts "On the Nature of the Discoloration of the Arctic Seas" were communicated last year to the Edinburgh Botanical Society by Mr. Robert Brown. The paper has been printed in Seemann's 'Journal of Botany.' Arctic voyagers have long ago noticed the sea in Davis's Straits, Baffin's Bay, and other parts, to be dark olive-green, or even black in colour, and the appearance has been considered to be due to the presence in it of great multitudes of minute animals (*Medusæ, Entomostraca,* and *Pteropoda.*) Mr. Brown noticed, however, that

* 'Transactions of the Academy of Sciences of St. Louis.'

though these animals often sunk, the water still in their absence retained its peculiar colour. On further examination he found the cause of this to be a vast abundance of *Diatoms*, chiefly of one moniliform species, the name of which does not appear to have been determined. The *Medusæ* and other animals were found to feed on these plants, and, as is well known, are themselves the food of the whale, hence the presence of those vast cetaceans in the "black water." The same *Diatom* (with others) is the cause of the brown "rotten ice" of explorers; but this fact has been previously noticed by Dr. Sutherland.

A paper by Dr. C. Collingwood on the same subject, read at the Microscopical Society in March, appears in the 'Microscopical Journal.' In this the cause of the coloured water in the Indian ocean and China sea is investigated; as in the former case, it is due to a minute *Alga*, not a *Diatom*, but referable to *Trichodesmium*, a genus of *Oscillatoriæ*. The appearance produced on the water is that of a yellowish-brown scum, the sailors call it "sea-dust." The plant consists of short filaments, composed of a single line of cells, combined into a cylindrical unbranched fibre. A good many of these are aggregated into little bundles, having the appearance either of a "sheaf" or a "wedge," according as they are in close contact either at the middle or at one end. A species of *Oscillatoria* (?) occurs with it. Dr. Collingwood has never seen any *red* discoloration of the sea, such as is said to have been observed by many persons in the Red Sea and Persian Gulf, and also in the North Pacific, and which is caused by one or more closely allied species of *Trichodesmium*.

Hederaceæ.—Dr. Seemann gives another instalment of his revision of this order in the May number of the 'Journal of Botany.' *Kissodendron, Didymopanax, Aralia,* and other genera are passed in review; and the characters of two new genera *Dipanax* and *Triplasandra* are defined. The author however appears to have a tendency to create genera in this order on somewhat slender grounds.

British Botany.—The curators (Mr. Baker and Dr. Trimen) of the London Botanical Exchange Club have published their annual Report for 1867. Three new plants are described: *Rosa Hailstoni*, Baker (a variety of *R. canina*), from Yorkshire; the true *Allium carinatum*, Linn., from Nottinghamshire; and *Salix Grahami*, Borrer, from Sutherland. The Report includes notes on the numerous interesting or rare species, native and introduced, which have been communicated to the Club during the year.

The recently discovered *Viola Arenaria*, D.C., is recorded by Mr. James Backhouse from a new locality "several miles distant" from the only previously known one in Teesdale, Durham.

A *Carduus*, said to be new to Britain, has been gathered in Ross-shire; from the description given it appears to be one of the many hybrid thistles already known. Specimens were shown at a late meeting of the Edinburgh Botanical Society.

M. Mitten adds to our Flora a new Moss, *Trichostomum flavo-virens*, Bruch and Müller. It was found on Shoreham beach, Sussex. A figure and description will be found in the 'Journal of Botany' for April.

New Books.—The Ray Society has published the second and concluding volume of *Robert Brown's works*, edited by Mr. Bennett.

'The Chinchona species of New Granada,' by Clement R. Markham, with notes by J. E. Howard, has been published by the India Office. It contains the hitherto unpublished descriptions of the species distinguished by Mutis, the celebrated Spanish botanist, which have been since 1807 kept at the Botanic Gardens, Madrid; and also those of Dr. Karsten, originally published in German.

The long-expected 'Flora of Northumberland and Durham' by Mr. Baker and Dr. Tate, is printed and forms vol. ii. of the 'Natural History Transactions of Northumberland and Durham.'

'Refugium Botanicum' is the title of a new periodical, edited by W. W. Saunders. It consists of figures and descriptions of little known or new plants of botanical interest. The plates are drawn by Fitch from living specimens in Mr. Saunders' collection, and the descriptions are by Mr. Baker of Kew. This first part contains 24 plates, chiefly of succulent and bulbous plants, many being South African. The smaller orchids are promised, and Professor Reichenbach of Hamburgh will describe them.

The first part of vol. xxvi. of the 'Linnæan Society's Transactions' has been issued. In Botany it contains a monograph of the Bamboos by Colonel Munro; an account of the geographical distribution of all known ferns by Mr. Baker; and a few other papers of less interest.

Dr. Milde has published in the 'Botanische Zeitung' his *Index Osmundarum*, with remarks on the fructification of the genus.

Botanical News.—A paper by Mr. Darwin "On the Specific Differences between Primula veris, P. vulgaris, and P. elatior, and on the hybrid nature of the Common Oxlip, with supplementary remarks on naturally produced Hybrids in the genus Verbascum," was read at the Linnæan Society's Meeting, March 19th.

A new part of 'De Candolle's Prodromus' is nearly ready. It contains monographs of *Salicaceæ* by Professor Andersson of Stockholm, and of *Coniferæ* by Professor Parlatore of Florence.

A 'Flora of Gloucestershire,' by Dr. G. O. St. Brody, is announced as preparing for publication.

Mr. Marmaduke A. Lawson of Cambridge has been appointed lecturer on Botany at St. George's Hospital, *vice* Dr. Masters, resigned.

5. CHEMISTRY.

(Including the Proceedings of the Chemical Society.)

The memoirs on subjects relating to pure and applied chemistry which have appeared during the last quarter are so numerous, that we shall be obliged to confine our notices under this heading to such discoveries as are likely to prove of commercial importance or are of especial scientific interest. Foremost amongst researches which are likely to benefit mankind we may place those which have for their object the discovery of a cheap method of preparing oxygen gas. Two processes having this object in view have lately been brought before the public. The first is by M. Gondolo, who has made some improvements in M. Boussingault's process of extracting oxygen from the air by means of baryta. M. Boussingault, in 1852, found that on passing a current of air over baryta, heated to dull redness, oxygen was subtracted from the air, and binoxide of barium formed, and that upon then raising the heat to bright redness the oxygen was set at liberty so easily that it might be first absorbed and then evolved *ad infinitum*. M. Gondolo has made, in carrying out the detail of the process, certain changes which admit of oxygen being prepared upon a manufacturing scale. For the porcelain tubes he substitutes iron ones, which may be made either of wrought or cast iron. Internally a coating of magnesia is applied, and externally asbestos, so as to diminish the porosity of the tube and the consumption of fuel. These tubes are arranged in a brick furnace having dampers, by means of which the temperature may be changed at will, and dull redness and bright redness easily obtained. To the baryta a mixture of lime, magnesia, and a small quantity of manganate of potash is added; this prevents fritting of the material. M. Gondolo says that he has made 122 alternate operations, and that the atmospheric oxygen and nitrogen are easily separated upon an industrial scale; the apparatus has been at work during six months, and fulfilled its purpose thoroughly.

The second method by which cheap oxygen can be procured is due to M. Mallet, who has just communicated to the Academy of Sciences an additional memoir in explanation of a process which he published last year. This depends upon the fixation of the atmospheric oxygen upon protochloride of copper forming oxychloride, which again gives out its oxygen at a higher temperature. The absorption of oxygen by protochloride of copper is spontaneous; the air being ordinarily moist, it will be complete in a few hours, if fresh surfaces be renewed. But elevation of temperature, and this is a main point, induces a much more rapid absorption: at temperatures between 100° and 200°, as well as at higher temperatures in the presence of water, this absorption may be considered as almost instantaneous. By this process 100 kilogrammes of cupreous chloride, usually mixed with inert matter for convenience, will yield 3 to 3½ cubic metres of oxygen, and as four or five operations may be made in four-and-twenty hours, this quantity, 100 kilogrammes, would yield 15 to 18 cubic metres of oxygen during the same time: the price of the chloride of copper does not exceed 1 franc the kilogramme.

A new method of preparing magnesium has been devised by M. Reichert. He takes 1,000 grammes of the anhydrous double chloride of magnesium and potassium, pulverizes it, and mixes it with 100 grammes of finely powdered fluor spar; this mixture is fused with 100 grammes of sodium. The compound proposed for use occurs in the mineral kingdom in tolerable abundance as *carnallite*. White pieces of this mineral are available, and require no previous treatment; coloured fragments must be dissolved in water, the impurities allowed to settle, and the lixivium evaporated.

Professor Gamgee, President of the Albert Veterinary College, author of several works upon the cattle plague, and a recognized authority in such matters, has discovered a new process for preserving meat, which is simple and inexpensive. The animal is caused to inhale carbonic oxide gas. Before it is quite insensible it is bled in the usual way. When dressed the carcase is suspended in an air-tight receiver, the air exhausted, and the receiver filled with carbonic oxide gas; a small quantity of sulphurous acid gas is also added. After remaining here for from 24 to 48 hours, meat may be removed, and hung in a dry atmosphere; it will keep for one, two, or three months, or longer, with no perceptible change in taste or appearance. The tests of the method thus far applied have been attended with success. Beef killed in London in March last year was sent to New York in June, and as late as the middle of July was shown to a prominent butcher in Fulton market, who did not discover that it was other than ordinary beef, and expressed the opinion that it had probably been killed about two days. Mutton killed in London last July, and sent to New York soon after, arrived perfectly fresh; and one piece of beef kept for ten days in a can surrounded by water at a temperature of 90° to 100°, came out perfectly fresh. The process, in the opinion of eminent chemists, does not injure the meat in the least; this is an advantage very difficult of attainment, even in the case of transportation of live stock, which is liable to the bad effects of confinement and the length of the journey. Among the beneficial results of the adoption of this scheme would be a better supply in our markets of wholesome meat and at a desirably cheaper rate.

The extraction of oils by means of bisulphide of carbon is now carried on at Moabit, near Berlin, upon a very large scale. In the manufactory of M. Heyl, 2,570 kilos. of oil, of sufficiently good quality to be employed in lubricating machinery, are manufactured daily. Colza and linseed are the materials chiefly operated upon; the residues serve very well to feed cattle with. The seeds are first crushed and dried by heating. For the daily fabrication of 2,570 kilos. of oil only six men are required. Analysis has shown the residues to contain only 2 per cent. of oil and 7 per cent. of water, while the residues of the ordinary pressure process contain 9 per cent. of oil and 15 per cent. of water. In the extraction of the oil, 7,000 kilos. of bisulphide of carbon are used daily, and the amount lost is 28 kilos.

M. Rakowitsch proposes a method of examining flour by means of chloroform. The following are the results which he says may be gathered from an experiment capable of being made in a few minutes:—The amounts of bran, the moisture between 10 and 25 per cent., the damaged flour, the mineral matters, the ergot of rye, and other impurities. The whole of these are determined by the relative specific gravities of the different substances in chloroform. The flour is simply placed in a tube and mixed with chloroform; the chloroform is enabled to hold in very thorough suspension the pure flour, while the other materials are not thus suspended. By adding spirits of wine of 95°, the flour is precipitated to the bottom of the tube. The more humid the flour, the more spirits of wine must be added, and thus the amount of humidity in the flour is arrived at.

The employment of charcoal filters has long been advocated, on account of the known property of this substance to absorb and oxidize organic matter. Mr. W. Skey, of New Zealand, has now shown that charcoal will remove arsenic from water. If a few drops of a solution of a salt of arsenic, or arsenious acid, be put into a few ounces of dilute sulphuric acid, and the mixed solution agitated at intervals with recently ignited charcoal for an hour or two, the clear liquid obtained by filtration does not manifest any reaction of arsenic when tested by Marsh's process. Tungstic acid also is removed from acid solutions by charcoal applied in like manner, and is given up to a solution of caustic alk

Proceedings of the Chemical Society.

The subject of water analysis still occupies the attention of this society to an extent entirely out of proportion to the merits of the inquiry. At the meeting on March 5th, Messrs. Wanklyn and Chapman read a long paper "On the Action of Oxidizing Agents on

Organic Compounds in presence of excess of Alkali." This paper was in continuation of researches which the authors had brought forward at previous meetings in reference to the estimation of organic nitrogen in water. They now state that an examination of typical substances lead them to the following results:—1. Some bodies yield the whole of their nitrogen as ammonia when treated with alkaline permanganate: of this class are asparagine, piperine, narcoline, and hippuric acid. 2. Some bodies give off *half* their contained nitrogen as ammonia: amongst this class are to be found morphia, strychnine, quinine, nicotine, toluidine, and acetate of rosaniline. 3 One body, creatine, gives off *one-third* of its contained nitrogen. 4. Theine gives off one-fourth of its nitrogen. 5. Other bodies have been found to evolve various proportions of nitrogen: thus, uric acid gives off about 7 per cent. of ammonia; caseine, 7·6 per cent.; and albumen about 10 per cent. This paper was followed by a "Note on Dr. Frankland's Process of Water Analysis," by Mr. Chapman; and another paper by the same author, "On the Estimation of Nitric Acid in Potable Waters." He first distils the water with pure caustic soda to remove all ready-formed ammonia, and then adds aluminium foil and distils again. The nascent hydrogen reduces the nitric acid to ammonia, which is collected in the receiver and estimated by Nessler's test. A general discussion on Messrs. Wanklyn and Chapman's proposed method of water analysis then took place, in which Dr. Williamson, Dr. Odling, and Professor Abel took part. The general opinion seemed adverse to the process.

Mr. W. H. Perkin, F.R.S., then read a paper "On the Hydride of Aceto-Salicyle," a body which was mentioned in a former paper. It is a white crystalline mass, possessed of aldehydic properties, formed by the action of acetic anhydride on the hydride of sodium-salicyle. A paper then followed "On the Absorption of Vapours by Charcoal," by Mr. Hunter. In these experiments, cocoa-nut charcoal was used, and amongst the substances whose absorptions were ascertained under various circumstances of temperature and pressure were the vapours of ethylamine, iodide of ethyl, acetate of methyl, camphor, nitro-benzol, bisulphide of carbon, alcohol, and methylic alcohol. The next paper was "On the Occurrence of Prismatic Arsenious Acid," by Mr. F. Claudet. This was interesting, as illustrating the dimorphism of arsenious acid. It had been formed by a very slow process of oxidation, and the form was probably modified by the sulphurous atmosphere pervading that part of the mine where it was found. The next papers were two by Dr. Stenhouse, "On the Action of Nitric Acid on Picramic Acid," and "On Chloranil." These were followed by one by Messrs. Chapman and Smith, "On the Action of Zinc Ethyl on Nitrous and Nitric Ethers;" after which the meeting adjourned at an unusually late hour.

At the meeting on March 19th the proceedings were opened by Professor Kolbe, who was invited by the President to give an account of his experiments "On the Conversion of Carbonate of Ammonia into Urea." Professor Kolbe, who spoke in German, explained that he had succeeded in producing urea by heating dry carbonate of ammonia in sealed tubes to a temperature a little lower than that at which the urea formed would be again destroyed. The speaker then referred to the electrolysis of acetic acid, which furnished a new acid isomeric with glycolic acid, but of which the properties were as yet but imperfectly known. Mr. Henry Chance of Birmingham, then delivered a most interesting lecture "On the Manufacture of Glass." The author briefly sketched the history of this manufacture, and quoted several analyses of various kinds of glass. The action of heat in causing dendrification, and of sunlight as affecting the colour, besides other considerations having reference to permanence, were discussed. Mr. Chance appended to his remarks upon glass, a statement of his mode of treating the Rowley Rag basaltic rock of South Staffordshire. This material gives by fusion a black obsidian-like glass, which again devitrified furnishes a material suitable for building purposes and capable of ornamental application. The formation of soluble silicate of soda by Gossage's process was described, and some of the corroded flints exhibited. An excellent series of samples illustrative of the manufacture of glass and of the two materials producible from Rowley Rag, were laid on the table for inspection.

The anniversary meeting of the Society was held March 30th, when the President, Dr. Warren De la Rue, F.R.S., reviewed the progress of the Society during the past year. The obituary notices were unfortunately more numerous than usual. The list of Fellows shows an increase of 11 over those last year, being now 510. Amongst the losses by death may be mentioned Professor Michael Faraday, Dr. C. G. B. Daubeny, Dr. Thomas Clark, Dr. William Herapath, Mr. Robert Warington, Messrs. J. Tennant, Walter Crum, W. H. Gossage, Alfred Noble, William Winsor, and Professor Jules Pelouze. The President indicated some of the leading researches published during the year in the several departments of the science, and referred to the progress made towards establishing the new chemical theory. The investigations of Graham, Hofmann, Kolbe, Abel, Fittig, Frankland and Duppa, Perkin, and Pettenkofer and Voigt were specially mentioned. The discussions on water analysis had elicited facts which would ultimately prove useful in establishing a new method; and the review of geological phenomena from the wide sphere of observation of so eminent a chemist as Mr. Forbes could not fail to be productive of great results. The treasurer's report was very satisfactory, showing that the balance at the bankers of the society was 637*l.*, and the amount invested in Consols 2,347*l.* The election of officers and council was then proceeded with, and after the usual votes of thanks the meeting adjourned.

On Thursday, April 2nd, the first paper read was one by Messrs. Perkin and Duppa, "On the Constitution of Glyoxylic Acid." This was followed by a very long and highly theoretical one by Dr. Odling, "On a Glyoxylic Amide." Mr. W. Chandler Roberts then read a note "On the Occurrence of Organic Appearances in Colloid Silica obtained by Dialysis." The interesting observations which formed the subject of this paper were elucidated by a series of specimens, both of natural and artificial origin, the structures of which were demonstrated by the aid of a microscope and illustrative drawings. In experimenting upon somewhat large quantities of soluble silicic acid prepared in Graham's dialyser, a portion of the liquid product was evaporated slowly in air to compare with the forms of hydrous silica left by a more rapid operation conducted *in vacuo*. All the specimens of jelly dried in air exhibited dendritic forms, varying in size from 0·2 to 0·5 mm.; these were at first supposed to afford indications of the passage of colloid into crystalloid silica, but when magnified 90 linear they appeared as radiating fibres, and upon being further magnified 700 times, each fibre resolved itself into a collection of elongated headed cells, with clusters of circular cells at intervals. Such a structure would indicate a vegetable growth, and the author concludes that the markings, which are similar to those seen in moss agates and Mocha stones, are due to the growth of fungi or mildew in the partially solidified jelly. The spores of organic life were probably derived from the air, since no evidence of similar structure was visible in the specimens of hydrous silica obtained in the desiccator. These last-named productions were very like the opal from Zimapan, but contained 21·4 per cent. of water. Dr. Bence Jones communicated the next paper, in which he demonstrated the "Solubility of Xanthin (Uric Oxide) in Dilute Hydrochloric Acid." This was followed by a continuation of Professor A. H. Church's "Researches on New and Rare Cornish Minerals," in which the author corrected the hitherto-received formula for the mineral *Cornwallite*, showing it to consist of arseniate and hydrate of copper, with a small proportion of phosphate.

At the meeting on the 16th of April, Professor Guthrie described and exhibited an *improved Voltastat*, by means of which the current of a galvanic battery could be maintained perfectly constant and regular by a self-acting arrangement. A paper "On Graphic Formulæ," by the same author, followed, in which he described a new system, founded on the same general principle as that of Dr. W. Crum Brown, but which would, in the words of the author, "serve to illustrate the molecular constitution of compound bodies from a somewhat different perspective." Instead of initial letters the author adopts pictorial symbols by which to represent the elements, and arranges them in a geometrical pattern to construct the compounds formed by their union. In the discussion which followed the reading of this paper, Drs. Atkinson, Russell, Stevenson, and Odling spoke briefly, and, in a general sense, adversely, as to the desirability of introducing the system to the notice of the student. Dr. J. H. Gladstone followed with a paper "On the Tetraphosphoric Amides," compounds produced by the action of water on the amidated oxychlorides of phosphorus; and the proceedings concluded with a paper by Mr. Carter Bell "On the Solubility and Crystallization of Plumbic Chloride in Water, and in Water containing various proportions of Hydrochloric Acid." The author finds the degree of solubility in pure water to be about 1 part in 121 parts, instead of in 135. The solubility in hydrochloric acid decreases up to a certain point, when the curve commences to ascend.

The meeting on May 7th was very fully attended, and many distinguished visitors were present to hear Mr. C. W. Siemens, F.R.S., deliver a lecture "On the Regenerative Gas Furnace as applied to the production of Cast Steel." The following is a very condensed account of this important lecture; and it is to be regretted that the many demands upon our space will not permit of its being given more fully. The lecturer commenced by briefly sketching the properties and modes of preparation of cast steel, which he defined as a compound of iron and carbon possessing the remarkable property of becoming exceedingly hard when heated and suddenly cooled. Steel containing 1·4 per cent of carbon partakes of the character of white cast iron, and below 0·3 per cent. the metal is incapable of being hardened. The presence of manganese improves the quality of steel, apart from its function in removing sulphur and other impurities. Tungsten, in quantities of about two per cent., has the remarkable property of increasing the power which steel possesses of retaining magnetism when hardened. This property of tungsten was illustrated in the lecture-room by a small permanent magnet of horse-shoe form, which supported twenty times its own weight from the armature; the celebrated Haarlem magnet being incapable of lifting a weight more than thirteen times heavier than itself. The principle of Mr. Siemens's plan of heating is already well known. The fuel is heated upon an inclined fire-grate, where it undergoes a kind of slow combustion which results in the formation of carbonic oxide; this inflammable gas is then conducted from the "producer" to the hearth or working platform of the furnace, where it meets a current of air already raised to a high temperature, which enables it to burn with great intensity; and the excess of thermal power, instead of being allowed to pass direct into the chimney and thus become wasted, is forced to traverse an intricate structure of brickwork, which absorbs so much heat that the escaping gaseous products of combustion rarely indicate a temperature above 300° F. At a suitable stage of the operation the gas-valves are reversed, and both carbonic oxide gas and air are forced to traverse these heated brick chambers in a contrary direction, so that they may in turn become the recipients of that heat which in ordinary constructions of furnaces would have been lost. The ashes and clinkers are in this way entirely separated from the region of manipulation, and are removed from the grate at intervals of one or two days. The author estimates the temperature produced by the combustion of the gas and air to be 1,000° to 1,300° F. when they are cold to begin with; but when they have been separately passed through the regenerator and thereby raised to a temperature of, say, 1,000° F. beforehand, the temperature of their combustion will be, say, 2,000°. The surplus heat from this will then raise the temperature of the regenerator still higher, and the gas and air will consequently attain a higher degree of heat before they unite. The platform of heat, so to speak, on which they commence their combustion, will be raised each time, until practically there is no limit to the degree of temperature which may be attained in this manner—the whole mass of the furnace, with its contents, having occasionally been melted down into one mass. The special furnace which Mr. Siemens has erected at Birmingham for the direct production of steel from the ore, has a tunnel-head or cylindrical hopper, fed with iron ore and small coke, passing through and raised above the crown of the regenerative gas furnace; the lower part of this upright cylinder rests in a bath of molten pig-iron, which dissolves the reduced (spongy) iron as quickly as it is separated from the ore. A blast-pipe descends through the stack of ore, and the process is interrupted when the steel is ready for casting, after which the charge of pig must be renewed. It is a very important point in connection with these furnaces, that the atmosphere of them may be changed at will into an oxidizing, reducing, or perfectly neutral condition, merely by altering the proportions of air and gas. After the delivery of this lecture, which was amply illustrated with experiments, specimens, and a series of diagrams and dissected models, an animated discussion followed, in which the President, Mr. Cowper, Professor Abel, Dr. Miller, Dr. B. H. Paul, Dr. Williamson, and Dr. Odling took part.

On May 21st, Dr. Russell opened the proceedings by showing some experiments "On the Application of the Measurement of Gases to Quantitative Analysis." The author considers the system of measuring to be more accurate than weighing in a variety of analytical operations wherein gases are evolved, and the results which he has obtained certainly corroborate this view. In the discussion which followed, Dr. Williamson said that as a rule the process of measuring was more accurate than weighing; for, whilst we could not weigh closer than one-tenth of a milligramme, it was possible to measure volumes of gas within one-hundredth part of a cubic centimetre. Mr. W. H. Perkin then read a paper "On the Combining Powers of Carbon." This was very long and theoretical, and related to the inquiry whether all four affinities or combining units of carbon are of equal value.

The proceedings were brought to a conclusion by a short paper by Mr. Parnell "On the Reducing Action of Peroxide of Hydrogen and Carbolic Acid."

6. ENGINEERING—CIVIL AND MECHANICAL.

The gradual, though, it is to be hoped, certain return of confidence in various existing undertakings, recently shown by the state of the money market and the quotations of shares, cannot fail to have exercised a beneficial influence on the progress of engineering schemes; but it must be acknowledged that there is still room for much improvement.

Ship-building.—The state of trade in the northern parts has of late exhibited a decided improvement, but the same cannot altogether be said of ship-building on the Thames. Messrs. Napier and Sons of Glasgow have recently completed an armour-clad twin-screw turret-ram for the Dutch, and Messrs. Laird of Birkenhead, have launched two sister monitors for the same Government. The last-named firm are also building a turret-ship of 4,200 tons, and a broadside-ship of the 'Invincible' class for Her Majesty's Government, as well as a composite gunboat for service in the China seas. A gunboat on a new model has recently been built for the Admiralty, on the Tyne, from the designs of Mr. G. Rendel, of the firm of Sir W. Armstrong and Co.; this vessel is only 70 feet long by 25 feet beam, having twin screws driven by two pairs of condensing engines. She carries as heavy a rifled gun as any in the Navy, mounted in the fore part of the vessel in a line with the keel, and firing through a bulwark, or screen, over the bow, which is cut down and plated something like that of a monitor. On the Thames the 'Repulse,' to carry eight guns, and of 800 horse-power, was launched at Woolwich Dockyard on the 25th April; and at Chatham, in addition to the 'Sultan,' a powerful new iron-clad ship, of the 'Herculus' class, has recently been laid down. There is now, it appears, no doubt about the closing of the minor Government ship-building yards, an order having been received for Deptford to shut up in the course of the year, and it is thought that Woolwich will, in all probability, follow Deptford.

On 25th April last, the first gunboat ever built in Ireland was launched from the yard of Messrs. Harland and Wolff of Belfast, which is one of six gunboats being built for the British Government.

Docks and Harbours.—One of the greatest and most important recent additions to private dock accommodation on the Thames was made on 14th March, by the opening of the Millwall Dock basins and warehouses; and on 21st April the foundation stone was laid of the first of four large new Graving Docks to be constructed at Chatham.

A new harbour under construction at Torquay, at the cost of Sir L. Palk, M.P., is rapidly progressing; it is intended to extend the harbour some 600 feet, and vessels drawing a much greater depth of water than heretofore will be enabled to enter it. A considerable sum is also about to be expended on the improvement of Great Yarmouth Harbour.

Works for the improvement of the basin at Brest were commenced so far back as 1863, but after sixteen months of persevering efforts, the contractor failed to make a water-tight dam. Recourse was then had to the compressed air process, and a caisson was sunk, having a capacity of 2,427 cubic metres, in which forty men have been working day and night in four-hour shifts.

During the recent visit of the Duke of Edinburgh to Australia, his Royal Highness laid the foundation stone of a fine Graving Dock at Williamstown, Victoria.

River Improvements.—The works undertaken for the improvement of the Sulina mouth of the Danube appear to have been successful, the depth of the channel having been increased to an average of 15 to 16 feet, while the Sulina Pass, formerly regarded as one of the dangers which shipping had to encounter, has now become one of the best refuges on the coast of the Black Sea.

Water Supply.—The Carnarvon Waterworks were opened by His Royal Highness the Prince of Wales on 25th April last. They are supplied with water from Llyn Quellyn, a lake situated about six miles from Carnarvon, and 600 feet above the level of the town.

The new waterworks at Helensburgh were opened on 26th March last. The water is collected from two streams intersecting the Mainshill lands before they reach the mossy portion of them adjoining the upper, or compensation, reservoir; the lower, or storing reservoir is seven acres in extent, and has a storeage capacity equal to a supply of 25 gallons to each inhabitant for a period of five months.

An extensive system of works for the supply of Calcutta with water are now in course of construction. The supply is drawn from the Hooghly at a point about sixteen miles north of Calcutta, and after being purified is carried by three branches to the

Southern, North-eastern, and North-western districts of the city respectively.

Railways.—The new line, belonging to the London and North-western Railway Company, from Llanrwst to Bettws-y-Coed, has commenced to carry passengers. The new line between Edinburgh and Leith was gone over on the 14th May, and was expected to be opened in about a week from that time.

The break of continuity which the Girdle of Paris Railway still presents, between the Batignolles-Clichy goods station and the Courcelles station on the Anteuil line, will soon disappear; the earthworks of the section in question being now nearly completed. The Paris, Lyons, and Mediterranean Railway Company appears to be pushing forward its lines in Algeria with much energy; that from Algiers to Oran is now in progress throughout, and one section—from Relizane to Oran—is expected to be opened for traffic in July. A second line, from Phillippeville to Constantine, is to be completed for traffic in the course of 1869.

Upwards of 472 kilomètres of railway are expected to be completed in Italy during 1868. Of these, the Lecce and Zellino line was opened at the commencement of February, and its extension to Otranto has been definitively approved. Mr. Fell's summit-railway over Mont Cenis has certainly not hitherto fulfilled the expectations of its promoters. In May last the Duke of Sutherland went over the line between St. Michel and Susa, a distance of 48 miles, in 4 hours 6 minutes, after deducting the time in stoppages for inspection. The line was opened to the public on 15th June.

The concession of a Government guarantee has been given to the Indian Branch Railway Company for its lines in Oudh and Rohilcund, and the extension of the Oudh system is now being proceeded with. The whole distance between Sholapoor and Raichore, on the Madras Extension line, is in course of completion, the rails having now been laid for about fifty miles beyond Sholapoor.

On 18th April last the rails of the United Pacific Railroad were laid on the Rocky Mountain summit of the line; according to Bilnkerderfer's survey, the railroad crosses the mountains at this point at an elevation of 8,242 feet, being the highest point reached by any railroad in the world.

Bridges.—The North-eastern Railway Company have set resolutely about the replacement of the whole of their numerous wooden viaducts with stone and iron, and in some places with solid embankments. The Hutton, Malton, and Whitby viaducts have been completed, the Ripon is in progress, and the Norton is being filled up.

A bridge was recently constructed by the Louisville and Nashville Railroad Company over the Cumberland river, at Nashville, which comprises two spans of 205 feet each in the clear, and a swing-bridge, giving two openings, and measuring over 276 feet. A new suspension-bridge has also been constructed over the same river, in Tennessee, connecting Nashville and Edgefield, to replace the one destroyed by the Confederate General Floyd when in possession of Fort Doneldson. A bridge is now in course of construction over the river Ohio, at Louisville, which is the longest iron bridge yet attempted in the United States. It will, when completed, carry across the Ohio a line connecting the Louisville and Nashville with the Jeffersonville and Indianopolis railroad, and form a connecting link between two immense railway systems—the northern and the southern, at present divided by the Ohio river. The Boston and Providence Railway Company are constructing a bridge from India Point over the Seekonk river, on a plan which embraces some new features. The whole length of the bridge is 876 feet, and the supports in the river are iron cylinders filled with wooden piles and concrete. The building of an iron bridge over the Great Miami, on the Ohio and Mississippi Railway, is considered a rapid feat in railway engineering. The first train crossed on the 15th December last, just 120 days from the time the first pile was driven, and 9 days and 4 hours from the time the last stone was put in place.

Tunnels.—On the 1st of last November, the heading of the Hoosac tunnel had reached a total of 4,382 feet from the east opening, and 1,004 feet in the western shaft. On the whole, confidence is expressed in the future rapid progress of this work.

Telegraph.—The English telegraphic system is soon to be connected with that of Denmark, Sweden, and Norway, by a cable now in course of construction, and which is to be laid under the North Sea. On 1st April, the Chancellor of the Exchequer brought in a Bill for giving to the Postmaster-General power to buy up, and work telegraph lines in this country in connection with the Post-Office.

The Indo-European Telegraph Company, for working a line of telegraph through Prussia, Russia, and Persia, has recently been successfully started; and the Anglo-Mediterranean Telegraph Company, which proposes to effect an independent communication between England and India by deep-sea cables through the Mediterranean and Red Seas and the Persian Gulf, has also been established, so there is now a prospect that before long England will possess two separate lines for telegraphic communication with India entirely under English supervision and control.

Mechanical.—A very clever steam flying-machine has recently been invented by Mr. Joseph M. Kaufmann of Glasgow, the action of which resembles that of the wings of a bird as closely as possible. It will appear at the Exhibition of the Aeronautical Society at the Crystal Palace in June.

We must not omit to notice the Steam Stearing-gear, fitted by Messrs. George Forrester & Co., of Liverpool, to the Great Eastern steamship, from the designs of Mr. J. McFarlane Gray. This apparently complex, though really simple machine, according to the evidence of Sir James Anderson, "saved the labour of eight men, and acted upon the rudder with a facility and certainty that no mechanical labour could effect." The construction of a thoroughly effective steam stearing-gear is no easy matter, for whilst the rudder should be under perfect command, it should at the same time be able to yield if exposed to excessive strain by the action of the waves. It would be impossible here clearly to describe this machine without the aid of drawings, but it may suffice to state that the above desideratum is fully accomplished by it; the rudder being capable of yielding, and at the same time returning to the desired position when the disturbing force is removed.

A very clever portable drilling-machine has recently been introduced by Messrs. Westray and Forster of Barrow-in-Furness, which has been designed so as to enable the drill to be worked at any angle, and to be used to drill holes anywhere within range of the machine when fixed.

A new arrangement of boring-machine has recently been designed and patented by Mr. Thomas Greenwood of Leeds, which is specially intended for boring gun-barrels, shafting, or other articles in which a deep hole is required to be formed. The work to be bored is mounted above a tank containing lubricating material, and in this tank the drills are placed, the work being bored upwards from the lower end.

Golay's millstone cutting and dressing machine has recently attracted great attention, and large sums have been paid for the right to manufacture it in this country. With this machine, the "cracks" are cut by a diamond fixed on the edge of a small disc, revolving at a very high speed, its spindle being mounted on a carriage which can be moved to and fro on the line of the cracks.

Experiments have recently been made at Chatham, with very satisfactory results, to test the merits of a new application of the diving apparatus invented by Mr. Siebe, submarine engineer, by which two divers can be sent down in any depth of water, and be supplied with air from the same pump. The diving apparatus is fitted with a self-acting pressure gauge, and the invention can be used as a submarine lamp.

A new method of extinguishing fires by the application of carbonic acid gas, projected from a portable fire-engine, was lately tested upon the battery in New York city. The engine is about the size of a common garden engine, it is worked much in the same manner, and may be operated by two men. When in action two cylinders are employed to supply an air-chamber, the pressure from which, acting upon the carbonic acid gas formed by the mixture of solutions of tartaric acid and carbonate of soda, or other suitable materials, forces it through a hose, by means of which it may be directed wherever requir

7. GEOGRAPHY.

(Including the Proceedings of the Royal Geographical Society.)

THE attention of the Royal Geographical Society, so far as it is not concentrated upon individual interests or the exciting game of politics, is directed to the little band of men who, in their indomitable perseverance, their cautious advance, their submission to scientific arrangement, the purpose and success of their expedition, and even their ethnological heterogeneity, represent, with tolerable fidelity, the relation of the British empire to outer barbarians. Neither the smallness of the force sent to Abyssinia nor the contemptible character of our opponent, is a gauge of the interest felt by educated men in the success of the expedition; because it has been all along seen that the contest was rather against nature than against man, and that the prize to be won was mental and moral rather than physical and political. That an engineer officer should be in command and that a select body of scientific men should accompany the force, was as essential to its character as that our Indian troops should make the roads, that "twenty men of the line, two artillerymen, an officer, and *the Press*," should capture and turn thirty guns, or that a newspaper correspondent should criticize the "brilliant blunder" of a commander. The real and permanent advantage that we shall gain from the expedition depends to a greater extent upon the care and the circumspection of the representatives of science, who, for the first time, accompany an invading army, than upon the valour, the foresight, and the good fortune of our troops.

Lieutenants Carter, Holdich, and Dumler, of the Royal Engineers, have been busy with a trigonometrical survey of the route of the army and of the country, from ten to fifteen miles on each side of it, including all the principal peaks visible along the road. This will furnish accurate data, to which may be hereafter safely added less carefully determined information.

In the meantime, Mr. Clements R. Markham is obtaining historical and topographical detail of the lines of watershed, geological structure, zoological and botanical products, all of which will no doubt be given to the public in papers before the Royal Geographical Society and in periodical publications. Several other members of the expedition have also used their spare time in making zoological and botanical researches, whilst the excellent sketches that have from time to time appeared in our illustrated newspapers have made all the world acquainted with the peculiar characteristics of various kinds of scenery in Abyssinia, which for grandeur and picturesqueness could scarcely be equalled.

A lecture on Abyssinia was lately delivered by Sir Samuel Baker at the Royal Institution, which, except that it contained a fair description of the surface of the country, added but little to the information already possessed or within the reach of every one of the enormous audience assembled to greet the traveller. By reproducing stories of Moses and of the Queen of Sheba entirely depending on tradition, and by the application of the indefinite word "Ethiopia" to Abyssinia wherever it may occur in biblical history, Sir Samuel showed that his authority as a historical critic could scarcely be so great as when he confined himself to his proper subject of geography.

These doings in the more northerly portion of the enormous district drained by the Nile (for near Adigerat and Antalo the British troops came upon the head waters of certain tributaries of the river of Egypt) have caused the interest about the explorers of the southern tributaries of the same stream to flag. A fictitious excitement concerning the researches of Dr. Livingstone was for some time kept up in consequence of the credit given to the untrustworthy story of the Johanna men, even to the extent of publishing a biography of the scientific missionary in the obituary of the 'Année Scientifique,' although Sir Roderick I. Murchison all along showed the improbability of their account, and the unreliable character of the men was patent to all who read their testimony. It is satisfactory to know that the authors of the false account are likely to reap the reward of their villany from their own sovereign, the Sultan of Johanna. The letters lately received from Dr. Livingstone, of which we give an abstract below, have been read, however, with great enthusiasm, though they serve rather to stimulate curiosity than to give much information concerning the countries he has traversed. It is extremely difficult in the present state of our knowledge to follow the statements of the Doctor, who does not seem to have got over the fault which so greatly spoilt the effect of his first work—a muddled and confused style. It is still uncertain by which route the traveller may return, but if he retraces his steps, he will probably fall in with a party of Irish officers who intend to take a small iron boat, fitted with a steam screw, up the Zambesi and the Shire, and then across to the lake Nyassa, which last piece of water they purpose surveying thoroughly, especially on its little-known northern boundary. It is to be hoped that the nationality of Captain Faulkner and his companions will not lead them to too hasty conclusions,—and that the results of their expedition may be worthy of the excitement caused in Dublin by an Irish attempt at solving the problems before them. The Zambesi itself is in a fair way to be known as well as the Rhine, as it not only forms the highway by which book-writing travellers journey towards the great lakes of southern Africa, but that wayfarers like Mr. Chapman, who attempt to cross the continent from west to east, make use of this opening. Another new source of attraction to this river is the discovery of a gold-field at a short distance from its northern bank, by M. Manch, who has also found another gold-field somewhat to the south-west of the former, nearer the colony of Natal. On the Guinea coast Mr. Winwoode Reade, who has already penetrated to the gorilla country, is commencing an exploration under the auspices of the Royal Geographical Society, by advancing up the Assinie river. The physical condition of the valley of the Nile in Egypt and Nubia, especially in its relationship to the intellectual precocity of the former country, receives considerable light from the careful survey of M. Ampère.

The course of geographical interest follows in the track that history has previously travelled. The earliest civilized continent, Africa, is now the least known and the most provocative of discovery. Asia, which followed closely on the path pioneered by Egypt, next affords the widest field for exploration and research The examination of the foundations of Jerusalem (one of the earliest of the old centres of civilization), interesting from so many points of view, has been delayed, though not entirely stopped, by the jealousy of the Turkish authorities. It is to be hoped that the difficulties, whatever they may be, will be overcome before the cooler weather again gives an opportunity of recommencing the labours of tracing water-courses, following drains, and laying bare foundations. Since Mr. Layard's investigation of the cities of northern Mesopotamia, we have heard but little of the remains of the old Assyrian and Persian empires. The necessity for collecting animals for the transport corps in Abyssinia has given some of our young officers the opportunity of traversing Persia. One of these gives a description of Persepolis as still containing much that is worthy of investigation, and it is to be hoped that this and other similar places will be examined by those who, enlightened by the discussions on ancient architecture and manufactures, have had their interest awakened to the seats of ancient learning and art.

The advance of the Russians and of Russian influence in Central Asia is still the cry of those who think our Indian empire is not safe unless it is enlarging its boundaries, and this cry is from time to time awaked by reports of fresh victories of the Muscovites. A knowledge of the condition of the countries to the north of the Himalayas may be scientifically useful; but meddling with the politics of this region may be anything but advantageous to our already overgrown empire, however much it may be desired by the continental enemies of Russia and a certain school of Indian statesmen. The condition of the vast empire of China, which seems to be so rapidly changing its character, is of much greater importance to the British merchant. Instead of crowding their over-peopled land and rivers, the Chinese are now constantly passing backwards and forwards to and from the various gold fields of America and Australia, where their incursions have a very serious effect upon the labour-market, and their habits incite a considerably amount of enmity. If, as seems probable, this huge kingdom should fall to pieces from its own inherent want of cohesion, it may become a matter of importance to us who succeeds to the various portions of the ruins of the mighty fabric. The neighbouring and closely allied kingdom of Japan is in like manner undergoing convulsions, both social and political, about the nature of which it is difficult to judge. The old aversion to foreigners and to intercourse with other nations seems to have left the middle and lower classes of the nation, who are making their influence felt by the governing class, and the presence of a troop of jugglers or tumblers among us has a deeper significance than might at first sight appear. It is a more trustworthy earnest of future intercourse than the appearance of their ambassadors at our international shows, or even treaties with rulers who cannot divert popular feeling. The internal evidence of the same change is to be seen in revolutions and in the attack upon our ambassador so satisfactorily punished by the Mikado, whom he now visits in place of the Tycoon who received our former attentions.

Two expeditions into Central Australia are spoken of. The one by Captain Cadell is nearly completed, after having traversed the country from the northern boundary of Southern Australia to the northern coast of the continent. Three rivers and a large harbour have been discovered. The other is the proposal of Dr. Neumayer, director of the Observatory at Melbourne, who is anxious to carry his line from east to west, from Port Denison to Swan River. Dr. Neumayer is anxious to have more attention paid to science in the new exploration than has been the case before; and in his opinion the expense ought to be defrayed partly by the colonies and partly by the mother-country.

The country, so long marked on maps as Russian America, but which on its acquisition by the Government of the United States required a new name, has been called from its principal peninsula Aliaska or Alaska. In Yankee parlance it is sometimes Walrussia. But little is known of this region, which is said to be of no great value on any account, and was only bought by the Americans through jealousy of British influence on their continent. An artist, Mr. Frederick Whymper, who spent a considerable time in that region, has traversed a large portion of the course of its principal river, the Yukon or Kwichpak, and has at length returned to England with the results of his stay, and we may expect shortly to hear something of his discoveries. He describes the climate as extreme, and the inhabitants vary in character from the Eskimo to the Red Indians. A series of sketches and a collection of characteristic articles made by the natives were exhibited by Mr. Whymper at the evening reception given by the President of the Royal

Geographical Society. The Red Indians are, like so many unfortunate natives of other lands, being driven out by our colonies of Vancouver Island and Columbia from their old hunting grounds through the forcible purchase of their land, which the Indians would willingly keep if they were allowed. It is the old story, the European makes use of the power that civilization gives him to act as an uncivilized savage would be ashamed to act, and then it is said that no barbarous nation can exist where educated man touches upon his borders. One rather awkward-looking fact accompanies the advance of the European. The price of wives increases as one nears the white settlements, and a regular slave trade is known to exist. A strong desire has been exhibited by the colony of British Columbia to be admitted into the confederacy with Canada and the other settlements of British America, provided only that a means of communication with these latter colonies be made from Lake Superior over the Rocky Mountains. The other parties to the confederacy seem willing to meet their wishes, and it is to be hoped that a strong alliance may be found to resist any attempts to alienate or seduce any of these our dependencies, or to sow discord where unity is so essential. The new territories of the United States are each in their turn explored by Government officials, and the various productions, mineral and vegetable, are described and catalogued. Nebraska has in this way been rendered accessible, and expeditions are still in progress in Colorado and Dakotah. Lignite has been found over a large extent of country in the former territory, and iron ore is in abundance in the same neighbourhood. Unlike the adjoining British colony, the Americans of California are not content with a mere road, but have already made lines of railway where no European would dream of laying a tramway, but one of the most extraordinary of these undertakings, and a very successful one too, is the Central Pacific Railway, which commencing in California passes the Sierra Nevada through a tunnel, and is descending into the plain of the great Salt Lake city to Utah. The rails are being laid at the rate of a mile a day. When this is finished there will be no more occasion for those trying journeys across the prairies so well described in Hepworth Dixon's 'New America,' nor for the scarcely less unpleasant journey round by Central America. But little seems to be known about this latter country, to judge from a late correspondence in which it is contended by one of the opposing parties that there is a water communication between the Lakes Managua and Nicaragua, whilst the other denies this. The explanation seems to be that some years ago the dry seasons lowered the former lake to such an extent that there was no overflow of water along the channel which has since been navigated by one of the correspondents. The Panama railroad, however, has its historian and guide, Dr. F. N. Otis, and around books of the character which he has written, there is soon accumulated an amount of fact which, without some nucleus of crystalization, is apt to flow away in a state of solution.

The German expedition to the North Pole has started from Bergen, and Professor A. E. Nordenskiöld has announced to the Royal Society that the Swedish Government has granted a steamer, provisioned for one year for the purpose of Arctic exploration, and that some private gentlemen have contributed towards fitting out the expedition.

Earthquakes are recorded in the Sandwich Islands (near the volcano, Mauna Loa, which was in violent eruption) at Tachkent (?) and about Vesuvius. The latter mountain is being watched not only by Palmieri and several Italian *savans*, but also by Professor Phillips of Oxford. Very valuable records of the lengthy disturbances will have been made by these and other scientific observers of the changes that have taken place, and it is to be hoped that the theory of volcanoes will receive some enlightenment.

We have to regret the death of Mr. John Crawfurd, whose face must be well known to all frequenters of our learned societies. His fame was won originally in the Malay peninsula, of which he wrote a history as well as a dictionary and grammar of the language, but he did not confine himself to matters connected only with that part of the world, but on most subjects, geographical and ethnological, he held, and frequently expressed, opinions of his own. He died at an advanced age in a sudden and peaceful manner.

Proceedings of the Royal Geographical Society.

The safety of Dr. Livingstone having been doubted by some members of the Society in spite of the opinion constantly expressed by Sir R. Murchison, letters from that traveller which were read at the tenth meeting excited some considerable interest. The news in these, however, did not reach to a very late period, the doctor's own letter being dated Bemba (lat. 10° 10′ S.), 2nd February, 1867, whilst that from Dr. Kirk contains news of him up to October last. The traveller, who had with him only the African boys educated at Nassick, Bombay, had remained at the town of Mataka, a chief whose dominions stretched from the watershed between Lake Nyassa and the sea to the lake itself, a distance of fifty miles. Hence the journey seems to have been continued westwards, but whether round or across the lake does not appear. The next points made seem to have been some of the tributaries on the left bank of the Zambesi, *viz.* the Chambese and the Loangwa, the watershed between which streams the doctor thought he had gained at Bemba. At the time he wrote he was making for Casembes, and thence he was to go to the lake of Taganyika, which Dr. Kirk says he reached in October last at Ujiji, at the point where stores awaited him. These letters were sent down by Arabs travelling to Ragamoyo, a place on the coast near Zanzibar. Letters, maps, and stores would meet the doctor at Ujiji, being forwarded from Zanzibar.

The Rev. F. W. Holland, during the last winter, has made a third visit to the Sinaitic peninsula. The results of his journey were given in a paper read on the 11th May. Starting from Suez on foot, he reached the monastery at the foot of the Jebel Musa (Mount Sinai), his head-quarters, whilst he explored the whole country in that neighbourhood for four months. Letting himself down from the wall of the convent, he daily traversed some mountain path, assisted by Arabic ibex hunters. Occasionally he took an Arab to carry his blanket and bag of provisions when he intended to camp out for three or four nights. He was thus enabled to take heights of mountains, and to measure and map out valleys hitherto incorrectly given. He found more vegetation than previous information had led him to suppose, and two or three springs were to be discovered on every mountain. Jebel Um Alowee (possibly a corruption of Elohim), north-east of Jebel Musa, is a fresh discovery of Mr. Holland's, and he puts it forward as a possible rival to the latter mountain as the true Sinai. The wilderness of Sin he would identify with the plains of Es Seyh; and he adds his protest to that of many others against the theory that the Sinaitic inscriptions are to be esteemed the work of the Israelites on their journey out of Egypt. The next paper was by Commissioner Chimmo on the north-east coast of Labrador.

At the anniversary meeting, on Monday, 25th of May, the Founder's Medal was awarded to Dr. Augustus Petermann, the well-known geographical writer, the originator of the German expedition to the North Pole, the editor of the 'Geographische Mittheilungen;' and at the same time the Patron's or Queen's Medal was assigned to M. Gerhard Rholfs, on account of his journeys into the interior of Africa from the northern coast, from which, on one occasion, he penetrated as far as the Guinea coast. A gold watch also was awarded as an extra distinction to the pundit, whose name has not yet appeared, but who was employed by Captain Montgomery to survey in Thibet. The report of the Council, recommending the presentation of two gold and two bronze medals to the successful candidates at an annual examination in physical and political geography, was afterwards received and approved. The Chief Commissioner of Crown Lands has promised the Society a site for building facing the Thames Embankment, where the maps and books of reference of the Society might be readily accessible to the public.

The President, in his address, enumerated those works that had been added to this library during the last year, amongst which may be mentioned Keith Johnson's New Atlases, and Major's 'Life of Prince Henry.' The obituary of the year included the names of the late President, Mr. William John Hamilton, Lord Rosse, Lord Colchester, the Right Hon. Sir George Clark, Captain James Mangles, R.N., Mr. Ashurst Majendie, the Rev. Pierce Butler, Sir Charles Lemon, &c., and as we have mentioned before, Mr. John Crawfurd. After a brief sketch of the additions to our geographical knowledge, as they have from time to time appeared in these Chronicles, Sir R. Murchison dwelt at some length upon the progress of Dr. Livingstone, and the success of the expedition sent in search of him. He then pointed out the three routes which were open to the traveller on his return, showing that, according to his own calculation Dr. Livingstone might return to England by August next, whereas according to Sir Samuel Baker he possibly might arrive at Gondokoro next April, but not before, and he scarcely could with probability be expected until a much later date. The President referred to the appointment by the Government of Mr. Clements Markham, as geographer to the Abyssinian expedition. One positive gain to the Society, resulting from this appointment, was the desire of Sir Robert Napier to become a member of that body. The memoirs of Mr. Markham might be looked forward to as one of the most worthy parts of the Journal of the Society.

8. GEOLOGY AND PALÆONTOLOGY.

(*Including the Proceedings of the Geological Society.*)

"The unique specimen of *Archæopteryx lithographica* (von Meyer) which at present adorns the collection of fossils in the British Museum, is undoubtedly one of the most interesting relics of the extinct fauna of long-past ages; and the correct interpretation of the fossil is of proportional importance." With these words, Professor Huxley commences a paper, read before the Royal Society on January 30th, the object of which is to show that Professor Owen has mistaken the dorsal face of most of the bones for the ventral; the left femur, left tibia, and bones of the left foot for the "right femur, tibia, and bones of the foot," and so forth. Professor Huxley concedes that the furculum (if it be such) turns its ventral surface to the eye, and he suggests "that it is the *bouleversement* of this bone which has led to that reversal of the proper nomenclature of the other bones, which, could it be sustained, would leave *Archæopteryx* without a parallel in the vertebrate sub-kingdom." By the light of his correction, however, he considers that many points of the structure of this remarkable fossil "acquire an intelligibility which they lose to those who accept the interpretations given in the memoir" by Professor Owen. But the "furculum" still presents an osteological difficulty which even Professor Huxley cannot surmount. He is also of opinion that if the head of Archæopteryx, when discovered, should possess jaws containing teeth, it would not, to his mind, on that account, cease to be a bird, any more "than turtles cease to be reptiles because they have beaks." An abstract of this important paper will be found in No. 98 of the 'Proceedings of the Royal Society.'

Another of Professor Owen's papers has been severely criticized by Messrs. Albany Hancock and Thomas Atthey. On June 3rd of last year Professor Owen read a paper "On the Dental Characters of Genera and Species, chiefly of Fishes, from the Low Main Seam and Shales of Coal, Northumberland," before the Odontological Society of Great Britain. An abstract of this paper appeared in the next (July) number of the 'Geological Magazine,' and the following number of that periodical contained a criticism upon it from the pen of Mr. Thomas Atthey. The paper having been published in full, with illustrative plates, in the 'Transactions of the Odontological Society' for 1867, Mr. Atthey, now in conjunction with Mr. Hancock (a well-known naturalist, and one of considerable eminence as a malacozoologist), has published his criticisms in detail in the April and May numbers of the 'Annals and Magazine of Natural History.' Professor Owen describes twelve genera of Fishes and Batrachians; but Messrs. Hancock and Atthey find themselves "compelled to conclude that there is positively not a single novelty in the whole series." For instance, they state that "it is apparently on fragments of the jaw-bones and on the teeth of *Rhizodopsis sauroides* that Professor Owen has founded the *Dittodus parallelus*, *Ganolodus Craggesii*, *Characodus confertus*, and the Batrachian genus *Gastrodus!!*" Again, other remains, described as teeth of a small fish by the name of *Mitrodus quadicornis*, his opponents consider to be a large kind of dermal tubercles, and remark, "this 'minnow,' then, of our shales is found to be identical with *Gyracanthus tuberculatus*, perhaps the largest fish of the Coal-measures." To the younger palæontologists these confident assertions of Professor Owen's errors will appear incredible. It therefore seems highly desirable that the matter should be investigated by yet one more eminent odontologist.

The fossils of the Portlandian deposits of the department of the Yonne have been carefully described and figured by M. de Loriol, in a monograph by that palæontologist, and M. Cotteau.* The latter author divides the series into two zones, namely, a lower one characterized by *Ammonites gigas*, and an upper by *Pinna supra-*

* Bull. Soc. d. Sciences hist. et nat. de l'Yonne, 2e série. Vol. i., 1868.

jurensis. The richness of the upper zone contrasts very strongly with the poverty of the lower, the species yielded by the whole formation numbering 122, of which only thirteen belong to the zone of *Ammonites gigas,* four of them being common to both. Twenty-six species are common to these beds and the lower zones of the "terrain Kimméridien," and twenty-two occur in the Lower Portlandian of the Boulonnais, while only four are common to them and the Upper and Middle Portlandian. To the Lower Portlandian, therefore, the authors refer the two zones of the Yonne formation. M. Cotteau, who has contributed the geological portion of this excellent monograph, records that the Neocomian beds are found reposing sometimes on the zone of *Ammonites gigas,* and sometimes on that of *Pinna suprajurensis.* From this fact he infers the existence of a stratigraphical break or unconformity between the two formations. M. de Loriol, however, from a palæontological standpoint, regards these two zones as two *facies* of the Portlandian, inferring that in the west of the Yonne district circumstances favoured the deposition of the zone of *Pinna suprajurensis,* or, in other words, the existence of its rich fauna, while in the remainder the more scanty population of the zone of *Ammonites gigas* could alone flourish. Similarly with the Neocomian, which at Bernouil is represented by the remarkable zone of *Peltastes stellulatus,* covering the Portlandian beds in that area, while at Auxerre the latter are succeeded by the ordinary marls and yellow limestones of the Lower Neocomian formation. M. de Loriol also remarks that the division between the Cretaceous and Jurassic series appears to be less decided in the Alpine area than in any other.

In a paper on the classification of certain Fossil Corals, published in the recently issued volume of the 'Philosophical Transactions' for last year, Dr. Duncan comes to the conclusion that the genus *Palæocyclus* must be abolished, and that its species must be added to the genus *Cyathophyllum.* Thus a representative of the Tertiary coral-fauna is removed from the Palæozoic. The author also shows that the genus *Battersbya* does not belong to the *Milleporidæ,* but should be associated with the formerly solitary genus *Heterophyllia* in a division of the *Astræidæ.* Thus two genera with Mesozoic affinities are introduced into the Palæozoic coral-fauna.

On March 12th Mr. J. A. Phillips read a paper before the Royal Society on the "Chemical Geology of the Gold-fields of California."* He infers that quartz-veins have generally been produced by the slow deposition of silica from aqueous solutions, that their formation is due to hydrothermal agencies, and that the silica may have been slowly deposited at low temperatures. The author also speculates on the cause of the presence of gold in the same solution, and sug-

* 'Proceedings of the Royal Society,' vol. xvi., No. 100, p. 294.

gests that the bisulphide of iron may have been connected with the solvent by which the precious metal was held in solution.

In a short paper in the 'Bulletin' of the Geological Society of France,* M. Gaudry announces that his researches at Pikermi have led him to doubt in some cases the generally received proposition, that if in a deposit we find the remains of vertebrata † which have not been derived from an older bed, the animals to which they belonged lived at the time that deposit was being accumulated, and that consequently they serve to characterize its age.

The 'American Journal of Science and Arts' for March contains two papers on recent geological changes in China and Japan, namely, one by Mr. Albert S. Bickmore, and one by Mr. Raphael Pumpelly. Both authors describe the gradual rise of the land in eastern China, and give more or less precise descriptions of the extraordinary changes that have recently taken place in the courses of some of the rivers, notably the Yellow River. Mr. Bickmore, however, believes that at Foochow and about the mouth of the river Min, there is an area which has for some time been slowly subsiding, presenting a remarkable exception to the general rule.

In the same number of that Journal is a paper by Mr. E. Andrews, on the Localities of Human Antiquities at Abbeville, Amiens, and Villeneuve, in which he advocates the theory that the annual rainfall at the period when the gravel was being deposited was immensely greater than it is at present; and that the time required for the deposition of the gravel was proportionately short, in consequence of the rapidity of the accumulation. It will be seen presently that Mr. Tylor has, in the 'Quarterly Journal of the Geological Society,' advocated the theory of a Pluvial Period at the epoch treated of by Mr. Andrews.

Professor G. Seguenza has a note in the 'Atti della Società Italiani di Scienzi Naturali' ‡ on the Middle Cretaceous deposits of central Italy, in which he shows their complete correspondence with the Cretaceous rocks of Algeria belonging to the zone of *Ammonites Rothomagensis*. The geological conditions are stated to be precisely similar; and in a list of forty-four species of Italian fossils, forty-three are indicated as occurring also in the African formation. Professor Seguenza, therefore, seems perfectly justified in concluding that the Middle Cretaceous sea extended from Central Italy to the Province of Constantine.

The 'Geological Magazine' for the quarter has been characterized by many valuable papers. The contents of the March number include a reply to Dr. Sterry Hunt's views on Chemical Geology, by Mr. David Forbes; a descriptive paper on the Geo-

* Proceedings of the Royal Society, vol. xxiv., p. 736.

† "Quadrupeds" in the title.

‡ Vol. x., fasc. 2, p. 225.

logy of Charnwood Forest, which possesses considerable additional interest on account of its having been written by the late Rev. Baden Powell; the conclusion of Mr. Carruthers's admirable revision of British Graptolites; and some other articles and translations of value.

In the April number, Mr. Carruthers describes some British Fossil, *Pandaneæ*, or "Screw Pines," from the Inferior and Great Oolite and the Potton Sands. This group of Pines at the present day inhabits the tropical and sub-tropical regions of the Old World. The other papers include a useful description of the Gault of Folkestone, by Mr. De Rance, and the commencement of a valuable account of the Fossil Insects of North America, by Mr. Scudder.

The last-mentioned paper is concluded in the May number, and from it we learn that 87 species of fossil insects have been discovered in North America. The *Diptera* (45), *Hemiptera* (6), *Hymenoptera* (3), and *Lepidoptera* (2), omitting one doubtful Carboniferous species, are restricted to the Tertiaries, as also are the *Coleoptera* (10), except one species from the Trias. The *Orthoptera* and *Neuroptera* (together numbering 18 species) are, the former Carboniferous, and the latter Carboniferous and Devonian, while the *Myriapoda* (2) are also Carboniferous.

Professor Huxley describes in the May number two new South African fossil reptiles, and there are several other articles of interest, especially one on Clacton, in Essex, by the Rev. Osmond Fisher.

Proceedings of the Geological Society.

A large portion of the last 'Quarterly Journal' is occupied by the Annual Report and the Anniversary Address of the President (Mr. Warington W. Smyth). The latter includes notices of a variety of recent researches—especially on the origin of crystalline rocks, and on the geology of the Alps—and of the latest results of various geological surveys; but it is mainly occupied with discussions of three very interesting subjects, namely: (1) the physical structure of Palestine; (2) the climate of the earth's surface during past geological periods; and (3) the temperature of the earth's crust at great depths below the surface.

On the first subject we must draw attention to Mr. Smyth's able summing up of the arguments relating to the origin of the Dead Sea depression. So impartially does he weigh the evidence, and state the various conclusions which it has suggested, that it is difficult to ascertain his own convictions on the subject. It seems probable, however, that he favours the view suggested first by Hitchcock and adopted by Lartêt, "that a fault or dislocation takes its course along the line of the valley, having a heavy downthrow to the west, and that, in fact, the present depression was produced by a relative descent of the eastern side of the hill-district of Judæa during the movements that raised the entire land from the sea." The change in the surface-level of the Dead Sea, and the speculations on the causes which have contributed to lessen the volume of its waters, lead Mr. Smyth by an easy step to a discussion of the numerous facts which prove oscillations of climate during past geological periods, and to an examination of the theories which have been advanced in explanation of the phenomena of the Glacial Period in countries which now enjoy a comparatively warm climate; and of a sub-tropical climate in Miocene times in regions which lie within the frigid zone of the Recent period. Considerable attention is given by the President to the familiar theory of the Swiss geologists, that the comparatively shrunken condition of the existing glaciers is due to the hot blast (called the Föhn or Scirocco) which keeps the snows and glaciers in check at the present day having its origin in the African deserts, while during the Glacial period this wind did not prevail in consequence of the deserts having then been submerged. It has, however, been shown by Professor Dove that the great bulk of the winds which descend hot, and full of moisture, on the Alpine regions has ascended from land and ocean far to the west of Africa. The inconclusiveness of the Swiss theory has also been illustrated on other grounds by Sir Charles Lyell, who has, in this connection, called attention to the fact that the sea of the North African deserts continued to exist in Post-tertiary times.

The possession, during the Miocene period, of a sub-tropical climate by the region of North Greenland, between the parallels of 70° and 80° N., is even more difficult of solution, as at present it is generally allowed that changes in physical geography are, alone, insufficient to produce the effect, while the probable results of cosmical changes are at present but slightly understood by geologists.

With respect to subterranean temperatures, Mr. Smyth gives an interesting summary of the principal facts and opinions, and succeeds in producing the impression that all existing theories on the subject are somewhat premature; but he most happily describes the efforts, successes, and failures of geologists in comparing them to the incidents in a voyage of discovery. "The region we make for is one of vast extent; and we sail on various courses and in very different varieties of craft. Some of us push rapidly forward in fast clippers; others cleave their way slowly, and yet not always surely."

Of the papers contained in the 'Proceedings' of the Society, we must first notice that by Sir John Lubbock, "On the Parallel Roads of Glen Roy," in which the author objects to the commonly received opinion that these roads are the beaches, in the ordinary sense of the term, of an ancient lake or arm of the sea. Sir John regards the roads as having been formed by material which fell from the hill-side above the lake to lower levels beneath the water, until at the water-level a shelf was formed. He regards the loose material on the hill-side as lying at the angle of repose, so that all accessions would roll into the water and be arranged beneath it at the same angle. The width and slope of the roads would thus be dependent on each other, and would be determined by the depth to which the water was affected by waves. "In fact the lower level of the roads marks the lower edge of the disturbed water, just as their upper edge coincides with its upper edge. We thus see why the three shelves are so similar in size, and also why their width is least when their inclination is greatest."

Mr. Tylor's paper "On the Amiens Gravel" is an attempt to disprove the well-known conclusions of Mr. Prestwich respecting the relative age of Quaternary deposits, and the date and manner of the excavation of the valleys on the sides of which they rest. The Amiens gravel is selected for this paper because, probably, it yields a typical example, and one to which a large amount of attention has been drawn. Mr. Tylor's principal conclusions are, (1) that the surface of the chalk had assumed its present form prior to the deposition of any of the gravel or loess now seen resting upon it; and (2) that the Quaternary deposits indicate a Pluvial period, just as the Northern drift indicates a Glacial.

Dr. Nicholson's paper "On the Graptolites of the Skiddaw Series" is a contribution to descriptive Palæontology of a very useful kind, but, as recent criticisms appear to indicate, of somewhat debateable value.

The scope of the elaborate paper "On the Glacial and Post-glacial Structure of Lincolnshire and South-east Yorkshire," by Mr. Searles V. Wood, jun., and the Rev. J. L. Rome, is difficult to chronicle. It is a description of local phenomena, and an attempt to assign to them the causes by which they may conceivably have been produced. On two points, however, it possesses a more general interest, namely, (1) in the separation of the Boulder-clay of Hessle from the true Boulder-clay of the eastern counties, and from the purple clay which in the district under consideration overlies it, and in the determination of the younger age of the first-named deposit than the true Boulder-clay; and (2) in the assignment of the so-called "Bridlington Crag" to an horizon included within the limits of the "purple clay."

We are glad to learn from the Annual Report that the Society continues in a flourishing condition, no less than sixty-two new Fellows having been elected during last year, amongst the names of whom we notice those of Earl de Grey and Ripon, Mr. R. H. Scott, Director of the Meteorological Department of the Board of Trade, Mr. A. W. Franks, Keeper of the Antiquities in the British Museum, and Mr. W. Carruthers.

Mr. Warington Smyth has been succeeded as President by Professor Huxley.

9. METALLURGY AND MINING.

Metallurgy.

Mr. C. W. Siemens has recently communicated to the Chemical Society a paper "On the regenerative Gas-furnace as applied to the production of Steel." Although the question relates more strictly to chemistry, we refer to it in this place for the purpose of directing the attention of those who are at all interested in Metallurgy to the curious facts stated as to the power of tungsten in giving hardness to steel, and in enabling it to receive and retain the magnetic force. The regenerative gas-furnace was of course fully described, and its advantages in many processes especially pointed out.

Ever and anon the combination of wolfram with iron, or more correctly speaking of tungsten and iron, claims our attention. The following extracts from a report on its use in Germany, which has been published by A. Keiffenheim and Co., may be worthy of attention:—

The pulverized wolfram ore is weighed off for each raw iron charge in a quantity corresponding with the intrinsic percentage which it is thought desirable to allow. This quantity is mixed with one pound of powdered manganese, and half-a-pound of salt, and the mixture is put into bags.

The raw iron charge is smelted in the puddling-furnace, and after a strong heat begins to develop and ascend; the bags containing the alloy are to be pressed one after the other, and, at short intervals, into the liquid mass, and at the same time the puddler must quickly stir up the whole mass with the raker, in order that the alloy may be equally distributed throughout.

Such is the general description of the process. This wolfram iron is said to be remarkable for toughness and strength. If it be so, we shall soon hear more of it.

Large quantities of wolfram have been obtained from the Kit Hill and Drake Walls mines in the neighbourhood of Callington. At one time the combination of tin ore and wolfram was treated by a process patented by Mr. Oxland, but worked by M. Jacob at Drake Walls, and the tungsten, as tungstate of soda, preserved. The demand for tungsten falling off, this process has been abandoned. Experiments are now in progress at East Pool mine, near Redruth in Cornwall, for separating the wolfram from the tin, the worth of which it considerably lowers, and it is hoped that the value of tungsten as an alloy with iron or steel may render the results profitable.

A considerable improvement has been made in the extraction of sulphur from its ores in Italy. It has usually been sublimed by different, but in all cases by wasteful processes. The new process is as follows:—A vessel made of boiler plate, in the form of a truncated cone, is filled with the ore of sulphur. There is a grating at the bottom to prevent the ore from falling through into the receiver, and under this a strainer of sheet-iron pierced with small holes. Up the centre,—passing from top to bottom,—is a pipe communicating with a steam boiler, which pipe is perforated with small holes. The vessel containing the ore is carefully closed, the steam is turned on, and issuing from the perforated pipe, it finds its way amidst the ore. In the course of a short time the sulphur melts, becoming very liquid it flows through the grate and the strainer into the receiver, in which it is kept in a liquid state until all the ore in the vessel is exhausted; it is then run off into moulds.

An apparatus of this kind has been put up at the Elvetica Iron Works, and the saving in time—and therefore of money—is very great. The production of sulphur appears to be increased from 20 per cent.—the quantity obtained by the old processes—to 37½ per cent. by the new one.

One of the largest blast-furnaces in Europe was blown in recently at Ferry Hill, Durham. Two furnaces have been built, 105 feet in height, and 28 feet diameter, blown by four powerful blast-engines. The experiment appears to have been most successful; and if it continues to prove so, the problem of monster furnaces would appear to be solved.

The manufacture of the metal aluminium has entirely ceased in this country, the works which were established at Washington, near Newcastle-on-Tyne, having been stopped. Aluminium bronze is, however, still made in small quantities. The 'American Artizan' informs us of a new process for making this beautiful alloy, which offers some advantages over the original process. Mr. Evrard, to whom this new process is due, uses pig-iron containing aluminium: this is slowly heated to fusion, and copper is added to the melted mass. After the mixture has been well stirred together, it is allowed to cool very slowly, when the aluminium bronze settles at the bottom of the crucible, it being much denser than iron.

A similar process is said to have been adopted for the separation of silicium from iron, the affinity of copper for silicium being exceedingly energetic.

Mining.

About a year since the Peruvian Government sent out an expedition to explore the northern parts of that country, about the rivers Maranow and Morona, which are tributaries to the Amazon. A Government steamer was employed under the command of a Major Vargas. An official report has been recently issued. This shows that gold exists in great quantities in the region through which the expedition passed. It is affirmed that an Indian using the ordinary gold-washing bowl could gather several ounces in two or three hours. That gold exists in the alluvial deposits in these parts there is no doubt, but the quantity said to be obtained is open to many doubts.

Dr. Gustav Tschermak read before the Imperial Geological Institute a very complete account of the gold mines of Transylvania. It appears that the precious metal is found disseminated in almost imperceptible particles in the trachytic rocks in the environs of Falathna and D'Abrud Banya, where it is still worked by the most primitive methods. There are 300 families or partnerships, consisting each of three individuals or thereabouts. A thousand quintals of the rock yield about 8,500 grains of pale-yellow gold, which contain a little silver. The rolled *débris* of the crystalline rocks found in the valley of l'Aranyos is carefully washed, and yields about half an ounce of gold to 31,000 quintals of stuff. This gold is of a deeper colour and contains less silver. They also find gold in a peculiar freestone (*Carpathiques bocardes*), which is of a pale colour, like that found in the trachytes. The gold mines of Transylvania have been worked from the earliest historic times, yet they still furnish above 2,000 lbs. avoirdupoise annually.

Chevalier C. von Hauer, of the Austrian Geological Survey, thus describes the emery of Asia Minor :—There are four beds of emery known in Asia Minor, that of Scalanuova, worked by an English commercial house, which furnishes alone all the demands of the Liverpool market. That of Tira, worked by a Turk, abundant, but of inferior quality, having in two or three years sent to England from 40,000 to 50,000 quintals (2,240,000 to 2,800,000 kilogrammes); that of Djelat-Kaffé, only recently opened ; and, lastly, that of Gamlik, in the neighbourhood of the sea of Marmora, still little known. The emery of Naxos, of which the Government reserves the monopoly, is supposed to be of a superior quality to any other. The emery beds of the province of Smyrna have not been geologically explored. All that we can say of it is, that this mineral is found in compact masses, above the granite, and is traversed here and there by veins of this rock. It is worked without method. The greatest part of the produce is sent to Liverpool as it comes out of the mine, to be prepared and reduced to the form of powder more or less fine. The analysis of the samples sent to the Imperial Geological Institute, has proved in a hundred parts to be—

Silica	27·6	
Alumina	59·0	71·0
Oxide of iron	12·0	
Water	0·7	

The quality of emery is improved in proportion to the larger quantity of alumina it contains, and the smaller quantity of silica. That of the first quality contains only from 2 to 9 per cent. of silica; that of Asia Minor contains between 60 and 77 per cent. of alumina, and between 6 and 33 per cent. of oxide of iron.

The Coal-field of Johusdorfk (Styria), which was acquired by the State in 1842, is worked for a bed of Tertiary coal, and opened lengthwise to the extent of 3,000 fathoms (5,688 kilomètres). It consists of 23 grants, on a surface of 288,805 square fathoms, and on an extent of 1,500 fathoms (2,644 kilomètres) in length, in the direction of the bed. The working is carried on partly by open workings and partly by pillars: the carelessness and want of method with which the ancient proprietors proceeded have caused considerable losses of coal by subterranean fires, whose ravages cannot be stopped, except by expensive means, which also interfere with the regular working. In each of the two principal shafts there is a steam engine of 20-horse power, used as much for the exhaustion of the water as for the extraction of coal. The annual production is about 460,000 quintals (a quintal equals 56 kilogrammes), of which 80 per cent. are consumed by the iron forges of the neighbourhood. The workings employ 250 workmen, lodged in houses belonging to the State, who are treated in a special infirmary in cases of illness or accident. In 1866 the treasury for mutual assistance possessed a sum of 30,000 florins. (M. A. Pallausch, '*Imperial Geological Institute*,' sitting of the 31st March, 1868.)

The Austrian Geological Survey—chiefly by M. Foetterle and M. von Hauer—have prepared a map of the coal-fields of the Austrian empire, which has many novelties in its construction. In addition to the ordinary geological colouring, the annual coal produce of each locality is indicated by differently coloured squares; and lines of the same colour traced along the lines of railway, canals, and navigable rivers show the distribution of the coal at a single glance.

The total annual production of coal in the Austrian empire is according to this, the most recent authority, 80,000,000 quintals, about 9,000,000 statute tons.

The boring-machine put into Tincroft Mine, near Camborne, Cornwall, by Mr. Dëhring, some two or three months since, is answering well. It is found to work economically, and, under the guidance of two ordinary miners, the end is driven with great facility and small cost. General Haupt's machine, which is a drilling-machine, is now adapted to mining and tunnelling with advantage; and one of those machines is employed in an open quarry, doing its work well and with economy. The legislature of Massachusetts have asked General Haupt to take charge of the Hosaic Tunnel. Mr. Lowe's boring-machine is reported on as doing good work in Australia. We have consequently three machines competing with each other, and proving their relative values under different circumstances. We hope to see those machines employed ere long in our mines, to relieve the miners from the most trying part of labour.

10. MINERALOGY.

Is it desirable that the mineralogist should cast aside all those long-established formulæ by which he expresses the chemical composition of his mineral-species, and introduce in their stead a new set of formulæ, written in accordance with the advanced views of our modern chemists? Such is the question which Professor von Kobell discusses in a short but interesting paper "On Typical and Empirical Formulæ in Mineralogy."* *Typical* formulæ, we need hardly say, are those in which certain compounds (such as hydrochloric acid, water, and ammonia) are taken as general types, from which other bodies may be derived by replacing their constituents, according to definite laws, by other elements or by groups of elements called radicals. To illustrate the application of this type-theory to express the constitution of minerals, our author selects the double silicate of potash and alumina, called *leucite*. The composition of this species we are accustomed to represent by the following formula:

$$KO, Si\,O_2 + Al_2\,O_3,\ 3\,Si\,O_2.$$

But behold the aspect which our formula assumes when written on the type-theory:

$$\left.\begin{array}{c}\overset{IV}{Si_4}\\ \overset{VI}{Al}\\ K_2\end{array}\right\}O_{12}$$

It may be necessary to remind those of our readers who have not kept pace with the advance of modern chemistry, that such an expression simply means that the mineral in question may be regarded as formed on the water-type, and that the 24 atoms of

* 'Journal für praktische Chemie,' 1868, p. 159.

hydrogen in 12 molecules of water (H_2O) have been replaced by 4 atoms of tetratomic silicon, 1 atom of hexatomic aluminium, and 2 atoms of monatomic potassium. But although this mode of representing the constitution of chemical compounds has been of eminent service in organic chemistry, it would seem, even from this single illustration, that it is by no means of equal value in mineral chemistry.

From this consideration of typical formulæ, we turn to the second question discussed in Von Kobell's paper. At the present time the mineralogist endeavours to express the manner in which the constituent elements may be grouped together in any given mineral, by what is termed a *rational* formula. Many chemists, however, would have us confess our ignorance of this mode of grouping, and would simply write the elements side by side, without regard to the manner in which they may be associated: such formulæ are said to be *empirical*. Thus, the antimonial sulphide of lead called *plagionite*, has a rational formula, as follows:—$4\,Pb\,S + 3\,Sb\,S_3$; an expression which plainly shows that the mineral is composed of 4 molecules of galena and 3 of antimonite. The would-be innovator objects, however, to this theory, and gives us therefore an empirical formula written in this fashion: $Pb_4\,Sb_6\,S_{13}$.

From such examples as these, Von Kobell concludes that there is no necessity, at present, for supplanting our old-fashioned expressions either by typical or by empirical formulæ—a conclusion by no means distasteful to so conservative a creature as the mineralogist.

"Agates, I think, of all stones, confess most of their past history." Such are the words of Mr. Ruskin in his pleasing little work, 'The Ethics of the Dust;' and under this belief he has, of late, set himself the task of studying their history, and interpreting it to the readers of the 'Geological Magazine.'* In one paper he describes a group of agate-like structures which he calls "Dipartite Jaspers," and in a second communication notices the class of "Folded Agates," while he hints that other papers are forthcoming on "Mural Agates" and "Involute Agates." Certainly the most attractive features of these articles are the admirable tinted engravings by which they are illustrated.

It has always been a moot-point whether the peculiar markings observable in the so-called moss-agates and Mocha stones are truly of organic origin. As bearing upon this point, we call attention to a subject recently brought before the Chemical Society by Mr. W. C. Roberts.† Certain specimens of colloid silica prepared in Graham's dialyser, and evaporated in air, exhibited singular den-

* 'Geological Magazine,' April, 1868, p. 156; May, p. 208.
† 'Chemical News,' April 10, 1868, p. 175; April 24, p. 195.

dritic forms which, under the microscope, were found to consist of radiating fibres having a cellular structure. These were evidently low vegetable organisms developed from spores which were deposited from the atmosphere, since similar specimens dried *in vacuo* were destitute of such appearances. It is possible, then, that vegetable life may be developed in siliceous solutions during solidification.

Mr. David Forbes has published the second part of his "Researches in British Mineralogy." * In this paper he describes the occurrence of a sulphide of iron and nickel—probably a nickelliferous pyrrhotine—near Inverary Castle, in Argyleshire, and also at the Craigmuir nickel-mine, near Inverary. Our author calls attention to the tendency of nickel to associate itself with pyrrhotine or magnetic pyrites; whilst the allied metal, cobalt, prefers association with the ordinary iron pyrites. The same paper contains a notice of an arsenio-sulphide of nickel, referred to the species *Gersdorffite*, also found in the Craigmuir nickel-mine. An abstract of both the first and second parts of Mr. Forbes's "Researches" will be found in the 'Geological Magazine.'†

The exceedingly rare arseniate of copper called *Cornwallite* has been lately examined by Professor Church, who shows that the mineral contains only two equivalents of combined water, instead of five, as hitherto supposed. Its amended formula is thus given,‡ using of course the new equivalents:—

$$Cu_3\ 2\,As\,O_4,\ 2\,Cu\,H_2\,O_2,\ aq.$$

At length mineralogists are beginning to recognize the value of the microscope as an aid in their investigations. Herr Zirkel, whose name must be familiar to every geologist in connection with his admirable 'Petrographie,' has recently laid before the German Geological Society his researches "On the Microscopic Structure of Leucite, and the Composition of Leucite-bearing Rocks."§ Many crystals of this mineral exhibit, on section, a number of included glass-like particles and acicular bodies, either accumulated in the centre or symmetrically distributed around the margin of the crystal. The use of polarized light reveals a beautiful system of alternate dark and light lines, bearing a relation to the micro-lamellar structure of the mineral.

In a paper on the Basaltic Rocks of the Lower Main Valley, Herr Hornstein describes a new mineral to be called *Nigrescite.*‖ It occurs in the anamesite of Steinheim near Hanau, and may pos-

* 'Philosophical Magazine,' No. 236, p. 171.
† May, 1868, p. 222.
‡ 'Chemical News,' April 10, p. 175.
§ 'Zeitschrift d. Deutsch. Geolog. Gesell.' Bd. xx., Hft. 1, p. 97.
‖ 'Zeitsch. d. Deutsch. Geol. Gesell.' Bd. xix., p. 342; 'Neues Jahrb. f. Mineralogie,' 1868, Heft 2, p. 202.

sibly be only an altered form of olivine. Its composition is thus given:—

Silica	52·29
Alumina	5·14
Lime	2·59
Magnesia	18·11
Protoxide of iron	15·71
" of manganese	0·23
Water	6·29
	100·36

Professor Hermann has again directed his attention to the study of the rare mineral *Columbite*.* He shows that the metal tantalium is present in this mineral in the state of tantalic acid (Ta_2O), and may therefore be replaced by the corresponding acids of niobium and ilmenium. Hence he establishes for columbite the general formula, RO, R_2O_3, where RO represents the protoxides of iron and manganese, whilst R_2O_3 represents tantalic, niobic, and ilmenic acids.

The Swedish mineralogist, Igelström, describes a new species from the iron mines of Långban, in Wermland.† From the manner in which it is disseminated through the matrix, he proposes to call it *Kataspilite*. It may perhaps turn out to be an altered variety of cordierite, with which it agrees in crystalline form. Its composition will be seen from the following analysis:—

Silica	40·05
Alumina and peroxide of iron	28·95
Lime	7·43
Magnesia	8·20
Potash	6·90
Soda	5·25
Loss	3·22
	100·00

An elaborate study of the optical characters of the minerals Harmotome and Wöhlerite has led M. Des Cloiseaux to the conclusion that the crystalline forms of these species must be referred to the *oblique* system, and not to the rhombic system, as previously imagined.‡

Professor Rammelsberg has been engaged in investigating the chemical composition of prehnite, talc, steatite, and chlorite; but his researches are not of general interest.§

On the 30th January of the present year a remarkable shower of meteoric stones fell at Sielce and Gostkow, near Pultusk, in Poland. Several of these stones are now in the British Museum. Externally

* 'Journ. f. prakt. Chemie,' 1868, p. 127.
† 'Neues Jahrb. f. Mineral,' 1868, Heft 2, p. 203.
‡ 'Proc. Roy. Soc.,' vol. xvi., No. 101, p. 319; 'Phil. Mag.,' June, 1868, p. 461.
§ 'Zeitschr. d. Deutsch. Geol. Gesell.,' Bd. xx., p. 79, 82.

they are covered with a dull dark-coloured crust, whilst internally they exhibit a bluish-grey colour, somewhat resembling the well-known meteorites of L'Aigle, in France.*

In spite of the value and variety of our British minerals, we have hitherto been without any work treating specially of their geographical distribution. Mr. Hall has therefore rendered a service to our science by collecting and arranging the principal mineral localities in Britain, and publishing them in the shape of a 'Directory.'† The topographical portion of the work is preceded by an alphabetical list of our 246 British species and sub-species, showing the percentage composition of each. The localities are arranged under their respective counties, and when possible the geological position of each mineral is noticed. Nothing would be easier, were we so disposed, than to point out numerous omissions and errors; but we refrain from doing this, under the belief that it would be wrong to seek perfection in the first edition of a work of reference of this character.

The continuation of Kenngott's 'Forschungen,' noticed in the Chronicles of last quarter,‡ has since been published in the shape of a bulky octavo,§ and the compiler turns out to be Dr. Kenngott himself.

Dr. Schrauf, of Vienna, has lately given us the second volume of his elaborate work on Physical Mineralogy,‖ the earlier volume of which has already been noticed in this Journal.¶

Tridymite is the name which Vom Rath proposes for a new Mexican mineral which promises to become of considerable interest; but as only a short preliminary notice has yet been published, we defer our description until we are in possession of further details.**

11. PHYSICS.

After a long series of experiments, Baron von Liebig has finally adopted the following process for silvering glass for optical purposes. The solutions employed are:—I. One part of fused argentic nitrate dissolved in 10 of water; II. (*a*) Commercial nitric acid, free from

* 'Poggendorf's Annalen,' 1868, No. 2, p. 351; 'Geol. Mag.,' May, p. 248.

† 'The Mineralogist's Directory; or a Guide to the principal Mineral Localities in the United Kingdom of Great Britain and Ireland.' By Townsend M. Hall, F.G.S.. London: 1868. 8vo, pp. 168.

‡ P. 256.

§ 'Uebersicht der Resultate Mineralogischer Forschungen in den Jahren. 1862–65,' entworfen von Dr. Adolf Kenngott. Leipzig: 1868. 8vo, pp. 482.

‖ 'Lehrbuch der physikalischen Mineralogie,' von Dr. Albrecht Schrauf. II. Band. 'Lehrbuch der angewandten Physik der Krystalle.' Vienna; 1868. 8vo, pp. 426.

¶ Quart. Journ. Sc., vol. iii., p. 293.

** 'Pogg. Ann.,' 1868, No. 3, p. 507; 'Geol. Mag.,' June, p. 281.

chlorine, neutralized with ammonic sesquicarbonate, and diluted to sp. gr. 1·115; or (*b*) 242 gr. ammonic sulphate dissolved in 1,200 c.c. water (sp. gr. 1·105 to 1·106); III. Solution of sodic hydrate sp. gr. 1·050 prepared from sodic carbonate, free from chlorine; IV. 50 grm. white sugar candy dissolved in little water, 3·1 gr. tartaric acid added, the mixture kept boiling for one hour, and diluted to 500 c.c.; V. 2·857 gr. dry cupric tartrate, covered over with water, and solution of sodic hydrate gradually added till solution has taken place, and the volume made up to 500 c.c. These solutions are mixed in the following proportions:—1st, 14 vol. of I., 10 vol. of II., and 75 vol. of III., = 99 vol. of (A) silvering solution; 2nd, 1 vol. of IV., 1 vol. of V., and 8 vol. of water = 10 vol. of (B) reducing solution. The silvering mixture is then made by diluting 50 vol. of the silvering solution (A) with from 250 to 300 vol. of water, and adding 10 vol. of the reducing solution (B). If ammonic sulphate has been employed for solution (A), the liquid, after mixing the three ingredients, must be allowed to stand three days before being used; the clear liquor may then be drawn off.

Professor Draper of New York, who has also paid great attention to this subject, recommends the following process as being very successful for silvering glass mirrors. He divides the process into five operations, *viz.* the cleaning of the glass, the preparation of the silvering solution, the warming of the glass, the process of silvering, and the polishing. (The description is for a 15½-inch mirror.) 1. Rub the glass plate thoroughly with aquafortis, and then wash it with plenty of water and set it on edge on filtering paper to dry; then cover it with a mixture of alcohol and prepared chalk, and rub it in succession with cotton flannel. 2. Dissolve 560 grains of Rochelle salt (tartrate of soda and potassa) in 2 or 3 ounces of water and filter; dissolve 800 grains of nitrate of silver in 4 ounces of water. Take an ounce of strong ammonia of commerce and add nitrate solution to it until a brown precipitate remains undissolved. Then add more ammonia and again nitrate of silver solution. This alternate addition is to be carefully continued until the silver solution is exhausted, when some of the brown precipitate should remain in suspension. Filter. Just before using, mix the Rochelle salt and add water enough to make 22 ounces. The vessel in which the silvering is to be performed should be a circular dish of ordinary tin plate, and coated with a mixture of equal parts of beeswax and rosin. At opposite ends of one diameter two narrow pieces of wood are cemented to keep the face of the mirror from the bottom of the vessel. 3. The glass is slightly warmed by putting it in a tub or other suitable vessel and pouring in tepid water to cover the glass; then hot water is gradually stirred in. 4. Carry the glass to the silvering vessel, into which the silvering solution has been poured, place the whole apparatus before the window, and keep up a slow rocking motion. Leave the mirror in the liquid twenty minutes or half-an-hour, and wash with plenty of water. 5. When the mirror is perfectly dry, take a piece of the softest buckskin, stuff it with cotton, and go gently over the whole silver surface to condense the silver. The best stroke is a motion in small circles; rub an hour. The thickness of the silver thus obtained is about 1-200,000th of an inch.

Dr. W. M. Watts, who has been occupied for some years in the spectral examination of the Bessemer flame, has collected together some of his most important results. The changes which take place in the spectrum from the commencement of the *blow* to its termination are extremely interesting. When the blast is first turned on, Dr. Watts says that nothing is seen but a continuous spectrum. In three or four minutes the sodium line appears flashing through the spectrum and then becoming continuously visible; gradually an immense number of lines become visible, some as fine bright lines, others as intensely dark bands; and these increase in intensity until the conclusion of the operation. The cessation of the removal of carbon from the iron is strikingly evidenced by the disappearance of nearly all the dark lines and most of the bright ones.

The spectrum is remarkable from the total absence of lines in the more refrangible portion; it extends scarcely beyond the solar line *b*.

The occurrence of *absorption*-lines in the Bessemer-spectrum is in itself extremely probable; and that this is the case appears almost proved by the great intensity of some of the dark lines of the spectrum. It was with this view that the investigation was commenced, with the expectation that the spectrum would prove to be a compound one, in which the lines of iron, carbon, or carbonic oxide, &c., would be found, some as bright lines, others reversed as dark absorption-bands. To a certain extent this anticipation has been verified; but the great mass of the lines, including the brightest in the whole spectrum, have not as yet been identified.

In dealing with a complicated spectrum like that of the Bessemer-flame, it is indispensable that the spectrum should be actually compared with each separate spectrum of the elements sought.

The coincidences observed were, however, but very few, and totally failed to explain the nature of the Bessemer-spectrum. The lines of the well-known carbon-spectrum do not occur at all, either as bright lines or as absorption-bands; nor was any coincidence observed between the lines of the Bessemer-spectrum and those of the carbonic-oxide vacuum tube.

The lines of lithium, sodium, and potassium are always seen, and are unmistakable. Three bright lines have been recognized as due to iron. The red band of hydrogen is seen as a black band, more prominent in wet weather.

After the charge of iron has been blown, it is run into the ladle, and a certain quantity of the highly carbonized *spiegeleisen* is run into it. The effect of the addition of the spiegeleisen is the production of a flame which is larger and stronger when the blow has been carried rather far. This flame occasionally gives the same spectrum as the ordinary Bessemer-flame; but more commonly a quite different spectrum is seen, which reminds one at first of the ordinary carbon-spectrum, but differs from it very remarkably.

In the carbon-spectrum each group of lines has its strongest member on the left (*i.e.* less refrangible), and fades gradually away towards the right hand: in the spectrum of the spiegel-flame the reverse is the case; each group has its brightest line most refrangible, and fades away into darkness on the least refracted side. A comparison of the drawing of the spectrum of the spiegel-flame with that of the Bessemer-flame will show that they really contain the same lines; but the general appearance of the spectrum is completely changed by alteration of the relative brightness of the lines. This was shown by direct comparison of the actual spectra.

Dr. Watts concludes his paper by saying:—There can be no doubt that the principal lines of the Bessemer-spectrum are due to carbon in some form or other. My own belief is that they are due to incandescent carbon-vapour. The experiments in which I am at present engaged have already shown the existence of *two* totally different spectra, each capable of considerable modification (consisting in the addition of new lines) corresponding to alterations in the temperature or mode of producing the spectrum, and each due to incandescent carbon. It is possible that the Bessemer-spectrum may prove to be a third spectrum of carbon, produced under different circumstances from those under which the ordinary carbon-spectrum is obtained; and the intensity of the dark bands is more probably due to contrast with the extreme brilliancy of the bright lines, than to their actual formation by absorption.

At one of the recent meetings of the Manchester Literary and Philosophical Society, Mr. Dancer made some remarks on crystals containing fluid. The author has examined a large number of crystals of various kinds, from the collections of friends; and has found fluid in quartz from South America, Norway, the Alps, Ireland, Snowdon, and the Isle of Man; and in fluor-spar from Derbyshire; this latter specimen contained a considerable quantity of fluid, which burst the crystal at 180° F. He suggests the employment of the microscope as a valuable assistance in detecting spurious from real gems; very few of the latter are perfect, and the flaws and cavities are so distinct in character from those which are so abundant generally in artificial gems that very little experience is sufficient for the purpose. This mode of testing, of course, is limited to transparent crystals, but might be employed when the usual methods are not practicable. At the conclusion of the meeting, crystals containing fluid were exhibited under the microscopes, and the expansion of the fluid by elevating the temperature of the crystal whilst under examination.

HEAT.—The intense heat of the voltaic arc has been utilized by M. Le Roux for increasing the amount of light emitted by the incandescent carbon poles. By placing the base of a cylinder of magnesia, about eight millimetres in diameter, at a little distance from the carbon points, so that the arc may just touch it, the magnesia acquires a degree of incandescence comparable to that part in the bordering carbon craters. At the same time the light acquires a remarkable degree of constancy.

M. P. Pellogio has described a contrivance bv means of which the troublesome "bumping" peculiar to certain liquids when under distillation may be entirely prevented. It consists of a glass tube, as wide as practicable, inserted through the tubulus, and reaching nearly to the bottom of the retort, and having the upper end bent at a right angle, and drawn out to nearly capillary dimensions, thus establishing a communication between the outer air and the interior of the retort. With the help of this arrangement such liquids as methylic alcohol, sulphuric acid, petroleum residues, &c., distil as smoothly as alcohol or water.

A memoir on the physical properties and the calorific power of petroleum and mineral oils has been brought before the Academy of Sciences by M. Deville. The mineral oil was submitted to distillation in a copper alembic furnished with a long worm tube, and also with a thermometer. By means of this apparatus the amount of distillate passing over at various temperatures was estimated. The possible danger by explosion was measured by the proportion distilling below 140°. The same experimental fact represents as well the loss which must be sustained to remove the explosive property of the oil. Another danger is encountered when the oils are enclosed in air-tight vessels—explosion by dilation. The amount of space necessary to be left above a mineral oil is calculated from the co-efficient of dilation. The data M. Deville has obtained from each sample are drawn generally from the following determinations. Loss by heating to 100°, to 120°, and so on, by intervals of 20° up to 200°; this is expressed in percentages. Composition of the oil, *i.e.* percentages of carbon, hydrogen, and oxygen, obtained by combustion. Density at zero, and at 50°, and co-efficient of dilation. Composition and density of the oil obtained by distillation, and density of the residue. In some cases the specific heat has been determined, and the latent heat at the mean temperature. M. Deville's memoir contains tables giving an immense number of experimental results; it is, however, only a first memoir; more upon the subject will be brought before the Academy shortly. It may not be without interest to state that M. Deville has undertaken this research by command of the Emperor, to report upon the most advantageous arrangements to adopt for the economic and safe employment of mineral oils, with especial reference to its use in transports.

ELECTRICITY.—The fabrication of porous carbon, for electrical purposes, engages the attention of no inconsiderable number of persons in the present day; this kind of carbon is made most advantageously by the following process:—A mixture of wood charcoal and animal charcoal is ground to a coarse powder, mixed with sawdust, and dried at a steam heat; as soon as the material is dried, and while still warm, 20 per cent. of tar is added. When cold a certain amount of asphaltum is added, and the mass pressed into moulds. The proportions in which the ingredients are used vary according to the circumstances. The moulded objects are placed in boxes of sheet iron, and covered all over with a mixture of sand and charcoal; afterwards they are heated on the sole of a furnace. Gases which are disengaged during the operation are burnt in the furnace. The entire operation lasts about 24 hours. Careful attention is required during the calcination; the properties of the carbon depend, in a great measure, upon the management of this part of the process.

Some recent correspondence between the Trinity House and the Board of Trade shows that the electric light at Dungeness can now be worked by either of the two engines, so that no disturbance occurs when one requires repair. The services of the high-class engineers and firemen have been dispensed with, and the Elder Brethren have since been enabled to do that which the connection of the men with the trades union prevented—*viz.* to have their own ordinary keepers trained to drive the engines, as well as to attend to the lamps, a steady old experienced keeper being placed at the head of the establishment. The magneto-electric apparatus shown at the Paris Exhibition presented several improvements. The working by either of two machines showed that the power or the light can be duplicated in thick weather; and the engines were utilized for working the pumps of an air fog-trumpet. The electric light was compared with the flash of a first-order revolving oil apparatus belonging to the French authorities; and at fifteen miles distance the Trinity House engineer, Mr. Douglass, estimated the power of the fixed electric light at twice that of the flash of the oil light. The superiority of penetrating power of the electric light in fog was shaken by some experiments made by the Royal

Engineers, but it turned out that this result, so different from all other experience, arose from a settlement in the wood-work supporting the electric lens, causing the lens to be out of its proper position. Since the alterations made at Dungeness the light there has worked with great regularity and efficiency; and the Elder Brethren have proposed to place similar lights at the South Foreland, Lowestoft, and Souter Point. The Board of Trade approve of the extension of this mode of illumination to the South Foreland and Lowestoft, but at present suspend their decision respecting Souter Point. The Committee of Elder Brethren who attended at the Paris Exhibition say:—As far as the eye is a test, the power of the English fixed light was considerably in excess of the French, and when both machines were in use, and there was a good current, the fixed beam of the English light did not contrast unfavourably with the revolving one of the French, the flash of which is of great power. The contrast of the electric fixed light with the French first-order oil dioptric revolving light was very marked: indeed, the one may be said to put the other out. But the most beautiful feature of the electric was the extraordinary beam it gave. It shone night after night, large, steady, and lustrous as a planet, and you could see in the darkness a beam passing as far as the eye could see. From the tower, with the light at our back, it was very marked, and quite lit the hills round Paris. The whole horizon in the plane of the light showed the white beam, and at the distance of four miles it shone upon the windows of some houses, making them appear to be lit up. By extinguishing, and relighting quickly several times, this was very plain. Altogether the light was very remarkable, and the committee are glad to be able to report such an advance as the powers of the light show over that at Dungeness; indeed, the latter gives to the observer no conception of what the present one is, and it is satisfactory to know that the result of five years' work and observation, with imperfect and ill-arranged apparatus, has now borne such good fruit, and that as England was the first to test and adopt this adjunct to the sources of lighthouse illumination, so she still retains her superiority. It is due, however, to Mr. Holmes to say, that great as are the improvements already effected, he states that he is confident he can yet greatly increase the illuminating power before the present apparatus is re-erected at a permanent station.

The following telegraphic feat, the particulars of which are taken from the 'New York Journal of the Telegraph,' deserves record here. At an early hour on the morning of February 1st, the wires of the Western Union Telegraph Company from San Francisco to Plaister Cove, Cape Breton and the wires of the New York Newfoundland and London Telegraph Company from Plaister Cove to Heart's Content were connected, and a brisk conversation commenced between these two continental extremes. Compliments were then passed between San Francisco and Valentia, Ireland, when the latter announced that a message was just then being received from London direct. This was said at 7.20 a.m., Valentia time, Feb. 1. At 7.21 a.m., Valentia time, the London message was started from Valentia for San Francisco; passed through New York at 2.35 a.m., New York time; was received in San Francisco at 11.21 p.m., San Francisco time, Jan. 31, and was at once acknowledged—the whole process occupying two minutes actual time, and the distance traversed being about 14,000 miles! Immediately after the transmission of the message referred to, the operator at San Francisco sent an eighty-word message to Heart's Content in three minutes, which the operator at Heart's Content repeated back in two minutes and fifty seconds. Distance, about 5,000 miles.

12. ZOOLOGY—ANIMAL MORPHOLOGY AND PHYSIOLOGY.

(Proceedings of the Zoological Society of London.)

New Species of Ape.—It will be remembered that M. du Chaillu described a species of ape under the native name of *Nshiego Mbouvè*, though zoologists were unwilling to accept it as a novelty, referring it to a variety of a known species. Dr. Slack of Philadelphia, however, has described it, in a communication to the Academy of Natural Sciences of Philadelphia, as distinct from the Chimpanzee; and says that a fine skeleton of an adult has been for some time in the Academy's collection, and was until recently regarded as a chimpanzee. Duvernoy had previously decided in favour of its specific distinctiness. Dr. Slack's description is, "general colour black, sometimes grey in old age. Size, about equal to *Anthropopithecus niger*. Head, black and shining; chin of adult bearded. Ears, large, much larger than in the gorilla, though smaller than those of the chimpanzee. Inhabits the deep forests and table-lands of Equatorial Africa."

Acclimatization of Sparrows.—The sparrows introduced into Australia by the Acclimatization Society bid fair to become as great a nuisance as those of the south of England, which we hear of as being slaughtered by the thousand. The latest complaint against them is contained in a letter from the Rev. George Mackie of South Yarrow to the Melbourne Corporation, in which he complains of the excessive damage done to his fruit-trees in consequence of the depredations of sparrows and similar birds, and asks permission to use a gun against them.

Moa Skull.—A perfect Moa skull is said to have been found near Westport, near a prospector's claim on the Caledonian Lead, at a depth of 25 feet from the surface, and embedded in clay that had no appearance of ever having been disturbed. The men who discovered it are now engaged in excavations, in the hope of finding the remainder of the skeleton.

Disease in Grouse.—Dr. John Young, of Glasgow, has investigated this subject, and finds that nearly every bird he examined was affected with tape-worm, not, however, as the primary disease, but arising from peritoneal inflammation, which resulted in adhesion of the intestines and in perforation. He considered the disease as not arising from local causes, but from mal-nutrition, inducing an inherited cachectic condition, which predisposed the young to suffer from temporary influences. Mr. Gray attributed great influence to over-protection—the annihilation of its natural enemies having allowed a greater number of sickly birds to survive; and thus a weaker race had sprung up where formerly only strong birds prevailed. Man's interference thus disturbed the nice balance of nature, and the consequent evils followed.

The Fauna of Palestine.—The Rev. H. B. Tristram recently read a paper before the Royal Society upon the results of the Palestine Exploration, as regards the Fauna and Flora. An examination of the Fauna shows that it forms an extreme southern province of the Palæarctic region, impinging upon the Ethiopian closely, and more distantly upon the Indian. The mammals point to an earlier settlement than that made across the recent deserts; there is no Indian immigration, and *Hyrax Syriacus* is an exclusively Ethiopian type. The birds are numerous and very irregularly distributed, the Dead Sea basin being distinct and typical, sometimes Indian, generally Ethiopian, in character, with no less than twenty-seven peculiar species. Among reptiles there is less intrusion of Ethiopian types, and snakes in particular are more limited to the original locality of the individuals. River-fish are few in number but distinct. Most of the eighty-one species of land and fresh-water mollusca have no geographical significance; the fresh-water being more distinct than the pulmonifera, and indicating a very ancient separation from any adjacent district. Similar inferences are drawn from the Arachnida and insects, as well as the Rhizopod fauna, which is similar to that of the Indian Ocean. It is remarked that the peculiar fish of the Jordan date probably from the earliest period after the elevation of the land.

Theory of Birds' Nests.—In an interesting paper by Mr. Wallace, in the 'Journal of Travel,' he endeavours to prove that the exact mode of nidification of each species of bird is probably the result of a variety of causes, which have been continually inducing modification, in accordance with changed organic or physical conditions, *viz.* first, the structure of the species; and second, its environment. He further points out that these are correlative, the former cause depending upon the latter, and *not vice versâ.* Mr. Wallace lays it down as a rule, that when both sexes of birds are of strikingly gay and conspicuous colours, the nest is such as to conceal the sitting bird; while whenever there is a striking contrast of colours (the male being gay and conspicuous, the female dull and obscure), the nest is open and the sitting bird exposed to view. He gives many illustrations of this view, embracing almost every group of bright-coloured birds. Mr. Wallace says he was first led to see these relations by the study of protective resemblance or *mimicry* among insects, and points out that there is no incapacity in the female sex among birds to receive the same bright hues and strongly contrasted tints with which their partners are so often decorated, since whenever they are protected or concealed during incubation, they are so adorned: hence, he infers, that it is due to the absence of such concealment that gay and conspicuous tints are withheld, as in the Chatterers, Manakins, and Tanagers. A few anomalous facts supply a crucial test, *viz.* in cases where the males assist in incubation, or perform it altogether, in which case, as in the Grey Phalarope, the sexes, which are alike in winter, become reversed in colours in summer, the female instead of the male taking on a gay and nuptial plumage—while the male sits on the eggs, which are laid upon the bare ground.

A curious instance of misplacement, for want of sufficient specimens for examination, seems likely to be corrected, in the case of a bird (*Steatornis caripensis*), referred to the goat-suckers from outward resemblance, but which is known to feed on fruits so hard as to require a hammer to break them. Specimens have lately been received in spirits, and presented to the College of Surgeons and British Museum, which will be submitted to anatomical examination.

Sexes of Spiders.—Mr. Pickard-Cambridge remarks upon the numerical relations between the sexes of spiders. He says that in the extensive group Epëiridæ, comprising several genera, he has never seen an example of the male sex; nor in an examination of the Museums of Vienna, Milan, Berlin, Frankfort, and Leyden, could he meet with a specimen, though females occurred in them all. He supposes that the males of this group are exceedingly small compared to females, and probably overlooked by collectors—and probably they would look like little horny and more or less spiny *ticks*. In Nephila, which are giants of the spider race, the males are almost unknown, and when known are ridiculously disproportionate in size to the females. Some species of other families also present a striking disproportion in the relative size of the sexes.

The extraordinary sexual history of the spiders may account for this on Mr. Darwin's principle of *sexual selection*. Thus the smaller the male individuals, the more chance they would have of escaping the ferocity of the female by playing at hide and seek among her limbs and over her body in the mode M. Vinson describes. This selection would go on exercising its inevitable influence upon the size of the males until at length they became what in M. Vinson's instances they appear to be—mere parasites upon the female; the indefinite diminution of the male would only be checked by the natural requirement of a certain size for the fulfilment of the offices of impregnation.

Lithodomous Annelids.—Mr. Ray Lankester records some cases of Annelids of the genera Sabella and Leucodore which occurred in calcareous boulders, and points out the curious fact that none of the accompanying sand-stones, however indurated, nor the clay, were ever bored, the perforations being entirely confined to rocks of the same chemical composition, whether soft as chalk or dense as limestone. Having pointed out that there is no hard structure in these annelids which non-boring species do not possess, he concludes that the constant apposition of the tail of the annelid is the cause—and this is proved to be acid, for placed on blue litmus paper it gives a strong acid reaction in both species. It is not contended, however, that all cases of boring are due to chemical agency, for some, as the Pholas in gneiss, disprove the universality of this explanation.

Pearl Fishing.—Australian letters relate a discovery of considerable importance, *viz.* the existence of an extensive pearl-fishery on the north-west coast of Western Australia. The fishing-ground is described as stretching along the coast no less than a thousand miles. There had been upwards of sixty tons of pearls obtained up to December, and these were purchased on the spot at the rate of 100*l.* per ton. The banks at Perth will advance 100*l.* per ton, not including the inside pearls, which are valued at from 1*l.* to 20*l.* sterling each. About thirty men were then engaged in pearling.

Swarms of Locusts.—Fearful devastation has been caused in Algeria by millions of locusts, which in the latter days of April last darkened the air for hours together, destroying every green thing. The inhabitants by every means in their power endeavoured to divert them from their fields, and torrents of rain drowned myriads of them, besides those killed by boys; but the destroyed numbers were but as a drop in the bucket to those which remained. Sickness was expected to follow this plague from the abundance of their putrefying bodies.

Breeding of Queen Bees.—M. De Romestin, English chaplain at Baden, calls the attention of English bee-keepers to a most important discovery made by M. Köhler, a Protestant minister in Hesse. It is no less than the secret of directing the breeding of the bee, so that, as with our cattle, we may select the choicest male to be the father of the future stock. The discovery would appear to be almost too wonderful to be true, but its value and reality are vouched for by some of the leading bee-keepers in Germany. Mr. Woodbury, a Devonshire bee-keeper, says, "M. Köhler's process having been communicated to me, I can state that it is simple and perfectly feasible; it has moreover been tried by some of the leading apiarians in Germany, who have publicly testified to its success. The natural method of pairing seems to be intended as a provision against unions between drones and queens of the same stock, which would be brothers and sisters, and therefore in directing their union artificially this point must be kept in mind. If pure Ligurian stocks can be maintained, the black bee will probably become an extinct species in a domesticated condition.

Proceedings of the Zoological Society of London.

The condition of this flourishing Society was laid before the Annual Meeting in April last, by which it appeared that there were 2,702 members, and the income of the Society amounted to 25,041*l.* The ordinary expenses were 21,566*l.*, and 4,652*l.* had been spent in new buildings or live animals. They have a reserve fund of 10,000*l.* The number of persons who had visited the gardens in the year was 556,214. The gardens contained 2,010 animals, *viz.* 531 quadrupeds, 1,320 birds, and 129 reptiles.

Every week new animals are acquired by the gardens of the Society, a weekly register of which will be found in the pages of Mr. Buckland's Journal, 'Land and Water.' Of course, the greater number of these are birds, among which a nightingale captured in the gardens figures, and which sings contentedly in the society of a hen which has lived through the winter. The Regent-bird of Australia (*Sericulus melinus*) has been brought, for the first time, to England, and is interesting from possessing bower-building habits in common with the Satin-bird and Bower-bird. Some of the magnificent Formosa pheasants (*Euplocamus Swinhoii*) have also been received. But perhaps the most popularly interesting animals are four ringed or marbled seals (*Phoca discolor*), which occupy the pond in the place of the curious Walrus which unfortunately died.

At the ordinary meetings of the Society the usual amount of interest has been exhibited. Perhaps the most important paper was one by Professor Huxley, on the classification and distribution of the birds belonging to his divisions, Alectoromorphæ and Heteromorphæ.* This elaborate paper treated of the homologies of the

* By the latter term the Professor proposed to designate the singular form Opisthocomus, which recent examination had convinced him must be arranged as a distinct group in the vicinity of the Alectoromorphæ.

parts of the skeletons of birds. Professor Huxley's remarks led him to believe in the existence of closer affinity than had before been held in birds of opposite habits, and which were widely separated by most authors. For instance, he did not find any important difference between the skeletons of Crax and Talegalla. He dwelt much on the peculiarities of the sternum in birds as separating genera and families.

Mr. H. Adams continues his researches among the shells of such places as Ceylon, Mauritius, Bourbon, and Seychelles; and Messrs. Sclater and Salvin continue their investigation of the birds of America. Mr. R. Brown read a paper "On the Fauna of Queensland." Dr. Baird described a new species of intestinal worm of the genus *Sclerostoma* from the stomach of the African elephant; and Mr. Blyth exhibiting a specimen of the Cretan goat, which he considered to be identical with the *Capra ægagrus* of Afghanistan, Mr. Busk took occasion to corroborate the identity, and to observe that he believed the species to be the ancestor of the domestic goat.

A very interesting paper was read by Mr. Bartlett upon the incubation of that singular bird, the Apteryx, or Kiwi Kiwi. It appears that a male bird having recently been introduced, the hitherto solitary female had paired, and it was hoped that young would have resulted. The female had previously produced eggs, but which were of course infertile. The birds, perfectly quiet by day, were heard to be active during the night, the male uttering the note *kiwi kiwi* from time to time, whence its native name. The female produced two eggs, and sat upon them, but with no result, as they did not appear to have been fecundated. Mr. Sclater stated that he considered two to be the normal number of eggs sat upon by the struthious birds.

THE PUBLIC HEALTH.

London.—After the reading of Mr. Rumsey's able address on "State Medicine," at the meeting of the British Medical Association in Dublin, a joint committee of that Association and the Social Science Association was formed, for the purpose of taking into consideration the best means of securing further sanitary legislation and, more especially, the revision and consolidation of existing sanitary laws. The committee has had several meetings, and an active correspondence has been carried on amongst its members. The result has been the publication of two separate documents, a "memorandum" and a "memorial," which have been submitted to Her Majesty's Government. On Friday, the 2nd May, a numerous deputation of members of parliament, members of the joint committee of the two Associations, and medical officers of health from various parts of the country formed a deputation to wait on the Duke of Marlborough, as President of Her Majesty's Privy Council, the Right Hon. the Earl of Devon, President of the Poor Law Board, and the Right Hon. Gathorne Hardy, the Home Secretary, for the purpose of urging the object of the memorial, which was to promote a better administration of the laws relating to registration, medico-legal inquiries, and the improvement of the public health.

If past experience had not demonstrated the almost utter hopelessness of pressing upon Government officials the necessity of amending the condition of our sanitary laws, it might have been hoped that the imposing demonstration that waited on the Government in May would have produced some impression.

Almost all sections of the medical profession and of the societies interested in sanitary matters were represented. The president elect of the British Medical Association, the president of the Medical Council of Great Britain, the late president (Sir Thomas Watson) of the College of Physicians were there. Dr. Rumsey, of Cheltenham, Dr. Farr, of the Registrar-General's Office, Dr. Guy, and Mr. Chadwick were there. The deputation was, in fact, a parliament, a body of men who thoroughly understood the great questions they were about to urge upon the Government, and who if representative institutions were in this country what they ought to be would not be suing to be heard, but would be placed in a position where they might legislate on the great subject they so thoroughly understand. The memorial of the deputation in the first place sets forth that the time has come when the imperial parliament ought to take seriously into its consideration the question of whether any of the crude mass of legislation of which they have been guilty for the last twenty-five years has been of any good at all; whether it has not "tended to defeat, in whole or in part," the object it has had in view. The memorial then speaks in detail of the deficiencies of certain departments of state action in relation to health matters, and begins with registration. It deprecates the present imperfect system of registering births and deaths, and speaks of the absence of any registration of still-births and disease. The next subject alluded to is the present imperfect method of working medico-legal inquiries, requiring the coroner to employ inefficient medical witnesses, and refusing him the aid of efficient and experienced experts in his inquiries, and thereby encouraging secret murders, especially poisoning. The memorial also speaks of the present system of dealing with medical evidence in courts of law as such that it "altogether prevents the discovery of truth, discredits scientific medicine, and is a fruitful source of perplexity and misconception to bench, bar, and jury."

The memorial then refers to the fact that in many of the large towns of the kingdom the death-rate is steadily increasing, and that, in spite of all our sanitary legislation, few towns have taken advantage of it; that in scarcely any of them have medical officers of health been appointed at all. It also draws attention to the fact that the amount actually disbursed under the present disjointed and very inefficient system would, if otherwise distributed—the districts and many of the duties being consolidated—go far to maintain a sufficient staff of specially trained and highly qualified district scientific officers with inspectorial functions. The memorial concludes:—

"For all these reasons, and for others set forth in the accompanying 'memorandum' (drawn up by Dr. Rumsey, and approved by the joint committee), we ask for a thorough, impartial, and comprehensive inquiry, by a royal commission, having power to visit, or to send sub-commissioners to visit, the large towns, and other districts of the country, to obtain information and evidence, and to report on:—

"1. The manner in which the cases and causes of sickness and of death are and should be inquired into and recorded in the United Kingdom.

"2. The manner in which coroners' inquests and other medico-legal inquiries are and ought to be conducted, having reference particularly to the methods of taking scientific evidence.

"3. The operation and administration of sanitary laws, with special reference to the manner in which scientific and medical advice and aid in the prevention of disease are and should be afforded; and also with special reference to the extent of the areas or districts most convenient for sanitary and medico-legal purposes.

"4. The sanitary organization, existing and required, including a complete account of the several authorities and officers. The education, selection, qualification, duties, powers, tenure, and remuneration of the said officers to be specially reported on.

"5. The revision and consolidation of the sanitary laws, having special reference to the increase of the efficiency of their administration both central and local.'

The speakers on the occasion were Dr. Acland, Mr. Chadwick, Mr. Michael (formerly a medical man, now a barrister), Dr. Sibson, Mr. Acland, M.P., Dr. Symonds, Dr. Stewart, and Dr. Rumsey. Most of the speakers urged upon the Duke of Marlborough the necessity of a Royal Commission. Dr. Symonds, of Bristol, late a president of the British Medical Association, urged the creation by the Government of a new order of medical men, who would give their undivided attention to sanitary matters and to questions of medical jurisprudence. He said, speaking of medical men as at present authorized, "they were chiefly educated for the care of the sick; and, in the practice of professional duties over some years, a great deal of the knowledge which they primarily possessed would be found to have slipped away from their memories when they were suddenly examined upon some particular point requiring minute investigation. Now the medical man, when called upon to give evidence in a court of law, had to do so on three different heads. He had to give evidence such as an ordinary witness would on points which would be within general observation; then he had to give evidence of matters which had come within his knowledge as a professional man; then he was called upon to speak as to circumstances of which he was supposed to possess a knowledge by an acquaintance with chemistry and natural science. But it must be stated that a man might have possessed a great amount of knowledge of chemistry and natural science at an earlier time of his life, without being able to prove his knowledge in a law-court; and he might be a most able practitioner, yet, when called upon to discharge the duties of a medical jurist, might show great shortcomings. Then medical men were differently qualified in different parts of the country, and while some were educated well, others were educated ill. Surely, under these circumstances, it was not right that men should have the administration of the sanitary laws with only a general professional knowledge. This was a most important point, for the people had the right to have the best and most efficient officers to be obtained. What was required in Lincolnshire was demanded in Lancashire, and it was not right that there should be any difference in the qualification of the men who were to administer these important laws either in the one place or the other. It seemed to those who attended there, that a new order of medical men should be called into existence, upon whom should devolve the consideration of all those questions, who should be able to advise and instruct in all matters of sanitary science, and who would be able to answer off-hand all points which might easily have passed from the mind of general practitioners. Such a new order of medical men, by their influence on the public, by the education of the public in the laws of health, would do a vast amount of good among all classes of Her Majesty's subjects."

The Duke of Marlborough listened attentively to all the speakers said, and having replied, concluded by saying, "Whether the information wanted could be obtained by a Commission or through the offices, was a matter of secondary consideration." The Duke was quite right; nothing but delays, vexations, and annoyance will attend either process. Why do not the sanitary reformers go to the public? For ourselves, we confess that we are heartily and indignantly tired of waiting on Government officials; it has never ended in anything but vague promises and disappointment. If sanitary legislation is to be ever more than a mere name, it must be done through the people. Their voice must be heard in the House of Commons, and six men in earnest about Sanitary Reform in the Lower House, would carry every object asked for by the memorial in six months.

In connection with the above deputation, we may mention that the 5th clause in Mr. Torrens' 'Artizans' and Labourers' Dwellings Bill,' appointing officers of health without medical qualifications, has led to the following resolution from the Joint Committee on State Medicine:—

"That the chairman and secretary of this Committee be instructed without delay to call the attention of Her Majesty's Ministers to the 5th clause of the 'Artizans' and Labourers' Dwellings Bill;' and to urge them to withhold their assent to that clause on the following grounds:—

"1. That it would increase the confusion already existing, by creating, under the title of 'officers of health,' an inferior, unqualified, and inefficient class of agents, whom it would be difficult to supersede.

"2. That it would leave the appointment, remuneration, and dismissal of the proposed officers of health unconditionally in the hands of the local authorities.

"3. That an inquiry is about to be asked for into the appointment and action of medical men in the public service, and that, until the results of such inquiry, if granted by Government, shall be known, it is highly inexpedient to legislate on the question of health officers.

"4. That a better agency than that proposed in the said clause already exists; namely, the district medical officers under the Poor Law, who, pending the appointment of medical officers of health duly qualified and properly protected in the exercise of their functions, might be employed in that capacity, and should receive additional remuneration for such services."

It has appeared good to Messrs. Dixon, Kennard, and Goldney, Members of the House of Commons, to propose a Bill to amend 'The Act for preventing the Adulteration of Articles of Food and Drink, 1860.' Whether the new powers to be given of fining and imprisoning persons who sell adulterated food, and which are also extended to drugs, will galvanize the old Act into life may be questionable. The effort, however, is a good one, and deserves to be encouraged. We miss from this Bill the authoritative declaration, "Thou shalt not commit adulteration." Like all other permissive Acts, it gives the impression that, provided the authorities do not appoint analysts, and do not analyze the food, it is a man's privilege to adulterate.

Another sanitary Bill has also been brought into Parliament by Messrs. Clive, Golding, Newton, and Wyld, entitled 'A Bill to make better Provision for facilitating and regulating the Supply of Pure Water in Cities, Towns, and Districts throughout the United Kingdom of Great Britain and Ireland.' The clauses of the Bill will give power to persons to require that every company supplying water to a district shall supply every house in that district, and also to persons to require that landlords require the said companies to supply all dwelling-houses and tenements occupied by human beings with water.

These Bills are undoubtedly efforts in the right direction, but they are a part of the everlasting tinkering that is going on about all our sanitary legislation. It is rotten and leaking in every direction, and nothing but a sound foundation will ever give it security or value.

SCOTLAND.—The 'Scotsman' newspaper has recently had a series of articles on the question, "Is the Rate of Mortality Increasing?" They were very ably written, and by a person who evidently has access to the freshest and most reliable information, and whose acquaintance with the sanitary literature of the last thirty years is both extensive and varied. Having read the articles in question, we can scarcely feel inclined to answer the author's question in the affirmative. It would be one of the greatest slurs that could possibly be cast upon the medical and sanitary science of the present day, if we were even to believe that the rate of mortality is increasing. It is certain that, so far as Scotland is concerned, there is much difficulty on the part of the authorities to abate those nuisances and insanitary arrangements which result in the production of epidemic disease, and necessarily in the production of a high death-rate. In Glasgow, for instance, there is perhaps one of the most completely organized staffs of Sanitary Officers that can be found in the United Kingdom, and yet epidemic disease and a high rate of mortality still continue to manifest their existence in the community. The staff in question consists of the principal Medical

Officer of Health, Professor W. T. Gairdner, and five district officers, all of whom are medical men, and have under them thoroughly experienced sanitary inspectors. Through the agency of this staff, together with the assistance of the police authorities and the officers of the various Parochial Boards, the provisions of the 'Public Health (Scotland) Act, 1867,' are now being gradually brought into operation.

If we look at the death-rate of Glasgow we do not find much to boast of, although there is certainly room to be hopeful. The following figures will show that there is some improvement in progress:—

Deaths in five weeks ending May 5, 1866	..	..	1513
" " " 1867	..	..	1304
" " " 1868	..	..	1304

It is true that a marked difference is observable between the mortality in 1866 and that in 1867 during the corresponding five weeks; but 1867 and 1868 do not afford such a favourable contrast; still, as epidemic disease was much more prevalent in April, 1866, than in the corresponding five weeks of either of the following years, we must not be despondent, as the increase of the population must be taken into account. Taking the weekly death-rate for four weeks in March during three consecutive years, the following numbers crop out:—

Death-rate of four weeks, March, 1868	..	29, 31, 31, 29
" " " 1867	..	32, 33, 35, 34
" " " 1866	..	33, 35, 35, 30

No well-wisher of his country, however, can feel satisfied with the Glasgow death-rate remaining at 30, 31, and 32, while London—even where there are certainly many hot-beds of epidemic disease—as frequently shows a mortality not exceeding from 22 to 24 per 1,000 of the estimated population per annum. But the death-rate of Glasgow must of necessity remain high, so long as the present system of constructing the smallest dwelling-houses prevails. The chief epidemic disease of Glasgow is undoubtedly typhus fever, and in thousands of the lowest class of houses in the city just named the structural arrangements of the "flats," as they are called, are the very best for assisting most effectually to spread the germs of the disease. From the inside common stair there is almost invariably a lobby from which entrance is obtained to from four to ten or more houses of one or two small apartments. Inwards this lobby is a *cul-de-sac*; there is no through ventilation from front to back; and thus as the air of the lobby is common to the whole of the houses, a case of typhus occurring in any one of them is rarely a solitary one, unless isolation is immediately effected by removal of the patient, and this followed by the requisite purifying and disinfecting measures. That epidemic fever is really decreasing in Glasgow, and that the decrease has been in progress from the beginning of the present year, may be learnt from the following figures :—

	Jan.	Feb.	Mar.	Ap.
Fever cases reported at Sanitary Office	423	344	343	279
Fever deaths reported to Registrars	45	39	31	28

Cases of typhus fever do occur, and deaths in a certain ratio do result, and this state of affairs will continue more or less extensively until the present fever-dens are rooted out by the operations of the City Improvement schemes and the City Union Railway. In the interim, however, overcrowding in other parts of the city is the immediate result, owing to the fact that many people are, or soon will be, dispossessed of their houses, and others with improved sanitary arrangements are not yet forthcoming.

Without the active sympathy and co-operation of other members of the community, it is found in Glasgow that the labours of the sanitary staff are not sufficient to eradicate or materially lessen the amount of epidemic disease, by removing the causes which lead to it, and hence a movement has been commenced to form an association to be called "The Sanitary Benevolent Association of Glasgow," two of the objects of which are thus stated in the circular furnished us by the secretary :—

"1. The visitation by a non-official voluntary agency, with the co-operation and advice of the sanitary officers of all parts of the city, especially of those which appear to be subject to the extraordinary pressure of the causes of destitution, disease, and death.

"2. The use of moral influence and the diffusion of information tending to the improvement of the sanitary condition of the inhabitants in all dwellings within which the evils above mentioned have been observed to prevail; *e.g.* the prevention of overcrowding and the removal of external nuisances, with or without the aid of the authorities; the recommendation of internal ventilation, cleansing, &c., when required; and the promotion, generally, of a higher standard of comfort, decency, and personal cleanliness, and of the habits of self-respect, temperance, and economy, which tend to the physical well-being of the community."

Our readers will doubtless join us in wishing the utmost measure of success to this praiseworthy movement. If it can in any way permanently reduce the enormous death-rate of the city of Glasgow we may expect to learn that the example will be followed in other disease-haunted towns.

It may not be undesirable to mention that we have now a valuable ally in the work of disseminating sound views on the subject of Public Health, in 'The Poor Law Magazine,' a monthly journal published in Glasgow, and the property of "The Society of Inspectors of Poor of Scotland." The usefulness of the magazine has been very greatly increased of late by the introduction of a

Public Health feature, embracing both original papers and articles from other journals. We are glad to know that our own pages have contained matter deemed worthy to be extracted by the editor of 'The Poor Law Magazine.' The monthly reports by the Glasgow sanitary officers regularly appear in the magazine, and as they frequently contain valuable sanitary hints and suggestions, the magazine ought to be of much value among the medical officers and inspectors of poor attached to the various parochial boards throughout Scotland.

The Glasgow Sewage Association previously mentioned is practically non-existent just now, but we are informed that the committee of the association, together with the gentlemen who read papers at the various meetings, will soon be called upon to draw up a report on the most valuable points embraced in the papers, and affirm a number of general principles on the disposal and utilization of sewage, and submit them to the town council for experimental trial before any general and expensive scheme is entered upon for the drainage of Glasgow and the permanent purification of the Clyde, on whose banks that great city is built. We would seriously advise our Glasgow friends to avoid the rock on which the scheme of the Metropolitan Board of Works has broken; let them firmly resolve to have no such outlet and deposit on the Clyde as are now threatening to prove a gigantic nuisance at Barking Creek, on the Thames.

It is some satisfaction to know that in Aberdeen there is at least one professional man, Dr. Robert Beveridge, who is wrathfully in earnest in determining to cope with the hydra-headed monster typhus, which, during three winters successively, has asserted its presence and authority in the "granite city." That gentleman, from his professional position in Aberdeen, has observed many startling facts in connection with the three years' epidemic; from the facts observed he has deduced many valuable opinions; and the facts and opinions he has dared to publish to the world in a pamphlet * which now lies before us. Aberdeen is a comparatively small and healthy town. Its population in 1866 was probably about 76,000, and yet the number of cases of typhus reached the enormous total of 4,631, and of that number no fewer than 610 terminated fatally. One in every 16·2 of the population was attacked, which is equal to 6·17 per cent. In one district, however, embracing about 42,000 of the population, there was an average of one person attacked with typhus out of every 12·56 of the population. Dr. Beveridge probably understates the cost of the epidemic at 55,021*l.* 4*s.*, equal, in fact, to a tax upon the in-

* 'On the Statistics of the recent Epidemic of Typhus in Aberdeen, showing its probable Cause and Cost.' London: W. W. Head, Victoria Press, 1868.

habitants of something over fifteen shillings per head. There are some persons so hard-headed and granite-hearted that they can only be spoken to on such a subject as this through the medium of "*£. s. d.*," and Dr. Beveridge has done well to speak to them in such unmistakable language as he adopts.

Dr. Beveridge strongly believes that the probable cause of the epidemic lies not external to the houses, but within them, and says, if it can be shown that the theory of overcrowding as a cause will account for the phenomena presented by the disease, it would seem probable that this is the true explanation of its origin. Here is a brief summary of the facts which Dr. Beveridge's observation has elicited. The disease is most intense in cold weather; it attacks females more than males; it attacks young persons in greater proportion than the old; contagious, and more dangerous in old than in young, and in males than in females; then, as specialities, it attacks individuals, as a rule, but once; the attack lasts three weeks, and is most dangerous in the second week. He adopts the theory of overcrowding, and shows that the facts would support it most satisfactorily. The epidemic, fortunately, is now got under; at all events, the ravages of the disease are at present on a much smaller extent. We learn that the sanitary condition of the town is fair on the whole, although in many points it might be improved. The water supply is excellent and in abundance, the water being taken from the Dee, about twenty miles from the town. The drainage is being improved, and a general plan adopted; but whether that will thoroughly answer the end in view, remains to be seen. The population, which was nearly stationary from 1850 to 1860, chiefly from commercial disasters, seems now to be rapidly increasing, but it is doubtful if house accommodation is at all keeping pace with the increase of population. Overcrowding is too common in many situations. Efforts have been made to set going a scheme for procuring statistics regularly on the sanitary state of the town, but hitherto without success, as the people in the far north are only with difficulty got out of their old jog-trot. Through paltry petty jealousies and parsimonious efforts at saving, there is room to fear that a laudable attempt being made just now to start a fever hospital will break down, and the people will only arouse from their apathy and stolid indifference by a return of the epidemic, for which no preparations will be made.

The benefits accruing to a town from having an active and lynx-eyed inspector of nuisances are well seen in Perth. During the first quarter of this year a typhus epidemic broke out very suddenly, and, notwithstanding the general mildness of the weather, soon ran the death-rate above that for the corresponding period in the two preceding years; but it almost as suddenly disappeared, owing, it is believed, to the active exertions of the officer just named. He is not only indefatigable in getting the lanes and "closes" cleansed, but when a case of fever occurs he comes down upon it forthwith, and effects a removal and therefore isolation, and then takes active measures to clean and disinfect the infected house.

In the last number of the Journal we referred to the efforts being made in Edinburgh to improve the condition of the poor of that city. The report from which we quoted has since been issued, and its startling facts have so thoroughly enlisted the sympathies of many professional, and well-to-do people generally, that an association is now formed for having the poor systematically visited, so that proper remedial measures may be adopted to ensure the eradication of at least some of the physical, social, and moral evil which at present runs riot in many parts of the Old Town of Edinburgh. The Lord Provost and magistrates of Edinburgh are now so much roused that they are publicly advertising their intention to enforce the provisions of the 'Local Police Acts' and of the 'Public Health (Scotland) Act, 1867,' against overcrowding in dwelling-houses, and that they will exact the prescribed penalties in every case of conviction. It is to be hoped that they will thus succeed in their efforts to diminish preventable disease; and that they may induce capitalists to build houses in healthy localities and in accordance with the most advanced sanitary knowledge of the present day. The water-supply of the city is in the hands of a company, and is frequently complained of both as to quantity and quality. If disease is to be diminished by personal cleanliness among the people, they must be in a position to get plenty of good water always when it is wanted; and we are glad to notice that an active member of the town-council is now (June) about to bring up the whole subject of water-supply to the city and surrounding districts for full consideration. The town-council of Leith is also moving in the same direction. Although the last-mentioned town is, generally speaking, in a healthy state, and the death-rate under the average, still for the last two months there has been an epidemic of scarlet fever prevalent in many parts of the burgh; and it has been particularly fatal among the young. This state of things ought not to exist; and it is satisfactory to know that both the Medical Officer of Health and the Health Committee are energetically endeavouring to cope with it.

A considerable amount of good has been done in the town of Paisley by a Ladies' Sanitary Society, which has been in existence for several years. As the new Public Health Act is now in operation, the well-intended labours of the Society are in a great measure superseded by those of the public authorities; still the ladies who have hitherto been banded together in well-doing do not wish to cease in their well-doing, and they have wisely, we think, resolved on directing their future efforts chiefly to sanitary education, by the distribution of tracts, visitation classes, mothers' meetings, and lectures; they have also resolved that special attention should be given to the spread of information on the treatment of infancy, so that the foul stain underlying the high rate of infantile mortality (43 per cent.) may be removed by diminishing the death-rate.

If any town in Scotland has acquired a notoriety over the others for the fatality of its epidemic disease, that town is certainly Greenock. A recent epidemic of typhus in that town (population 43,894 in 1861) was so dreadfully fatal, that it carried away no fewer than five of the medical me , who were perhaps even too faithful to the call of duty. The risk incurred by medical practitioners in Greenock from typhus, has, for many years, been very great. Of those who are at present in the town, it is probable that one-half have at one time or another passed through the ordeal of typhus. The fact of the extraordinary mortality just referred to created an excitement in the town, which resulted in a proposal to erect a monument in memory of the medical men who were stricken in the strife in the combat with the disease. A site was got for the proposed monument, and a design was prepared by Sir J. Noel Paton, and the public gratitude towards the memory of those who were faithful in duty seemed there to have completely evaporated. Greenock is now in a somewhat improved sanitary condition; but the authorities of the town may thank Dr. James Wallace, and not themselves, for it. So far as we can learn, he even incurred very serious displeasure from the "powers that be," because he would not rest content with things as they were, and threatened to bring the power of the law to bear on those who should always be ready to enforce it for the public good.

Quarterly List of Publications received for Review.

1. Rambles of a Naturalist on the Shores and Waters of the China Sea: being Observations in Natural History during a Voyage to China, Formosa, Borneo, Singapore, &c., made in Her Majesty's vessels in 1866 and 1867. By Cuthbert Collingwood, M.A., M.B., Oxon, F.L.S. 450 pp. 8vo. 10 *Illustrations.* *John Murray.*

2. Elements of Chemistry: Theoretical and Practical. By William Allen Miller, M.D., LL.D., F.R.S. Part II., Inorganic Chemistry. Fourth Edition. 900 pp. 8vo. *Longmans & Co.*

3. A Treatise on the Metallurgy of Iron, containing Outlines of the History of Iron Manufacture, Methods of Assay, and Analyses of Iron Ores, Processes of Manufacture of Iron and Steel, &c. By H. Bauerman, F.G.S. 46 *Engravings on Wood.* 400 pp. Post 8vo. *Virtue & Co.*

4. First Lessons in Astronomy, in Question and Answer. Seventh Edition. 100 pp. 24mo. *Jackson, Walford, & Hodder.*

5. The Rudiments of Mineralogy: a Concise View of the General Properties of Minerals. By Alexander Ramsay, jun. 338 pp. Fcap. 8vo. *Virtue & Co.*

6. Reliquiæ Aquitanicæ. By Edouard Lartet and Henry Christy. Part V. *H. Baillière.*

7. Celestial Objects for Common Telescopes. By Rev. T. W. Webb, M.A., F.R.A.S. Second Edition. 330 pp. Post 8vo. *Longmans & Co.*

8. The Great Architect: His Plan of Salvation in the Temple of Dead Stones and Living Stones, God and Man. 180 pp. Crown 8vo. *Longmans & Co.*

9. A Dictionary of Chemistry and the Allied Branches of other Sciences. By Henry Watts, B.A., F.C.S. Assisted by Eminent Contributors. 5 vols. Demy 8vo. *Longmans & Co.*

10. Thoughts of a Physician: being a Second Series of Evening Thoughts. *John Van Voorst.*

11. On the Ventilation of Dwelling Houses, and the Utilization of Waste Heat from Fire-places. By Frederick Edwards, jun. *R. Hardwicke.*

12. A Treatise on the Action of Vis Inertiæ in the Ocean. By William Leighton Jordan, F.R.G.S. 12 *Plates.* 220 pp. Demy 8vo. *Longmans & Co.*

13. General Catalogue of Books. 1130 pp. *Quaritch.*

14. Education and Training, considered as a Subject for State Legislation; together with Suggestions for making a Compulsory Law both Efficient and Acceptable to the People. By a Physician. 110 pp. Demy 8vo. *John Churchill & Sons.*

15. Transactions of the Woolhope Naturalists' Field Club, 1867. 200 pp. Demy 8vo.

PAMPHLETS, PERIODICALS, AND PROCEEDINGS OF SOCIETIES.

Sketch of the Geology of Spitzbergen. By A. E. Nordenskiöld. 2 *Maps.* 55 pp. 8vo.

Lichenes Spitsbergenses. By Th. M. Fries. 53 pp. 4to.

On the Existence of Rocks containing Organic Substances in the Fundamental Gneiss of Sweden. By L. J. Igelström, A. E. Nordenskiöld and F. L. Ekman. 9 pp. 8vo.

Om Trias-och Juraförsteningar fråu Spetsbergen. Af G. Lindström. 3 *Plates.* 18 pp. 4to.

Förberedande Undersökningar rörande Utförbarheten af en Gradmätning på Spetsbergen. Af N. Dunér och A. E. Nordenskiöld. *Map.* 16 pp. 4to.

History of Induction: the American Claim to the Induction Coil and its Electrostatic Developments. *With Engravings.* 124 pp. 8vo. *From Washington, U.S.A.*

Index to Vol. I. to XI. of Observations on the Genus Unio, together with Description of New Species of the Family Unionidæ, and Descriptions of New Species of the Melanidæ, Paludinæ, Helicidæ, &c. By Isaac Lea, LL.D. 60 pp. Imp. 4to. *From the Author.*

India: a Review of England's Financial Relations therewith. By Robert Knight. 70 pp. 8vo.

Intercolonial Trade, our only Safeguard against Disunion. By R. G. Haliburton, M.A. 40 pp. 8vo.

Against the Theory of the Retarding Influence of Tidal Action on the Axial Motion of the Earth, and showing the true Source of Tidal Energy. By A. R. Molison. 20 pp. 8vo.

On Sub-aërial Denudation, and on Cliffs and Escarpments of the Chalk and the Lower Tertiary Beds. By William Whitaker, B.A., F.G.S., of the Geological Survey. 24 pp. 8vo.

On Geological Time and the probable Date of the Glacial and Upper Miocene Period. By James Croll, of the Geological Survey of Scotland.

Beetroot Sugar: Remarks upon the Advantages derivable from its Growth and Manufacture in the United Kingdom. By Arnold Baruchson. *Effingham Wilson.*

On Hœmodromometers. By W. Handsel Griffiths.

On certain Butterfly Scales characteristic of Sex. By T. W. Wonfor.

On the Cost of Cultivation and Returns for Land manured with Latrine Poudrette in the vicinity of Cawnpore during the year 1866–7. Official Report from R. Simson, Esq., Secretary to the Government of the N.W. Provinces.

Christianity and Modern Progress. By Rev. A. Raleigh, D.D. *Jackson, Walford, & Hodder.*

The Fifth Annual Report of the Coroner for the Central District of Middlesex. By Edwin Lankester, M.D., F.R.S. 30 pp. Royal 8vo.

Transactions and Proceedings of the Royal Society of Victoria. Part II. Vol. VIII.

The American Naturalist.

Vargasia. Boletin de la Sociedad de Ciencias Fisicas y Naturales de Caracas. Num. 1–3.

The London Student. *John Churchill & Sons.*

The Westminster Review.

The Geological Magazine.

Proceedings of the Royal Institution of Great Britain.

" " Royal Society.

" " Royal Astronomical Society.

" " Royal Geographical Society.

" " Zoological Society of London.

M&N HANHART LITH

THE GREAT SOUTHERN TELESCOPE

THE QUARTERLY

JOURNAL OF SCIENCE.

OCTOBER, 1868.

I. DESCRIPTION OF THE GREAT SOUTHERN TELESCOPE.

By William Crookes, F.R.S., &c.

Several years ago the Government of Victoria voted the sum of 5,000*l.* for the construction of a large equatorial telescope to be erected at Melbourne, for the observation of the nebulæ and multiple stars of the Southern Hemisphere.

The construction was entrusted to Mr. Grubb, F.R.S., of Dublin, who stands in the first rank as an optical and telescopic engineer in the manufacture of instruments in which every step is required to be preceded by mathematical research. At the commencement of the present year the telescope was completed and examined by the Committee of the Royal Society who had superintended the work throughout. In a report recently communicated to the Royal Society, the Committee express their unanimous opinion that the equatorial is a masterpiece of engineering.

Before this notice meets the reader's eye, the telescope will probably be on its way to Australia, and as it is beyond comparison the largest and most elaborate equatorial ever constructed, it seems due both to the constructor and to the importance of the instrument that a detailed account of it should appear in the 'Quarterly Journal of Science.' Through the kindness of my friend Mr. Grubb, who has placed at my disposal drawings, photographs, and ample descriptions of all parts of the instrument, I have ventured to undertake this office.

The great Melbourne telescope is of the form known as the Cassegrainian reflector, and is mounted equatorially on what Mr. Grubb calls "the German system improved."

The mirrors, two being supplied in case of accident, are 4 feet in clear aperture, 4½ inches thick, 30 ft. 6 in. in focus, and rest in their box on Mr. Grubb's system of hoops; the whole system of suspension and levers, presently to be described, weighs altogether nearly 2 tons.

Of the tube, 7 feet is made of boiler-plate iron, quarter inch thick, to which is attached by flanges and bolts a skeleton tube, 21 feet long, of steel bars, 3 inches wide at bottom, 1½ at top, and ⅛ of an inch thick, wound spirally round rings of carefully turned angle iron and riveted at the joints, forming a spiral lattice of amazing strength, stiffness, and freedom from tremor. The 7 feet of boiler-plate tube weigh 1,300 lbs., and the 21 feet of the ventilated tube only 1,370 lbs.

At the upper end of the tube, about 25 feet 6 inches from the large mirror, is bolted a very stiff hollow arm of steel-plate, on the extremity of which is a V-shaped gun-metal casting, in which slides an arm carrying the small mirror of 8 inches diameter. This arm is acted upon from behind by a screw, from a pulley on the shaft of which wire-cords are carried over iron guide-wheels down the side of the tube, where they are wound round a wheel to which motion can be given by the observer, for the purpose of focussing.

The polar axis is made up of four distinct parts, *viz.* a cube 3 feet square, to which is bolted on one side a cone 8 feet long which terminates with a bearing 12 inches diameter, resting in a peculiar "plumber-block" on the polar pier, on the opposite side a short toe-piece, which carries on parts prepared for them the two hour circles, sector, and clamp, and terminates in a bearing 6 inches diameter resting in a Y block in the equatorial pier, and on a third side a bell-shaped casting about 2 feet long, which terminates in a slide carrying one bearing of the declination axis, the other being in the side of the cube opposite the bell.

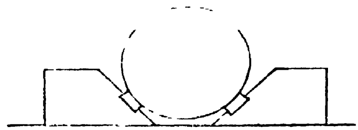
The declination axis is 24 inches diameter at the bearing next the telescope, and 12 inches at the other, the bearings being 5 feet asunder and the axis itself about 9 feet long. It carries at one end the telescope strapped into its cradle, and at the other counterpoise weights, amounting to over 2 tons.

The counterpoise weights are four circular cast-iron boxes, consisting of a ring 10 inches diameter, which is bored out to fit the axis, and an outer ring 30 inches diameter, both 6 inches deep, connected by a plate to form a bottom, and divided into six segments by ribs. These chambers are mostly filled with lead, the outer one being left with a little spare space for adjustments.

The bearings of the polar axis, on the principle of Ys, are constructed with as much delicacy and care as those of a theodolite.

The upper bearing, 12 inches diameter, consists essentially of a large "plumber-block," in which slide, in horizontal grooves, two massive wedge-shaped prisms carrying gun-metal blocks, bearing the axis, and which are acted upon by screws, so that motion can be given to them in a horizontal direction. (See Fig. 1.)

Fig. 1.



This arrangement is for finally adjusting the axis into parallelism with the pole of the earth. It will be readily seen that by these two screws any required motion can be given: thus forcing both screws in or out equally, will give a vertical motion up or down; while by advancing one screw in proportion as the other is withdrawn, a horizontal motion results in the direction of the retreating screw.

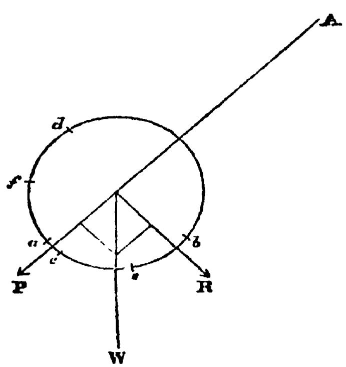
The lower bearing rests in a block of gun-metal bored to fit the axis, and cut away for about 70° at the bottom to give it the property of a Y. The axis terminates in a flat-polished piece of chilled cast-iron, 5 inches diameter, bearing against a flat cushion of bell-metal, which cushion, of a spherical shape on its lower face, rests in a spherical cup. Therefore as the axis is adjusted into its proper direction by the screws in the upper bearing, the motion of the bell-metal cushion in its cup ensures a perfectly even bearing between it and the chilled iron and bell-metal surfaces. Now as the weight of the instrument as it rests on these bearings, of 12 and 6 inches diameter, amounts to about 8 tons, it follows that the friction, if not disposed of in some manner, would be so considerable as to render the instrument quite unmanageable; but in all these bearings there is only about $\frac{1}{50}$th or $\frac{1}{100}$th part of the weight really resting in the bearings themselves, whilst the remainder is supported by apparatus which reduces the friction to a minimum. In this manner are obtained great freedom of motion, less wear, and at the same time all the steadiness of the Y bearing; practically, in fact, more steadiness than if the whole weight were allowed to rest, for then it is found that an inclination exists to *ride up* on the forward side. Accordingly, close above the lower bearing is placed a sector working on a hardened steel pin, and forced up by a screw and strong laminæ of springs on which the axis rolls with a pressure of about 4 tons. Now as the radius of the sector is 27 inches, and the half diameter of the pin is $\frac{7}{16}$ inch, it follows that the friction is reduced in the proportion of $\frac{7}{432}$, or about 62 to 1. The same principle is carried out in the upper bearing, but here the weight not being so excessive, a roller of 8 inches diameter was thought sufficient, acted upon by a lever and weights hanging on the west side of the pier. In addition to this, to take off some of the pressure on the toe-pieces —more to prevent danger of *biting* than for the purpose of reducing

2 I 2

friction—the polar axis is laid hold of by a very peculiar steel link chain, so constructed that the links can twist a small quantity on each other without producing friction, which chain is held up by a trussed lever of the proportion of about 8 to 1, acted upon by weights at the back of the pier amounting to about half-a-ton, so as to relieve about 4 tons of end pressure.

So effective is this arrangement, that a force of 5 pounds at a point 20 feet from the centre of motion, is sufficient to move this mass of 8 tons.

Fig. 2.



The arrangement for the relief of the friction in the declination axis is necessarily much less simple. It will readily be seen by an inspection of Fig. 2, which we may suppose to represent the end of the declination axis, and which for simplicity is drawn for a latitude of 45°, P A being the direction of the polar axis, that if we place the axis on Ys at the points say *a* and *b*, when we reverse the instrument to the other side of the meridian these bearing-points will be at respectively *c* and *d*, and the axis would roll out of its bearings; or if we put the Ys at mean points *e* and *f*, all the weight would be on one or other of the Ys, as the instrument is reversed from one side of the meridian to the other, and it would be quite impossible to relieve any portion of the friction by apparatus similar to that used for the polar axis, for what would be right on one side would be quite wrong on the other. Up to the present time this has been the great objection to this form of equatorial; for as explained above, the axis had necessarily to be put into the entire collared bearings without any possible relief of friction, the force necessary to move the telescope, if of any considerable size, became so great as to oblige the constructor to make the bearings of the declination axis very small, and consequently rendered the support of the telescope weak and unsteady. Only in this telescope, and in one other (also constructed by Mr. Grubb) which is now mounted at Dunsink Observatory, near Dublin, the object glass being presented by the late Sir James South to the University of Dublin, has this difficulty, one of the very few objections to this form of equatorial, been overcome.

Referring to Fig. 2, suppose the weight W, acting perpendicularly, to be resolved into two forces, one, P, acting parallel and the other, R, at right angles to the polar axis. The first, P, inasmuch as it is parallel to, and along the axis, is constant in its direction to that axis as it turns round. The second, R, varies in its direction with respect to the axis as it turns, but is constant as regards any vertical line. Now if R could be disposed of, it is evident that the case would be that of an equatorial at the pole of the earth, all the pressure being in a direction parallel to the polar axis. This, then, could be readily relieved by anti-frictional apparatus. To understand how this R is disposed of, refer to Figs. 3, 4, and 5.

FIG. 3.

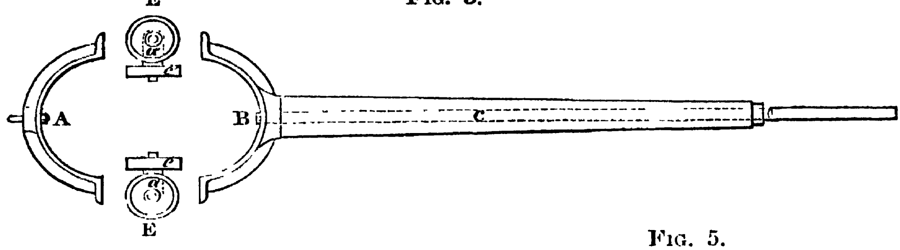


FIG. 4.

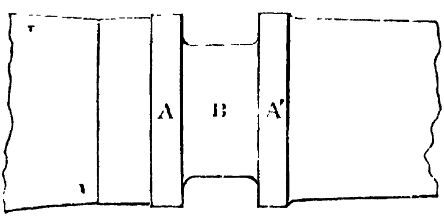


FIG. 5.

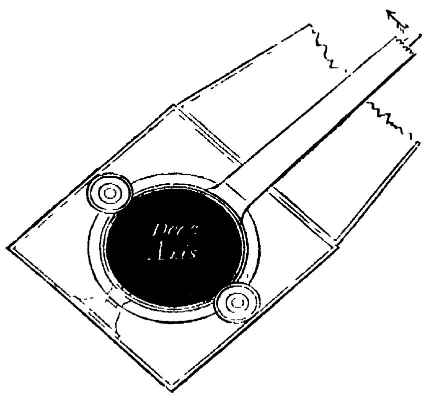


Fig. 3 shows the apparatus, by which this is accomplished, taken asunder. It consists of two nearly semicircular cast-steel rings, A and B, very strong, between the jaws of which, when together, are held the gun-metal carriages, shown at E E', carrying three rollers each, one pair each, *a a'* (one only of each pair can be seen in the figure), and one single, *e e'*, at right angles to the other two. This apparatus when bolted together embraces the declination axis where its axis crosses that of the polar axis (where the declination axis is formed as at Fig. 4). The two pairs of rollers *a a'* (Fig. 3) work on the rings A A' (Fig. 4), whilst the third rollers *e e'* (Fig. 3) work in the groove B (Fig. 4). The lower half-ring has a steel pin *d* (Fig. 3), which rests in a cavity prepared for it at the bottom of the polar axis, where it forms the fulcrum of the lever, while the upper half-ring is prolonged into a stiff trussed bar which runs up through the polar axis and projects at the upper end, where it is acted upon by a sector and lever, which by the application of sufficient weights, which hang down the eastern side of the polar pier, exert a certain force upon it in a direction at right angles to the polar axis. The direction of the force is *independent of, and does not vary with, the turning of the polar axis*, but is constant as respects any vertical line; therefore by applying a sufficient weight to the lever, the whole of the force R (Fig. 2) can be raised on this apparatus and so got rid of. When the instrument is on the meridian, either of the pairs of rollers *a a′* (Fig. 3) is bearing the whole of this R, according to whether it be east or west of the piers: in a position six hours off the meridian the internal rollers *e e′* are bearing all this; while in any intermediate position the weight is divided between *e e′* and either of the pairs *a* or *a′*. It should be remembered that in this instrument the counterpoise of the telescope is hung on the declination axis itself, consequently both the polar and declination axes are balanced *inter se* round their point of intersection, which is very much preferable to the too common mode of hanging the counterpoise to an extension of the polar axis; in which case both axes are out of balance, and this apparatus could not be effectively used.

Having now got rid of the force R, the remainder, P, is easily disposed of. There are two large frames carrying two rollers each, one placed between the large bearing of the polar axis and the cradle, and the other outside the smaller bearing. These are connected by levers running along the side of the cube of the polar axis, where they are centred; and it is so arranged, that by screwing up a nut which connects the levers to the frames, the whole or any portion of the weight of the declination axis can be raised out of its Ys in a direction parallel to the polar axis P (Fig. 2), while the apparatus mentioned above relieves the remainder R (Fig. 2).

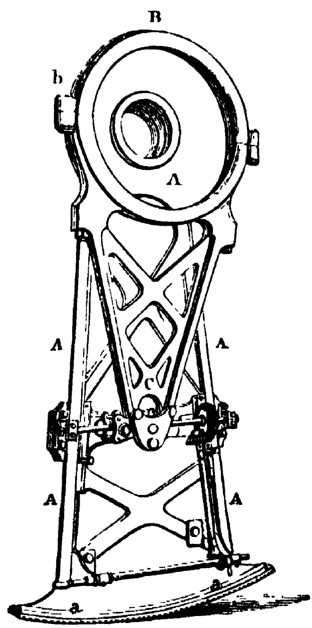
The combination of these systems gives a wonderful ease of motion, combined with perfect steadiness. Fig. 5 shows the apparatus *in situ* in the polar axis.

Hand Motions.—There are four separate gearings for these, *viz.* quick motion in right ascension (*Æ*); slow motion ditto (*Æ*); quick motion in declination (D); and slow motion in declination (D).

Quick Motion Æ is obtained by a pinion working into a toothed wheel on the polar axis, immediately below the cube, from which a shaft is brought down, connected by bevel wheels to another running through the equatorial pier, with a wheel at each side, to which motion can be given by a person while watching the *Æ* circles.

Slow Motion Æ is obtained by a differential motion between the clock-work sector and *Æ* clamp, see Fig. 6, where A is the sector made up of a cast-iron foundation piece, bored accurately to fit a portion of the polar axis, on which it is strung, but not made fast. From this branch two tubes of steel, trussed with cast-iron lattice, and carrying the toothed sector (*a*) on their extremities. B is the clamp, which is a cast-iron halved ring, which runs on another portion of the polar axis, and to which it can be clamped by half a turn of the screw (*b*). This clamp is connected to the sector by the lattice arm and tangent motion C, of a very peculiar construction.

FIG. 6.



When the clamp is loose the instrument is quite free of all this apparatus; but the moment the clamp is tightened it becomes a portion of the polar axis; and, as it is connected to the sector by the tangent screw mentioned above, it serves to carry the telescope as the sector is moved by the clock. Again, small wheelwork and shafts being carried to a convenient position low down on the sector from the tangent screw, hook's joint handles can be attached to each side, by which motion can be given by an observer looking into the telescope or finder, whether the clock be in action or not.

Quick motion in declination is obtained by a pinion working into a toothed wheel 4′ 6″ diameter, bolted on the cube of the polar axis, from which a spindle is carried down to the end of the tube, where it is worked by a hand-wheel, accessible to a person looking into the telescope or finder.

Slow motion in declination is obtained by a clamp 4′ 6″ diameter, and tangent screw, somewhat similar to the AR, from which a shaft and hand-wheel is carried to make *it* also accessible to the observer. With such ease are all these motions worked, that two persons at the AR quick motion can reverse the instrument from east to west of its piers in three-quarters of a minute, and that with so little labour as to be compared by some to the working of a table microscope. It will be seen that, with the exception of the quick motion and clamping in AR, all the other operations are brought within reach of the observer himself while looking through either the large telescope or its finder, *viz.* slow motion AR, quick and slow motion declination, clamping declination, and focussing; which last operation is performed by a large hand-wheel, which surrounds the eye-piece, and round a portion of which the wire cords which come from the small mirror are wound.

The support of the specula is one of the most important points in the mounting of the large reflector, and one which, if certain difficulties were not disposed of, would be a complete bar in the way of mounting them equatorially. Two things are essentially necessary.

1st. A system of back supports on which the speculum may lie in a state free from strain of any kind, as if in fact it were floating in mercury.

2nd. A system of lateral support which will preserve the mirror free from strain when turned off the zenith, and will not constrain any slight movement of the speculum.

Now as regards the first condition, nothing could fulfil it better than the system introduced long ago by Mr. Grubb, which was made use of on such a grand scale by the late Lord Rosse as well as by others, and this system therefore with some modification was adopted.

To understand it, suppose the speculum to be divided into forty-eight portions as in Fig. 7, each of them being exactly equal in area and consequently in weight. Now if the centre of gravity of each of these pieces rested on points which would bear up with a force = the weight of each segmental piece, it is evident that there would be no strain in the mass from segment to segment. This is exactly what is accomplished by this system; in fact, if when the speculum is resting on these supports it could be divided up into segments corresponding to those lines they would have no inclination to leave their places, showing a perfect absence of strain across those lines. Suppose now the points representing the centres of gravity of these segments were supported on levers and triangles, so as to couple them together as at A, Fig. 8, and each of these couplings to be supported from a point *a*, representing *the centre of gravity of the sum of the segments supported by that particular couple*, and it is evident that there can be no strain between the components of these couples. Again, let these points *a* be coupled together by the system shown at B, Fig. 8, and their centres of gravity *b* coupled as at C, and it is evident that *the whole weight of the speculum ultimately condensed by this system into these points is supported on forty-eight points of equal support, being the centres of gravity of the forty-eight segments at* Fig. 7. In Fig. 9 is seen the whole system complete. It consists of three screws passing through the back of

FIG. 7.

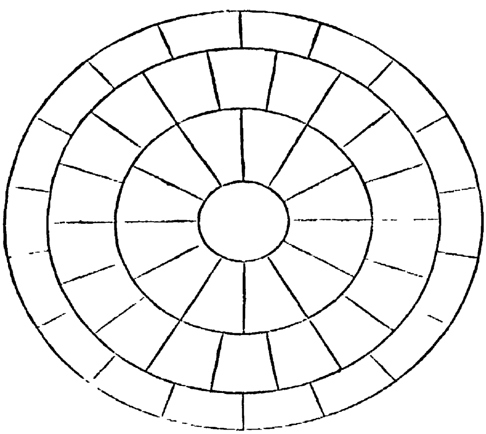


Fig. 8.

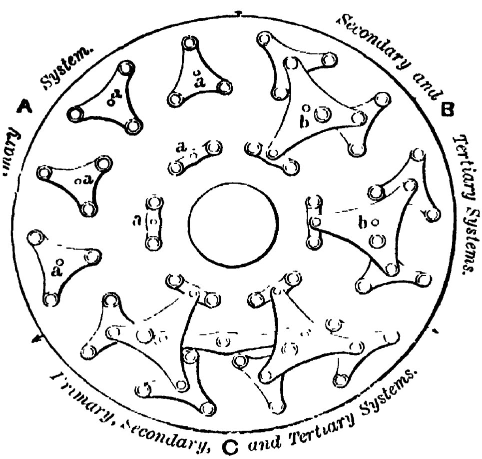
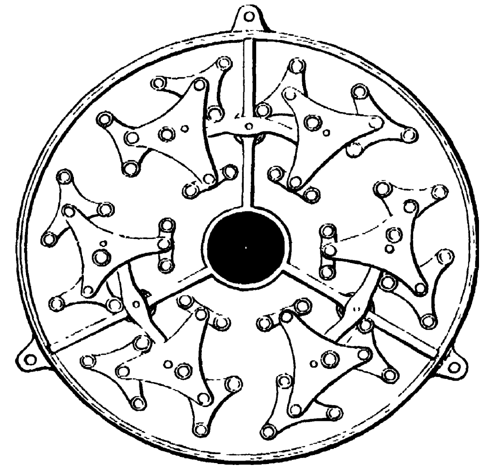


Fig. 9.

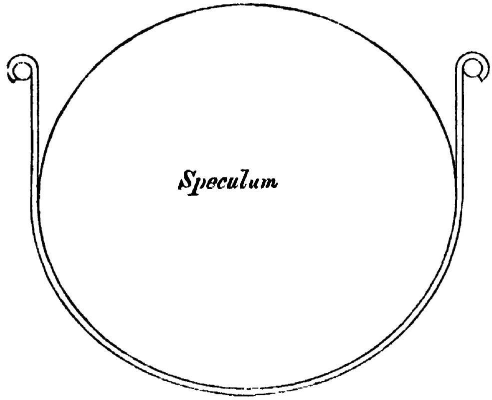


the speculum box (which serve for levelling the mirror), the points of which carry levers (*primary system*) supporting triangles on their extremities (*secondary system*), from the vertices of which are *hung* two triangles and one lever (*tertiary system*). All the joints of this apparatus are capable of a small rocking motion, to enable them to take their position when the speculum is laid upon them. In the system of those levers made by Lord Rosse for his six-feet speculum, the primary, secondary, and tertiary, &c., systems were piled up one over the other, so that the distance from the support of the primary to the back of the speculum was about 15 inches. This, as will be readily seen on consideration, introduced a new strain when the telescope was turned off the zenith, and had to be counterpoised by another very complicated system of levers. But in this telescope, by the substitution of cast-steel for cast-iron, and by *hanging* the tertiary system from the secondary and allowing it (the tertiary) to act in some places through the secondary, the whole system is reduced to 3½ inches in height, and the distance from the support of the primary lever to the back of the speculum is only 1¾ inch, by which means this cumbersome apparatus is entirely done away with.

The ultimate points of the tertiary system are gun-metal cups which hold truly ground cast-iron balls with a little *play*, and when the speculum is laid on these it can be moved about a small quantity by a person's finger with such ease as to seem to be floating in some liquid.

The System of Lateral Supports was devised by Mr. Grubb specially for this instrument. One objection originally raised to the mounting of these large telescopes (reflectors) equatorially, was that such heavy mirrors could only be supported *laterally* in a

Fig. 10.



flexible hoop, as in Fig. 10, to preserve them from strain, and consequently it was impossible to mount them equatorially, when they would sometimes be turned upside down and would roll out of their hoop. Mr. Lassel ingeniously got over this difficulty by making his telescope revolve in its cradle so that he could always keep one diameter vertical; but this plan, apart from its inconvenience and clumsiness, destroys all accuracy of adjustment.

Mr. Grubb's system will be best understood by reference to Figs. 11 and 12. Both these figures are sections of the speculum

Fig. 11.

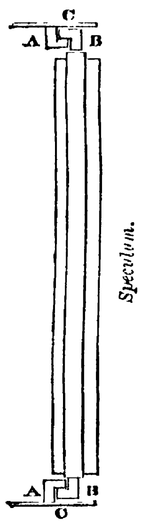
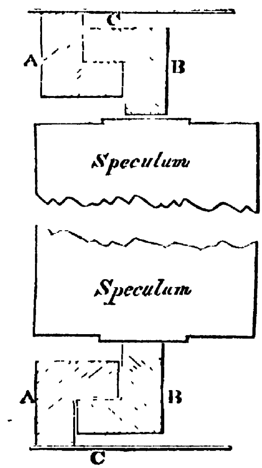


Fig. 12.



and its box, Fig. 12 being enlarged to show better the rings of support. C is a portion of the speculum-box, to which is attached on the inside a wrought-iron ring of the section shown at A; this may be considered inflexible from its construction. On this ring hangs another, B, another portion of which embraces the speculum round a part that was carefully turned by revolving grinders. Now this ring B may be considered as *the indispensable flexible* *hoop* hanging from A, and on which the speculum is hanging, but with this peculiarity that it is equally effective in all positions; and again at the upper side the speculum is free from the ring B, while at the lower side the ring B is free from A. Therefore the speculum is not confined in any exact position or prevented from taking a proper bearing on its back supports. This is just what is required, and so effective is this apparatus that on no occasion could any evidence of strain be detected by the most critical observer.

The driving clock is, as may be readily supposed, of rather ponderous dimensions, but is still, considering the size of the telescope it has to move, as compact as possible, fitting in a niche 2 feet square and 3 feet high. Its regulating power is that of a governor, the balls of which, when the desired speed is attained, fly out and bring two leather pointed screws into contact with a circular disc, which serves by the friction thus produced to prevent any acceleration of rate. Several driving clocks have been constructed on this principle, but owing to the omission of some very important details, nearly if not all of them have proved quite insufficient for their work, and consequently clocks of this kind are looked upon by many with distrust and incredulity of their efficiency, but it has been found that when this clock is constructed with proper attention to its details it presents some very important advantages for driving large equatorials. No clock is able to produce any correction in speed until *after* an error has been committed. Consequently the question becomes, What clock is it that corrects these errors most efficiently and most instantaneously? That this clock corrects errors in speed efficiently is proved by the fact that doubling the driving-weight (*viz.* that weight which will just keep the friction screw in contact) produces an acceleration in speed of only $\frac{1}{360}$ part, whilst the great *vis inertia* of the balls themselves (weighing about 20 lbs. each) prevents any sudden oscillation, so to speak, in rate; and that this regulating action takes place more instantaneously than in other clocks may be readily understood by inspection of the construction, when it will be seen that the actual movement required in any of the members of the governor to correct an excessive difference of power like the above amounts to something probably under $\frac{1}{1000}$ inch, instead of having to move by some considerable quantity a complicated system of link-work connected with fans, breaks, water regulators, air regulators, &c., &c., whose name is legion, and whose principal effect is that if one of them gets out of order all the rest are powerless. The general effect of these complicated systems is that when any error is made the ensuing correction is too great, which necessitates a counter-correction in an opposite direction, and so an oscillating effect is produced, which gradually subsides until matters again attain their equilibrium. An experiment has been tried with this clock which will form a record of its work and a comparison for other clocks. The clock was used to give motion to a long ribbon of paper on which lines were traced by a pencil worked by a free pendulum in a direction at right angles to the motion of the paper itself. The result was of course a wave line, the length of each wave being a measure of the second as given by the clock. During the process at certain points the driving weight was increased from $1\frac{1}{2}$ cwt. to 2, $2\frac{1}{2}$ and 3 cwt., but the difference of rate is insensible on the diagram, although capable of being measured to the $\frac{1}{1000}$th of a second. If this experiment were tried with other clocks it would form a valuable record of their work, independent of the testimony of their constructor. The shaft which is carried from the clock to drive the telescope is severed in one place and a system of six differential wheels introduced by which the rate can be rapidly altered $\frac{1}{20}$th part, this being the mean of the extreme differences between siderial and lunar rate, whilst a small lever and graduated arc, in front of the clock acts on the governor spindle, moving it up or down, and by this means altering the working angle of the balls, to make the final correction per lunar rate *pro tem.* Both of these adjustments can be made while the clock is in action.

It is difficult to understand how in this system of clockwork a great increase of power (2 to 1) can produce such a small difference of rate ($\frac{1}{100}$), and how the great overplus of power is used up by the small increase of velocity. The principle will, however, be understood by the following:—Suppose the arms of the governor are working at an angle of 45°, and the pressure on the friction-wheels to be applied at the same radius as the circle described by the centres of gravity of the balls. Then $c^{\circ} = \zeta$, where c° is the centrifugal force which will just keep the balls at this angle. Let p°, p, and p' be the pressures on the friction-screws corresponding to the velocities v°, v, and v'; the centrifugal forces c°, c, c' will evidently be as $v^{\circ 2} : v^2 : v'^2$, while the corresponding pressures will be as $c^{\circ} - \zeta : c - \zeta : c' - \zeta$, or as $v^{\circ 2} - \zeta : v^2 - \zeta : v'^2 - \zeta$. Now if $c^{\circ} = \zeta$, the first pressure $= 0$, whilst if c and c' be very small increments on c°, p' will bear a very large proportion to p. Suppose, for instance, the velocities to be as $100 : 101 : 102$, the centrifugal force will be as $10{,}000 : 10{,}201 : 10{,}402$, and the pressure will be as $0 : 201 : 402$, so for an increase of 1 per cent. in velocity, we obtain double the retarding force in this particular instance.

The hour circles are 34 inches diameter, and covered with a band of an alloy of silver and palladium, they are divided to minutes of time, and read to seconds by the nonius, the differential reading always giving actual Æ.

The declination circle is 30 inches diameter, covered with the same alloy; it is divided to 10′ of arc, and reads to 10″ of arc.

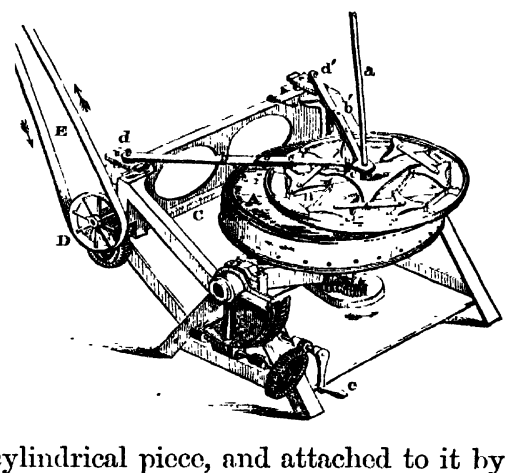
The preparation of the specula was carried on at the same time and in the same premises in buildings specially constructed, wherein the mounting was both manufactured and erected.

The alloy used was rather higher than what has hitherto been used for such large mirrors. The proportion was copper 32, tin 14·77. The mirrors were cast on Lord Rosse's "Bed of hoops," but with several very important modifications of his process.

The annealing was conducted in a circular oven and took twenty-three days. Immediately on being removed from the oven, the specula were placed on the machine, and rough-ground on front, back, and edge, during which process they rested on several thicknesses of cloth; from this they were removed to their own boxes, where they rested on the system of levers before described. The finer grinding and polishing was then proceeded with, and the specula were never after raised from their supports.

The Grinding and Polishing Machine, as devised by Mr. Grubb, is shown in isometric perspective in Fig. 13, where A is the speculum in its box, revolving on a vertical spindle, which, by a peculiar mechanical contrivance, is made to work with great ease and steadiness. B is the grinder strongly ribbed at back, and supported from its strongest points by six triangles of wrought iron. Three coupling levers unite these, which are in their turn supported by a strong central tripod. In a hole in the centre of this tripod is inserted a collared cylinder, so formed as to allow of a rocking motion through this cylindrical piece, and attached to it by a cross key, passes the bar *a*, which is supported at its upper end by a lever and weights (not shown in drawing) to balance a portion of the weight of the grinder. This vertical bar is laid hold of by the double bar *b b′* linked at *c*, and to which motion is given by the cranks *d d′*. These cranks receive their motion from the main shaft C, which is worked by the wheel pinion and pulley D, driven by the belt E. By the adjustment of the lengths of the cranks *d d′* of the beam *b b′*, and the relative velocities of the crank, shafts, and

FIG. 13.



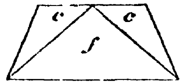
speculum, all the curves given by Lord Rosse's machine, and any of those given by other machines which have been found practically useful, are obtained. Some consider that the motion of the grinder or polisher should be itself controlled and capable of being regulated at pleasure, but it has been found that the free motion of the polisher forms a most accurate criterion of the action, *pro tem.* If that action be good, the polisher revolves just as it is desirable; but if anything occurs to disturb that good action, immediately it commences to revolve fitfully, either too quickly or too slowly, and thus gives notice of something requiring attention.

For the purpose of trial, as it would have been very troublesome to be obliged to remove the speculum to the telescope on every occasion of trial, the machine is so constructed that by turning a handle ($\cup$), the whole frame carrying the speculum is tilted into a vertical position by the endless screw and worm *f*, and a dial-plate and artificial star being placed at 800 feet distance, the mirror, used as a front-view telescope, is ready for trial in five minutes, which saves some two days' work on every occasion, besides avoiding risk. So efficiently and with such certainty did this machine do its work, that on no occasion, having once ascertained what was required, did it fail in providing the requisite alteration of figure, while as compared with other machines the ease and steadiness of its working was remarkable.

The photographic apparatus embraces every improvement proposed by Mr. W. De la Rue, and more especially those suggested by some experiments made with a rough trial apparatus fitted to the great telescope, with which photographs of the moon have been taken, exceeding in beauty and sharpness any hitherto accomplished in this or any other country.

The spectroscope has been made with a totally different style of mounting to those in general use, with a view of making it a more practically useful tool, whilst the prisms which are adapted to it are made of one very dense flint of about 90° or 100°, with prisms of light crown cemented on each side of angles of about 20° to 25°, Fig. 14; this gives a very large amount of dispersion with very little deviation, whilst the crown prisms protect the surfaces of the flint from tarnish, which has proved such a drawback to the use of heavy flint, for although it can be removed by friction and nitric acid, yet every time this operation is resorted to it leads to a depreciation of surface.

FIG. 14.



The contract signed in the beginning of the year 1866, included all the above-mentioned parts, with the exception of the photographic apparatus and the spectroscope, and amounted to 4,660*l.*; the instrument to be completed in twenty months, and although that time was slightly exceeded, yet, as stated by the committee, the delay arose solely from he state of the weather precluding all observation for trial of the r ecula.

In their report on this agnificent instrument, presented to the Royal Society in April las the committee pay a well-earned compliment to Mr. Grubb. / ter minutely examining and testing it, they express their admiration of the perfection of the telescope, and of the mechanical contrivances for its adjustment; and they add that, considering the contract price and that special works had to be erected for the purpose of constructing the instrument, they are convinced that Mr. Grubb has been influenced much more by the desire of producing a scientific masterpiece than by any prospect of pecuniary advantage.

II. ON THE POST-TERTIARY BEDS OF NORWAY AND SCOTLAND.

By Rev. Henry W. Crosskey, F.G.S.

Many of the grave difficulties attending the study of the glacial epoch result from two causes: (1) the want of discrimination between different members of a whole series of deposits; and (2) the looseness of the nomenclature employed. By the "Glacial Epoch" we understand that period intervening between the commencement and cessation of more rigorous conditions of climate than are now prevalent south of the Arctic Circle, and during which a large and varied series of clays, sands, and gravels, frequently fossiliferous, were accumulated and deposited through the northern districts of both hemispheres. These deposits, however, have been confusedly heaped together under various general names, and little distinction has been drawn between their upper and lower members, while the same terms have seldom been used in precisely the same sense by investigators at separate localities. It may, *e.g.*, be said that certain shells occur in the "Boulder Clay," and this may mean that they are found fossil, either in the higher or lower bed of a series, the members of which were deposited under considerable varieties of climate, and have had their position determined by different oscillations of the earth's crust.

The only method of obtaining a clear and comprehensive classification of these deposits of the glacial epoch, and solving the great problems involved in those recent changes in physical geography with which they are connected, is by instituting a careful comparison between their developments in various countries. Scotland, Canada, Sweden, and Norway furnish beds containing a large series of well-preserved fossils, and when their relationships are fairly determined the key to many larger questions will be discovered.

In order to commence one portion of the many investigations required, the writer, in company with a well-known Scotch naturalist (Mr. David Robertson), visited many of the Post-tertiary beds on the West of Norway, and in the present paper will endeavour to record a few results of the observations made.

I. The first great series of shell-beds indicates the extremest degree of cold (as far as this can be indicated by any fauna) attained during the glacial epoch.

These oldest Arctic shell-beds furnish a clear and definite starting point for our inquiries, and their analogies in Scotland and Norway, both in position and general character, are curious and instructive.

The position of the shell-beds indicates the existence of glacial conditions previous to their deposition, together with the gradual submergence of the ice-clad land. In the west of Scotland the shell-bed rests upon a hard and compact clay, containing striated stones and travelled boulders, but devoid of fossils. The boulders and stones are in the larger proportion from neighbouring hills, a certain number however being always traceable to more distant heights. The force by which this clay was accumulated acted under local conditions, but extended from afar. The striæ upon the underlying rock, and even upon enclosed fragments of shale, are so delicate that they indicate considerable slowness and gentleness of motion in the formative power, while the compactness of the mass indicates long-continued pressure, and not the drifting action of a storm. In one remarkable instance in Ayrshire a face of encrinal limestone has been exposed exquisitely polished. It rests beneath a mass of the clay now described and sections of encrinite are displayed in every position as perfectly as in any marble mantel-piece from Derbyshire. It may be noticed that in hollows the polishing process has been only half complete, but even when half complete it is almost more delicately worked than would be possible by the hand of man.

The shell-beds of the west of Scotland rest in hollows washed out from this boulder clay, so that a long period of ice action preceded the existence of the Arctic Fauna. There is evidence of the same fact in Norway. Resting upon the grooved and polished rocks at various points throughout the country, and reaching elevated positions on the mountain slopes, is a boulder clay which is precisely similar (local circumstances being taken into account) to that so well known to Scotch geologists. This is older than the shell-clay. It contains no record of a fauna, and was probably produced by the action of land ice. A comparison between the two countries thus gives a well-marked period for further study, *viz.* the history of the period between the commencement of the severe climate and the deposition of the shell-clays.

Another period also may be noted, between the beginning of life within the waters and the point of its extremest abundance. In such localities as the Upper and Lower Foss near Christiania, the lower part of the shell clay is very finely laminated, and contains comparatively few fossils.

The fine laminations of the lower clay, also, are characteristic of the beds at Paisley and throughout the whole Firth of Clyde,—beds equally deficient in fossils. A few foraminifera of the hardiest types are the only animals which have yet been detected in the laminated mud of the Clyde district. The flowing of mud-laden waters from inland ice would produce precisely such a mud as that we have observed beneath the more abundantly fossiliferous clays of Norway and Scotland. The highly comminuted particles deposited in layers would cause the laminations, while the coldness of the waters would limit the development of animal life.

A period of most abundant arctic life succeeded that of which we have in the laminated mud so imperfect a record. We have a deep sea instead of the estuaries into which the cold waters of great rivers were poured. The profuseness of molluscan life at this period, both in Norway and Scotland, is most remarkable. The beds of Pecten Islandicus, *e. g.*, extend along the Firth of Clyde at intervals for many miles. The shells in the clay-pits at Paisley interfere with the working of the clay. Exactly as at the present day, molluscan life is abundant at the edges of the glaciers as they overhang into the sea, so it must have been during this part of the glacial epoch. Another arctic characteristic is the connection of this abundance of life with the extensive development of a few species, rather than the distribution of the fauna into many genera.

The shell-beds of Scotland indicate a degree of cold almost as great as that manifested by the most arctic shell-clays of Norway.

There is a remarkable correspondence between a clay at Moss on the south of the Christiania fjord and a clay at Errol in the Carse of Gowrie. The characteristic shell in both clays is Leda arctica. It evidently has not been drifted but occurs *in situ*. Leda arctica is found living on the east coast of North America and within the arctic circle, not in the British seas or North Pacific.

At Moss and Errol, also, we find that the shells with which Leda arctica is associated are precisely the same and equally arctic in their characteristics. Tellina calcarea is large and abundant, while Buccinum Grœnlandicum may also be collected. It is not therefore the question of an isolated species; and the Norwegian and Scotch beds at these localities must be held to represent the same climate, so far as similarity of climate can be represented by correspondence of fauna.

Taking the older arctic shell-clays generally, Sars has described fifty-nine species of mollusca from the Norwegian beds, and of these fifty-nine species forty-eight have been collected in Scotland by Mr. Robertson and the writer. Sars has collected his specimens from Trondhjem to Avemark; we have collected ours from Caithness to Paisley, and are yet only deficient in eleven species, all of which may possibly occur in connection with those already found, since they have at the present day the same habitat in the Northern seas.

The great divisions under which the glacial fossils of Scotland may be classified render this comparison still more striking. The first class includes mollusca, unknown in the British seas, but living in high northern latitudes, such as Astarte borealis, Pecten Grœnlandicus, Tellina calcarea, Velutina undata. The second class comprises northern forms of species yet existing in British seas. Trophon clathratus, *e. g.* attains a large size, while Lacuna divaricata occurs in a variety, which Torell states can be abundantly collected on the coast of Iceland. The third class includes species comparatively rare in British waters, but very abundant in the shell-clays. Panopœa Norvegica, *e. g.*, now only found in deep water on the Dogger Bank, is far from rare as a glacial fossil. The fourth class includes those species which, while found both living and fossil in their ordinary forms, have yet a high range, no shell being found fossil in the older glacial clays which does not also possess an arctic habitat.

Associating together these facts, (1) the precise agreement between the characteristic shells at special localities; (2) the actual occurrence in Scotch beds of a large proportion of the most arctic species of the Norwegian clays; (3) the exhaustive classification which may be made of the glacial fossils of Scotland, showing even the most delicate arctic variation of existing species; we have a close correspondence of conditions now only prevalent in very high latitudes, common to Scotland and Norway during the glacial epoch.

The elevation of the older shell-clays of Norway extends from 10 feet to 450 feet, or 500 feet above the sea-level. Balani have been found attached to the rock in Avemark at a height of 450 feet. The highest shell-bed found in Scotland is 526 feet, near Airdrie, and the beds extend to this height, as in Norway, from points not far above sea-level. The correspondence upon several points of detail connected with this elevation of the earth's crust, is curious. Within a radius of a few miles near Glasgow, shell-beds of the same glacial character crop out at varying heights, from half-tide mark, in the estuary of Clyde, to 10 feet, 40 feet, 150 feet, 526 feet. In the Christiania fjord the same phenomena appear. A clay bed may be found, *e. g.*, 50 feet above the sea, and within a few miles another, belonging to the same age in its fossil contents, at 240 feet.

Whether therefore we investigate the physical position of the older glacial shell-beds of Scotland and Norway, their order and elevation, or their fossil contents, we find that they unfold a series of parallel phenomena, and suggest problems which refer to cosmical causes rather than the accidents of local circumstance.

II. The second great series of beds indicates a change from the extreme arctic conditions of the preceding period. 1. There are sufficient proofs, we believe, that the change of climate did not take place suddenly. The phrase "Raised Beaches" entirely fails to express the varying characteristics of the beds usually comprehended by it. It is necessary to study each deposit by itself, and carefully catalogue the contents, with the proportions in which the species occur; and different zones of marine life will frequently be found comprised under the general term "Raised Beaches."

Many of the Norwegian beds contain a mingling of arctic species with a large development of those, now the common inhabitants of the neighbouring seas.

The first characteristic indeed of these semi-glacial or post-glacial beds, is the very large increase in the number of species contained. Individual specimens may be as abundant in some glacial as in some later deposits, but invariably, species are far fewer in the more arctic clays. We previously quoted the fact, that Sars has collected fifty-nine species of mollusca from the glacial beds; from the succeeding series, he has catalogued 175.

In these deposits also, both individual specimens of arctic species, as well as arctic species themselves, are less predominant. We have reached the period at which arctic forms have not left the waters, but have received a check, and are being driven northward to a more congenial clime. Magnificent examples of this class of beds occur near the small town of Skien, on the northern side of the Christiania fjord.

At the south end of the beautiful lake Nordsaeen is a large shell bank, scattered in massive undulations over many acres. Its elevation is about 100 feet above the sea. It contains 128 species of mollusca, a number in itself far exceeding that contained in the whole of the older glacial clays. Among these 128 species, there are very few that may not be found living in Christiania fjord; but these few are arctic in character. For example, Pecten islandicus is small and rare; Tellina calcarea is large and tolerably abundant; but some characteristic arctic species have disappeared. Leda arctica, and even Astarte borealis are absent; while the relative proportion of the remaining glacial forms has become entirely subordinate.

The same phenomenon is developed in a large series of similar beds, spread over the west of Norway; and appears conclusively to establish the gradual character of the climatic change.

In Scotland, careful study of the clay-pits will, we think, manifest a corresponding fact. On the lower part of the Dalmuir deposit, *e. g.*, is a sandy clay, in which the arctic mollusca are very large and abundant; but in the upper part of the bank, they are neither so large nor plentiful. The general aspect of a collection made from the upper and compared with one from the lower part, of almost any clay bed in the nighbourhood of Paisley, will indicate a striking difference of condition.

At the base, resting either on the boulder clay or the native rock, is the laminated mud, with a few foraminifera, evidently indicating conditions unfavourable to molluscan life. This is followed by a large and fine development of arctic shells, which often are so plentiful as to interfere with the economic working of the clay. These shells, however, gradually become more and more rare. Evidently they have been driven away by the shallowing of the water and other physical alterations. At last, in the uppermost marine clay, scarcely a shell occurs, until in the sands and gravels of the old river bed we have the remains of a fresh-water fauna.

These deposits thus unfold a series of changes from the comparatively deep waters of the glacial sea, to the estuary of the ancient Clyde; and their evidence corresponds with that of the Norwegian beds, in emphasizing the quiet and gradual nature of the successive steps.

The elevation of the land, which took place during this period, has left its record in the existence of fossil beds, both of deep sea and of littoral character. In the island of Barholmen, off Dröbak, a remarkable instance occurs. A fossil bank, reaching from the sea level to the height of 20 or 30 feet, contains a wonderful and peculiar deep-sea fauna. Oculina prolifera is abundant, a coral which, Sars states, is found on the north and west coast of Norway, but never at a less depth than from 150 to 300 fathoms. A clear proof of the elevation of the land to the extent of, at least, 800 feet, is thus obtained. The argument is strengthened by the association with Oculina prolifera of both mollusca, entomostraca, and foraminifera, characteristic of great depths of water. Lima excavata is found, abundant, and of very large size, together with Pecten vitreus and Pecten aratus.

At the summit of this island, a height of about 100 feet, a fossil bank also appears. This contains fragments of Oculina and a few of the shells common in the shore bed, but they are associated with littoral species. Littorina littorea, *e.g.*, is most abundant, and completely characteristic of the deposit.

The upper and the lower banks on Barholmen thus belong to the same age, but the one is littoral in its character, and the other must have been uplifted from beneath a very great depth of water.

In these beds at Barholmen, the peculiar species of the older arctic clays do not occur, and they must be classified in the post-glacial series. An elevation of at least 800 feet therefore has taken place in this district, since the retreat of the arctic mollusca to their present latitude.

There are also signs in Scotland, of elevation of the land since the glacial epoch. The large bed of Ostrea edulis, which extends through the whole plain at Stirling, and is associated with a clay containing several specimens of the whale, is post-glacial, and the shells are undoubtedly *in situ*. In the course of the river Irvine, the following section occurs:—(1) clay, with Cyprina islandica; (2) sand, with remains of whale; (3) purely littoral sand both in aspect and contents, equivalent to that on the present shore. The gradual upheaval of the land in post-glacial times, converting the habitat of Cyprina islandica over which the whale journeyed into the shallow sandy shore which became its tomb, is by this section very closely indicated.

The courses of arctic currents and of currents equivalent to the Gulf-stream, must have been greatly affected by the physical alterations in the relative position of land and water, produced during the history now briefly sketched, and have acted upon the direction of the isothermal lines.

In certain beds, the fauna appear to indicate results of this description. At Bisæt, near Christiania, Isocardia cor, a shell which inhabits the Mediterranean, as well as the southern parts of the Scandinavian waters, is associated with the eminently arctic species Tellina calcarea. A corresponding fact may perhaps be quoted from the Hebrides at the present day, where several especially northern forms reach their most southern limit; and certain peculiar species have no locality recorded between that district and the Mediterranean.* A fossil bed at half-tide mark, in the Kyles of Bute and other localities, differs somewhat in its contents from the present fauna of the district. Pecten maximus and Ostrea edulis are far larger than now found in the Firth, while Psammobia Ferroensis and Tellina incarnata are more abundant than in recent dredgings in the neighbourhood.

Reviewing the various points indicated in the present paper, we arrive at the following suggestions for further investigation:

(1) The course of physical changes from the glacial epoch to the present day, was the same in its broad outlines in Norway and Scotland.

(2) These changes were gradual and have left their evidence in the shell-beds as well as in physical phenomena.

(3) It is necessary, therefore, to separate and classify these various shell-beds and not include them under the general names of "Drift" and "Raised Beach."

* See Reports by Mr. Gwyn Jeffreys on Dredging among the Hebrides.

(4) A general order of succession and variation in the glacial deposits characteristically prevails both in Scottish and Norwegian localities, and embraces the phenomena of an epoch, rather than the merely subordinate accidents of local circumstance.

III. ON THE IRON-PYRITES MINES OF ANDALUCIA.

By A. H. Green, M.A., F.G.S., of the Geological Survey of England and Wales.

For abundance and variety of mineral products, scarce any land in the world can match Spain; but owing to the state of torpor into which this once active country has fallen, it has become all but a matter of impossibility to work her mines with profit. English and French capital and energy have, however, of late, in many instances, successfully battled with the difficulties of such an undertaking; and among the districts thus opened out is a mineral tract reaching across the western part of Andalucia and the adjoining portion of Portugal, which contains many very large and remarkable deposits of Iron-pyrites.

My own knowledge of this ground was gathered during rather a hasty visit, but I have been able to add to it from the works *quoted below:** these, however, are but little known to general readers, and are besides of a somewhat technical character, and I therefore hope that the rather more popular account which I am undertaking may be neither unacceptable nor superfluous.

The rock of the district is clay slate, Silurian in age,† bedded, but not cleaved; talcose and micaceous slates are also met with, and here and there beds of quartzite. The strata rear up at very high angles, and are much contorted; but I was told that a general north-easterly and south-westerly strike could be traced. Over the slate tract are scattered many "masses of porphyry of different kinds, passing here and there into diorites, accompanied at some points by masses of cupriferous iron-pyrites, which at the surface are represented by deposits of oxide of iron, known in the country by the names of *colorados, monteras de hierro*, or *requemones*. The porphyritic masses are as a rule not very large, of small breadth, and

* 'Notes on the Copper Mining Districts of the Provinces of Seville and Huelva.' By James Mason. London. 1858.
'Notes on the Mines of Rio Tinto.' By J. Lee Thomas. London. 1865.
'Memoria sobre las Minas de Rio Tinto:' presentada al Gobierno de S. M. Madrid. 1856.

† 'Carte Géologique de l'Espagne et du Portugal.' M. E. de Verneuil et E. Collomb. Paris. 1864.

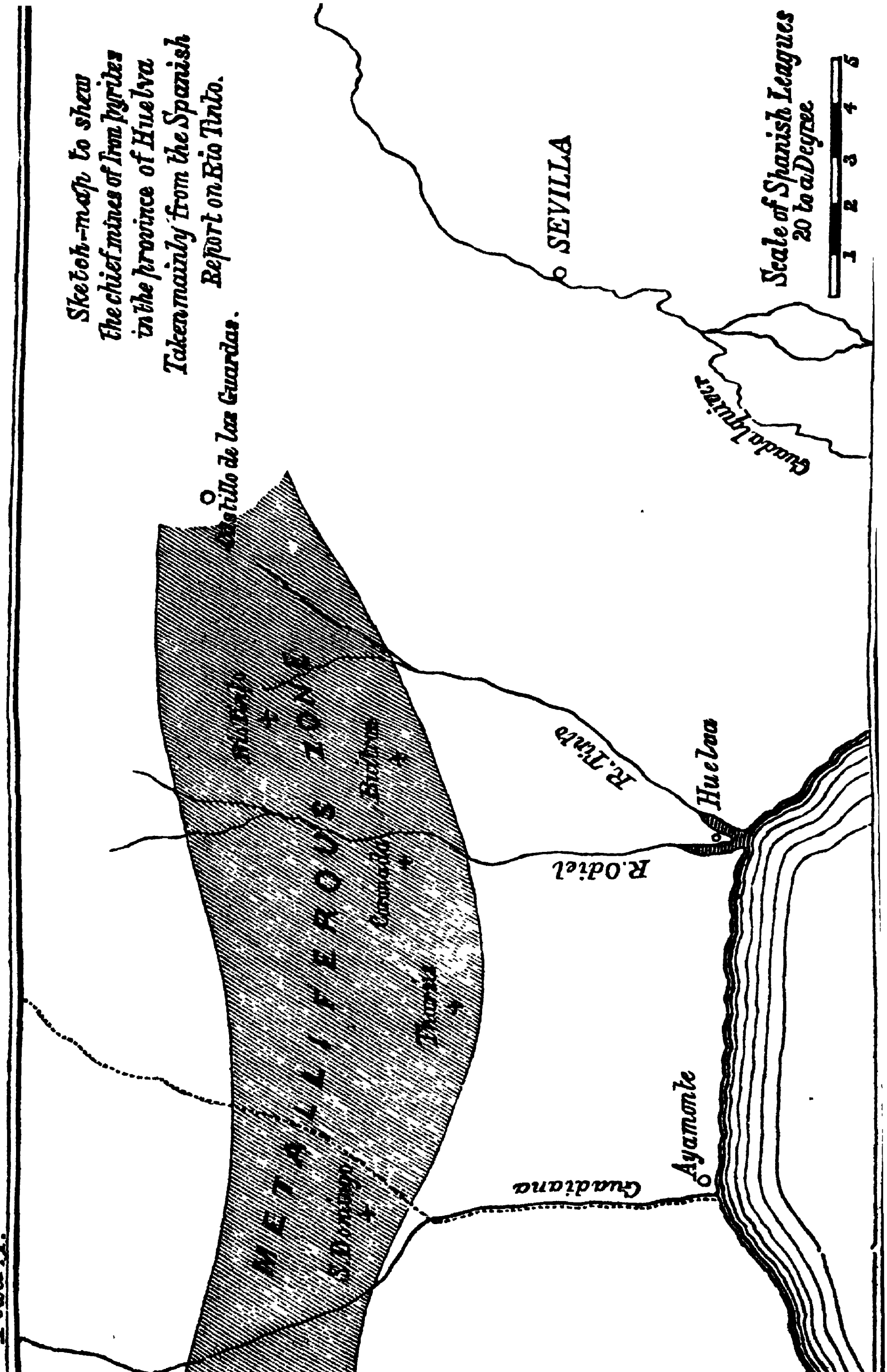
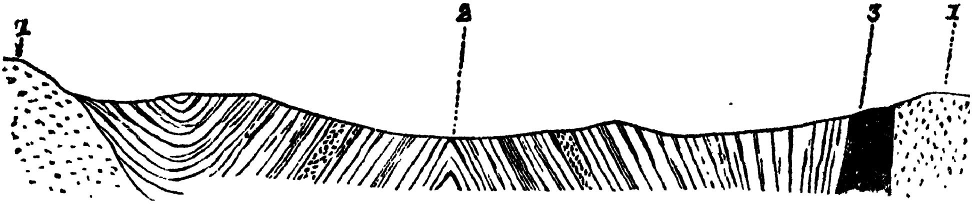


Plate I.
Sketch-map to shew
The chief mines of Iron pyrites
in the province of Huelva
Taken mainly from the Spanish
Report on Rio Tinto.
SEVILLA
Scale of Spanish Leagues
20 to a Degree
1 2 3 4 5
Guadalquiver
Castillo de las Guardas
METALLIFEROUS ZONE
R. Tinto
Huelva
R. Odiel
Ayamonte
Guadiana
S. Domingo

have their greatest length in an easterly and westerly direction."* The section on Fig. 1 shows the general arrangement of the rocks in the neighbourhood of Rio Tinto.

FIG. 1. GENERAL SECTION AT RIO TINTO.*



1. Porphyry. 2. Clay-slate, &c. 3. Pyrites with overburden of oxide of iron.

Except in size, the mineral masses differ but little from one another, and the characters common to all are as follows:—The ore is granular iron-pyrites, with a very small mixture of copper-pyrites, and about four per cent. of silica: here and there are slight traces of other ores, of copper, lead, and zinc. The ore, instead of being distributed, as is the case in most mineral veins, in strings, layers, or bunches, among unproductive "veinstuff," forms a homogeneous mass, unmixed with any foreign matter, or traversed only by a few insignificant veins of quartz. In the larger deposits "riders" of rock do sometimes occur, splitting up the mass, more or less, into several subdivisions; but these are as distinctly marked off from the body of the ore itself as the rock of the surrounding country. The horizontal section is rudely lenticular in shape, its longer axis ranging parallel to the strike of the slates in the neighbourhood. No bottom has been reached in the larger deposits, but some of the smaller masses have been followed downwards till they thinned away altogether.

These masses of ore are surrounded by a belt of altered slate, known to the miners as the "Salbanda," from the German "Sahlband," consisting in the main of bleached and porcelanized rock: the part, however, immediately in contact with the ore is often soft and crumbly, seemingly from the effect of chemical action occurring at the junction.

The ore itself never shows at the surface, but is covered by a "gossan" or "overburden," consisting in the main of oxide of iron, mixed with red clay and fragments of the adjoining "country," slate, or porphyry, as the case may be. There can be little doubt that this is the result of atmospheric decomposition of the pyrites: at Rio Tinto lumps of it have been found, containing unaltered pyrites in the centre.* The overburden varies in thickness at different mines,

* Spanish report on Rio Tinto, where will also be found a detailed account of the lithology of the district.

being very rarely as little as 20, and sometimes as much as 160 feet: on an average perhaps about 40 feet.

The ground covered by the gossan is usually lower than the level of the surrounding country, and looks as if it had sunk bodily, while the Sahlband stands up as a wall all round: the cause of this depression seems to be unequal atmospheric denudation, caused by the unequal hardness of the crumbly oxide and the firm Sahlband. A fanciful notion among the Spanish miners is, that the ore boiled up in a melted state from below till it reached the surface, and then shrank in cooling.

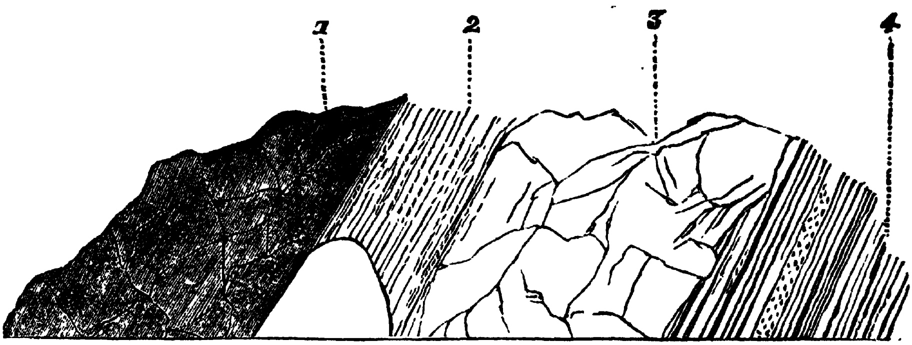
The Sahlband and the depressed crust of oxide of iron form sure guides by which we can detect, without underground explorations, the presence of a pyritous mass, and determine its shape and size. Some caution, however, is needed, for other deposits of oxide of iron occur, which to the unpractised eye are very like those which overlie a mineral mass, but beneath which no ore will be found. These may be called "false caps" of oxide of iron. Many of these have doubtless been formed by water charged with oxide of iron, produced by the decomposition of pyrites, for like deposits, the recent origin of which is proved by their containing bits of slag, are now being laid down by the water issuing from the mines. Some of these "false caps," however, are found in places where no stream can now flow: in this case they may have been deposited when the surface configuration of the country was different from what it is now; or they may be the remnants of a pre-existing pyritous mass, the greater part of which has been denuded away, and the remnant entirely oxidized. If the latter explanation be correct, extra precautions will be necessary when exploring for a deposit of pyrites, for while surface indications give the position and horizontal section, boring will be required to determine whether any unaltered mineral remains below the oxidized crust.

The general look of the country is tame and monotonous: after a time, however, the constant repetition of the same features begins to impress forcibly on the mind their very peculiar character. As far as the eye can reach, there stretches what looks like an unbroken flat, thickly overgrown with gum-cistus. Entering on this seeming plain, we find that it is deeply channelled in every direction by steep-sided brook and river valleys; but till we actually stand on the edge of one of these valleys there is scarce anything to lead us to suspect their existence: looking back, we wonder what has become of those precipitous glens down which our horse so carefully planted each footstep, and up which he so laboriously toiled, for the country looks an unbroken flat; ahead it is to all appearance the same, though closer acquaintance will show us how deceitful looks are. With scenery so marked daily before the eye, a conviction is very forcibly brought home to the mind that the country was once just such a plain as it now seems to be, and that the valleys were carved out afterwards, and all weariness at the monotony of the landscape vanishes in the delight of realizing the idea of a Plain of Marine Denudation, not by the aid of maps, sections, and description, but the thing itself, the size of nature, yet as clearly shown as in a model.

We may now turn to a few of the mines at work, beginning with that of Santá Domingo,* in the province of Alemtejo in Portugal, not far from the Guadiana and the Spanish frontier.

The deposit, which is of the usual lenticular shape, but irregular in outline, is between 500 and 600 mètres long and 70 mètres across at the widest part, and is split up by several "horses" or "riders" of slate: the ore is uncrystallized iron-pyrites of a dull grey colour, intimately mixed with a small percentage, from 2½ to 4, of copper-pyrites; the latter sometimes occurs in larger quantity, and hard specimens may be picked out containing perhaps 20 per cent. of copper. Galena and other minerals are also sparingly present, and the joints are thinly coated with carbonate of copper.

FIG. 2. SECTION ACROSS THE ADIT AT SANTA DOMINGO.



1. Pyrites. 2. Soft part of the Sahlband. 3. Porcelanized rock. 4. Clay-slate.

Fig. 2 is a section across the adit. The plane of separation between the mineral and the sahlband was most distinctly marked and haded to the north at an angle of from 45° to 80°: it was marked at some spots by beautifully polished slickenside. The sahlband itself consisted of a belt (2), next the ore, of a white, soft, quartzose rock, about 2 or 3 mètres broad; beyond this is a belt, said to be as much as 30 mètres broad, of very hard, flinty, porcelanized rock (3), white with narrow red stains: this passes outwards into slate rock. Here and there in the outer belt is seen a breccia of porcelanized rock and white quartz cemented by oxide of

* I gladly take this opportunity of acknowledging the courtesy of Mr. Mason, the managing partner, who entertained us during our stay.

iron. The altered rock seems to be the result of intense heat acting under pressure; the breccia and slickenside point to movements and rending of the rocks, the fragments being afterwards cemented by water percolating from the ore through the resulting fissures. The soft belt is probably only a portion of the porcelanized rock corroded by decomposing agents produced by chemical action at the junction with the ore: such action is constantly going on, for the roofs and walls of the mine are thickly coated with incrustations and stalactites of sulphate of copper, and the water that flows from the workings holds in solution much of this and other salts.

The mine is entered by inclined adits, and where these strike the ore, a level is carried in the sahlband of the southern or foot-wall alongside the mineral mass: the overhanging of the solid mineral, which to a certain extent protects the tunnel, makes this side the best for driving. At right-angles to the level, galleries or "cross cuts," about 40 feet high, are driven across the mass to the northern wall, ribs or pillars of ore being left between to support the roof. The ore is carried by boys in baskets, made of esparto grass, into the tunnel, drawn up to day in waggons, and conveyed on a railway, with startling curves and gradients, to the shipping-port on the Guadiana.

Thus much of the mine itself: but the spot has an interest for others besides the miner and geologist. In the middle of this wild country, on a spot which but a few years ago was as lone and barren as all around it is still, there has sprung up a good-sized village, with the offices, stables, and outbuildings of the mine, a church, and the handsome house of the resident partner: weekly markets are held, and the place boasts its clergyman, doctor, and police. All this change has been brought about by the energy of a single man, to whom and to whose like the country owes no small debt of gratitude. For this material civilization cannot fail to lead some day to higher results. It will be envied and sought after by the people of the land, and will be found to be beyond reach so long as their present ignorance lasts. To obtain it, education in the highest sense is not needed, but some degree of knowledge is; and even if this be of the most technical kind, and have only the lowest ends in view, it cannot fail to rouse and strengthen the mind; and men, taught to think for themselves on one class of subjects, will soon shake off the fetters of dogmatism, and do the same on all; and thus by a side-wind we may hope that education proper will find its way into a land where any attempt to introduce it directly would be put down as profane, or revolutionary, or both. Undertakings such as this, whether they are started with such a view or not, are true missionary work, and almost the only kind of missionary work practicable under the circumstances.

Of the large mineral deposits, that of the Tharsis comes next in drive this adit level, and the mine is unwatered to a considerable depth by natural drainage, an immense gain in a country where scarcity of fuel makes pumping by steam-power an almost ruinous expense. The property has only lately come into the hands of the present company, who are energetically pushing forward their operations, and have laid down a railway to the port of Huelva. There are estimated to be 4,000,000 of tons of ore above the level of the present adit, and there is little doubt that the present adventurers will reap as rich a harvest as has fallen to the lot of their predecessors at Santa Domingo.

About four leagues to the north of the Buitron is the Government mine of Rio Tinto, to which I paid a hasty visit in company with Señor Don Manuel Ortegosa, to whose guidance I owe much both on this and other occasions. The ground-plan in Plate II. is reduced from that given in the Spanish report above quoted, and the following account taken from Mr. Thomas's pamphlet:—"Within the sett there are three lodes which traverse it from east to west. The northern and central ones are divided for the greater part of their length by a wedge of porphyry, but meet at either extremity. The southern lode is of greater length than the northern and central ones, and is separated from them by a larger wedge of country than they are from one another. It is to this deposit that the workings of the Spaniards have been confined; it has been opened up by them for a length of 500 mètres, its average width for that distance being 71 mètres nearly. The thickness of the overburden over the part worked is about 25 mètres." Much cannot be said for the management of the mine: shortly before my visit a "crush" had taken place which had deranged the ventilation, and I believe a similar accident has happened since. The drawing-tackle consisted of one gin, of enormous size and ill-balanced, worked by a team of mules, at least one-half of which were required to start and keep going the dead weight of the cumbrous machine, whose creakings and groanings as it was dragged painfully round mixed with the shrill torrent of incessant abuse by which a Spanish driver urges on his animals. It must not be supposed that this blundering, of which further examples might be quoted, is due to any want of skill on the part of the managing engineers, who are fully up to their work; but any suggestion of theirs must be submitted for the approval of officials at Madrid; and our experience of red-tape at home, when matters of science are concerned, will give us some notion of what must be the fate of any proposals for improvement in Spain.

History and Uses of the Mineral.—The vast heaps of slag found in the neighbourhood of most of the deposits, and the old shafts and adits, show that the mineral has been largely worked in bygone times. No certain traces of the Phœnicians and Carthaginians have been met with; and those Roman remains whose date can be fixed belong to the times of the emperors Nerva and Honorius.* Strabo's remarks on Spanish mines† are vague, and none of the localities he mentions can be identified with those treated of in this paper. In one passage, however, he mentions, quoting Posidonius, that the people of Turdetania (nearly the same as Andalucia) drive their levels *zigzag* and deep; and to get rid of the streams of water they encounter, employ Egyptian spiral pumps.‡ The levels and water-wheels at the Coronada, already described, agree so closely with this description, that we can have no doubt about referring them to the Roman period. The ore was worked by these early miners for the small percentage of copper which it contains, and the metal extracted by smelting: their industry is shown by the immense heaps of slag they have left, especially at Rio Tinto, which Mr. Thomas suggests may have been a centre of smelting; and an examination of these slags shows that their skill was far superior to that of the Spaniards during the first half of the present century.

Leaving these uncertain traces of the old miners, we find that the mine of Rio Tinto was reopened about 1727, and has been worked since 1849 by the Spanish Government. Before the latter date the metal was extracted by smelting; but since 1849 a process has been employed known as Cementation, which is as follows:— The ore is first calcined in heaps in the open air: a small quantity of brushwood and roots of trees is used as fuel to light the pile, which, when once on fire, burns of itself. By this means a certain amount of the insoluble sulphide of copper is converted into soluble sulphate. The calcined ore is then placed in tanks of water, and when the latter has become saturated with the salts of copper and iron, it is run off into another tank, where the copper is precipitated on lumps of pig-iron. When a sufficient thickness of precipitate has accumulated, it is scraped off, and made into balls, which are dried in a kiln: these are reduced in a German blast-hearth, and the proceeds refined in a reverbatory furnace and cast into pigs. The results are far from satisfactory, as little more than half the copper contained in the ore is extracted; a far better method is that of "kernel roasting," as practised at Agordo in the Venetian States,* for an account of which the reader may consult Dr. Percy's 'Metallurgy of Copper.' We may also note that the water flowing from the mine is strongly impregnated with salts of copper: it is collected in long wooden troughs, and the metal precipitated by iron.

By the cementation process all the sulphur in the ore is lost,

* See Mr. Thomas's pamphlet, p. 5.

† 'Geographia,' book iii.

‡ I have to thank my friend, the Rev. T. C. H. Croft, of Caius College, Cambridge, for directing my attention to this passage.

passing off as sulphurous acid, the fumes of which destroy the surrounding vegetation, and corrode the iron used in the neighbouring buildings. It is only of late years that the ingredient just mentioned has been turned to account; but the commercial success of using the mineral as a source of sulphur has been so great, that it is now looked upon more as a sulphur than a copper ore. Up to 1840 Sicilian sulphur was chiefly used in the manufacture of sulphuric acid, but about that time the King of Naples granted a monopoly of the export of Sicilian sulphur to Messrs. Taix and Co., of Marseilles, and the price of the commodity was in consequence doubled. The manufacturers were thus obliged to cast about for other and cheaper sources of sulphur, and many adopted the use of iron-pyrites, procuring them at first from Wicklow and Cornwall, and since 1856 from Spain. This mineral has now almost superseded sulphur, only a small quantity of acid, which is required for chemical purposes to be of great purity, being manufactured from the latter. Details respecting the introduction of pyrites into this country and the process of manufacture will be found in 'A History of the Trade and Manufactures of the Tyne, the Wear, and the Tees,'* p. 159.

The other ingredients of the ore are also turned to account by the manufacturers of the North of England. The copper is extracted from the residuum both by cementation and smelting, and in one manufactory at least the remaining oxide of iron was smelted as an iron ore; it would seem likely, however, that with regard to the last process the remnant of sulphur and arsenic would tell very much against the quality of the metal obtained.

The above sketch deals mainly with facts; for though I would gladly have attempted some explanation of the method of formation of these strange mineral masses, I felt that with the scanty data at my disposal any such attempt would have been rash theorizing. My own visit was too hurried, and my time too much taken up with other matters, to leave leisure for questions of purely scientific interest; and the works I have had access to treat the subject more from a mining than a geological point of view.

* London: E. & F. N. Spon, 1863.

IV. ARTIFICIAL IRRIGATION.

IT is undoubtedly one of the most important duties entrusted to man that he should learn to control the elements, and by bringing science and art to bear upon the works of Nature, to render them subservient to his will in promoting the general welfare of the human race, and in contributing to its every-day requirements. Thus we see that destructive element, Fire, fairly brought into subjection, and forced to contribute to our wants in a thousand different ways. The Earth yields its hidden treasures for a similar purpose, and every description of soil which covers its surface has its allotted task to perform; whilst Air and Water, in addition to being absolute necessities of existence, have yielded the force and power with which they are invested to be applied in an infinite variety of ways to the wants of mankind.

In many parts of the world where rain is uncertain, or only occurs at stated periods of the year, it would be impossible to carry on cultivation to an extent sufficient to produce food for the inhabitants, without the aid of some artificial means by which water could be applied to the land, when most required by the growing crops. This fact seems to have been recognized many centuries ago in France, Peru, China, Spain, Italy, and in the East Indies, and at a still earlier date in Africa, systems of irrigation being clearly traced as having existed in the ages of the early histories of those countries. Few are perhaps aware of the extraordinary fertilizing powers of water even upon a barren sandy desert; but it has been proved by actual demonstration that the whole of Sindh, the greater part of which is marked on some of our maps of India as the "Great Desert," might be turned into a perfect garden merely by diverting some of the waters of the Indus, which now run away into the sea, and applying them to the parched-up land. Again, along the banks of the Suez Canal fertility has in many places succeeded to a sterility of probably some thousands of years' existence, and there is no practical reason why the entire desert, now for the first time cultivated only in parts, should not in course of years again fulfil the Divine mandate and "bring forth herbs, and fruit for the use of man."

Artificial irrigation consists in conducting water from some natural source of supply, such as rivers, springs, or lakes, by means of channels, or ducts, to the cultivated land which it is desired to irrigate. In some places this is done by throwing dams across rivers so as to raise their levels, and by forcing the water into a canal cut from the river at some point above the dam; the canal is then carried along the highest ground consistent with giving a sufficient slope to its bed to ensure a regular flow of water, from which minor channels are led off for the purpose of distributing the water to the various fields or divisions of land. Where existing lakes are to be found, the process of leading off the water in canals is simple enough, but artificial reservoirs are often constructed by damming up a gorge in a range of hills, in which is collected and stored all the rainfall draining into it; and where rock abounds a practice prevails in some parts, of excavating a subterranean passage having the usual slope of an irrigation canal, in the direction where water is supposed to exist. We shall notice these various methods of obtaining supplies of water for artificial irrigation more in detail hereafter, when the several varieties of each form of work will also be further described.

It is impossible now to state, with any degree of certainty, which was the first country to introduce a system of irrigation, but it would appear from the records in our possession that the palm of priority must be yielded to Spain over Italy, but France was probably before Spain, and Africa anterior to any in Europe. Whether irrigation was introduced into Africa before the second century it would be difficult now to determine, but if not, then the Peninsula of India may perhaps claim to have first received the benefits of irrigation. Mr. Markham, in his 'Report on the Irrigation of Eastern Spain,' states that the works of irrigation which are met with along the eastern coast of Spain from Cartagena to the mouth of the Ebro, in the old Arab kingdoms of Murcia and Valencia, "all owe their origin, and the rules and customs by which they are managed, to the ancient Arab rulers of the Peninsula, and have been in working order for upwards of a thousand years; though in some instances they have been enlarged and improved in more modern times. It is probable that there were some few irrigation works in this region, even in the time of the Romans, when Spanish agriculture was represented by Lucius Columella; but this is uncertain, and to the Spanish Arabs the credit is due of having instituted a system whereby the rocky deserts and dried-up valleys of the Peninsula were converted into terraced gardens and fertile *vegas.* The government of the Caliphs of Cordova, so far as its Public Works Department was concerned, was certainly the most efficient that has ever existed in the world, with possibly the single exception of that of the Yncas of Peru; and to the long period of peace and prosperity which was secured to this part of Spain by the firm and benevolent rule of the Ommiad Caliphs, is to be referred the execution of the great works of irrigation in Murcia and Valencia. Some of these works are actually ascribed to particular reigns, and there can be little doubt that all date their origin from this period, about A.D. 760 to 960. The subsequent centuries of Arab dominion were periods of strife and internal dissension, ending in a struggle or existence. Those were not times for originating public works, though the irrigation system that had been instituted in the days of the Caliphs was perpetuated and confirmed under the succeeding dynasties, until when the Christian conquerors appeared in the thirteenth century, it recommended itself for adoption, backed by the experienced benefits of five hundred years."

Turning now from Spain to Northern Italy, we have been unable to obtain any very definite information on the subject of irrigation as adopted there either in the classic times or during the dark ages; but it is not unreasonable to suppose that such works did exist at a period anterior to that of which any record exists. There are, however, to be found references to the question by writers of the Augustan era, especially the line of Virgil in the Georgics (Ecl. III.), "*Cludite jam rivos pueri, sat prata liberunt.*" An inscription of Hadrian's time commemorates the construction of an aqueduct in the vicinity of Milan; and some few scattered vestiges of dams and other works still exist, which are attributed in a doubtful way to the times of the empire from Augustus to Theodosius. The late Colonel Baird Smith, in his valuable work on Italian Irrigation, says, "That the system was to a certain extent employed there cannot of course be any doubt, but I think it most likely that water for irrigation was derived chiefly from springs, and was used to a limited extent; for had great works like those constructed for supplying cities with water, of which so many remarkable examples remain, been also used for purposes of irrigation, we should have had traces of them left to this day, far more distinct than any we now possess. Irrigation on a large scale, and by canals fed from large rivers, never seems to have existed until comparatively modern times. As in the East, so probably in Northern Italy, springs and wells, or small streams, easily diverted from their channels, were the sources of supply; and these would, of course, leave but evanescent traces on the surface of the country. It is in France that the most ancient traces of actual canals are to be found; and one of these, constructed it is supposed about the close of the fifth century, bears at the present day the name of Alaric II., king of the Visigoths.* In Northern Italy there are no such works so clearly identified, and it is in vain that we seek for detailed information on any one point connected

* Berra quotes from Cassiodorus (Dei Prati detti á Marcita, p. 6) two very curious letters of Theodoric I., king of the Goths, one to the Senate of Rome, directing that all possible encouragement should be given to a certain Desius, who proposed to drain and restore to culture a portion of the Pontine Marshes; the other is addressed to Desius himself, and exhibits the king as a most earnest and encouraging land improver. He promises liberal rewards in terms of great courtesy, and says he regards the operations with the deepest interest. The same author (p. 8) quotes another letter of Theodoric, in which orders are given for the payment of travelling expenses of a hydraulic engineer brought from *Africa to Rome*, to show the manner of obtaining and regulating supplies of water from rivers.

with the system of irrigation which existed there. On this branch of the subject we must therefore be content to know only, that while irrigation certainly was employed in the valley of the Po, from the remotest epoch of which we have any record, there is every reason to think that few, if any, works of magnitude were constructed, that the extent of the system was limited, and as compared with its more modern development, of very minor importance."

In India, the chief irrigated districts lie to the North-west, in the Punjab in the first place, and in the Peninsula in the second place. In their most important natural features the plains of Northern India and Northern Italy bear a striking resemblance to each other. Situated alike at the bases of the greatest mountain ranges on the continents to which they belong—drained alike by rivers which, flowing from regions of perpetual snow, have their volumes influenced by similar causes; possessed of slopes which, though differently distributed and arranged, are still equally well adapted to the necessities of each, belonging to the same geological epoch, and having physical structures with the same leading characteristics, it may be said of them that they are generically the same, whilst they differ somewhat in their physical aspects. Similarly, the eastern coast of Spain may, with equal propriety, be compared with the eastern side of the Indian Peninsula. Both in Eastern Spain and in the Carnatic the rivers rise in mountains below the level of perpetual snow, and are deficient in that permanence and regularity of supply which is the characteristic of more favoured irrigated regions. In both countries the rainfall is scanty and precarious, and the dry crops which are dependent upon it often fail. In both, the supplies of water for irrigation are secured by similar contrivances.

The first Indian canal of which there exists any satisfactory record dates from the year 1351, and it is stated to have been constructed by Feroze Toghlak. An interesting document discovered by Lieutenant S. A. Abbott, being a decree of the great Akbar, dated A.D. 1568, referring to the canal of Feroze Shah, which at that date had become so choked that its bed was scarcely discernible, directed that it should be excavated deeper and wider than formerly. Sixty or seventy years later new works were undertaken during the reign of Shah Jehan. The foundation of Shahjehanabad, and the natural desire to secure for his new capital and favourite residence the benefit of an abundant supply of water, induced the emperor to project the Delhi Canal. This canal, which was constructed in 1626, continued efficient for a century and a quarter. Aged men informed a British officer on survey duty in the neighbourhood in 1807, that they were finally deprived of the canal water about the year 1753, in the reign of Alumgir II. The canal of Feroze had ceased to flow in Hurriana about 1707, and at Suffidum in 1740; so that the Mogul canals became practically extinct nearly in the middle of the eighteenth century.

Irrigation works seem to have been very general in the peninsula of India under its native rulers, but in this part of India tank irrigation was, perhaps, more general than canal irrigation, although there were evidently many works also constructed of the latter class; and some very interesting ones in the southern Maratha country are clearly traceable to the Hindoo dynasty. "In the delta lands of Tanjore," says Colonel Baird Smith, "it is probable that artificial irrigation was contemporaneous with agriculture itself; but the first marked development of that native system, upon which modern mprovements have been grafted, is traceable to a period corresponding with the close of the second century of our own era, and to the reign of a certain Rajah Veeranum, to whom many of he gigantic pagodas, as well as the great irrigation channels in Tanjore, are attributed."

Besides canals which were taken from the rivers of the district, anks were (as we have already stated) largely employed in Southern ndia for purposes of irrigation; and some of these were formed on uch a scale as fairly to be denominated gigantic. The embankment of the Poonary Tank, in the Trichinopoly district, for example, vas 30 miles in length, that of the Veeranum Tank about 10 miles; nd numerous others of scarcely inferior dimensions are scattered ver the face of the country. All these tanks were provided with luices for distributing the water to the fields, with escape weirs for egulating the surface level of the water, and with other necessary orks of detail. The authority previously quoted refers in one of is writings to works of a similar character which were in existence the delta of the Kistnah when the country fell into our hands in 766. In Guntoor, two ancient channels, having all the characeristic marks of natural rivers, traverse the district in different irections, and for ages have been subservient to the irrigation of e delta. All the irrigated portion of the Madras presidency ounds in tanks, and the extent to which irrigation there is exnded is truly extraordinary. An imperfect record of the number tanks in fourteen districts shows them to amount to no less than 3,000 in repair, and 10,000 out of repair; or 53,000 in all.

In this hasty review of ancient irrigation works, an attempt has en made to record, so far as information has been obtainable, some count of the dates at which they were introduced into Europe. ith respect to India, the foregoing may be taken as a very brief t concise statement of all that is known regarding their origin in at country, and their progress under native dynasties.

In all civilized countries where irrigation has once been introced, that system of promoting agriculture has been promoted and extended. In France it is still extensively employed, more especially in the southern districts. In Eastern Spain the old Arab systems of irrigation are to be met with to this day; and it appears that the Spanish conquerors, far less civilized than their defeated foes, could, at the best, merely follow in the footsteps of the Arabs; but the enlightened subjects of the Western Caliphs had brought the science of irrigation, and indeed of all branches of agriculture, to the highest perfection. Markham, in his work above referred to, states—"Thus the irrigation systems of the Arabs continued in operation, with slight alterations and few improvements, after the Spanish conquest; the old rules and customs were adopted by the Spanish municipalities, and many of them have since been embodied in modern ordinances; and the works of irrigation have simply been kept in working order, and periodically cleaned, according to immemorial usage. The Arabs irrigated every place to which water could be conveyed, either by subterranean tunnels or ordinary canals; and most of these localities continue to present bright patches of green amidst the bare and rocky hills."

The repeated irruptions of the barbarian hordes of the north into the valley of the Po during the earlier centuries of the Christian era, led naturally to the neglect of even those works of irrigation which in happier times may have been constructed, and the rich plain of Lombardy was threatened with devastation. "A great part of the province," Bruschetti remarks, "was at this time covered with forests. Tracts, now richly cultivated, were then stagnant marshes or arid wastes. The cultivation of rice or the mulberry was unknown, and the products of the soil were the common grains required for food, and flax for clothing." The struggle against the superabundant waters, which threatened to submerge the plain, did not, however, begin for two centuries later. Before the year 1100, but at what precise date is unknown, the ancient works in the interior of Milan, originally constructed in the times of the Romans, were restored and extended. The destruction of Milan by the Emperor Frederick Barbarossa in 1162, and its subsequent re-construction on a grander scale about 1176, led to a great extension of these hydraulic works. Up to the middle of the twelfth century there appears no reference to the employment of the waters contained in these canals for irrigation. Continued local traditions, however, established the fact, that during the latter half of this century the modern system of irrigation had its origin; and it was to the intelligence of the Monks of St. Bernard, who founded the monastery of Chiaravalle, near Milan, that Lombardy was indebted for this blessing.

The date of the most ancient of the existing canals of Piedmont ascends to the commencement of the fourteenth century—the same period at which the great canal maker of India, the Emperor Feroze, was employed in the construction of the work which still bears his name.

Subsequent years saw a gradual development of the systems of irrigation, both in Lombardy and Piedmont, but they were for a long time administered in a very rude and imperfect way. No surveillance was exercised over the distribution of the waters, and every man supplied his own wants very much according to his own wishes. In the year 1474 the first indications appear of a regulated outlet being applied to the canal of Ivrea, in Piedmont, which, though of a rude plan at first, became modified and improved step by step, until the metrical module of the present day was arrived at.

Soon after the North-western Provinces of India came under the British Government, the propriety of restoring the Mogul canals began to be agitated. Attention, it is said, was first drawn to the subject by the offer of a Mr. Mercer to re-open the Delhi canal at his own expense, on being secured the whole proceeds of it for twenty years. This offer was declined, and about the year 1810 several officers were deputed to survey and report upon the lines both east and west of the Jumna. The subject was, however, soon dropped, but it was resumed with characteristic vigour during the administration of the Marquis of Hastings, who, in 1817, appointed an officer to superintend the restoration of the Delhi canal; and in 1822 another officer was deputed to survey and report upon the Doab canal. Similarly, in Southern India, the works of the natives were followed up and improved upon soon after the acquisition of the country. The hopeless state of confusion into which the Tanjore Government had fallen having led to the cession of the country to the English in 1801, the maintenance of the works of irrigation in that province, of course, devolved upon them from that time forward; and it was not long before certain defects inherent in the system began to exhibit themselves in a very clear and unpleasant manner.

The earlier works of this character, undertaken by the British in India, were, almost without exception, the restoration of ancient native works, and the defects originally existing in their construction were too often followed and imitated. On the Ganges canal, for the first time, was any entirely original work of this class attempted. Ground was broken on the 16th April, 1842, and the canal was opened, by the admission of water, on the 8th April, 1854.

It would carry us beyond the limits of a single paper were we to attempt to trace down the continued progress of irrigation works from the period of their revival in the different countries to which reference has been made in the foregoing pages; we shall, therefore, conclude this brief historic account of artificial irrigation by a short description of some of the methods adopted in their construction.

All canals taken off from rivers require a dam to be constructed across the stream, just below the point of their debouchure, and there are two distinct systems of this canal irrigation in ordinary practice, according to the nature of the country to be irrigated, and its physical peculiarities. The high table-land lying at the foot of mountain ranges, as in Northern Italy and North-western India, requires the adoption of a system very different from that pursued in the delta lands of the coast, as in Eastern Spain and Madras. The latter system consists in throwing a dam across the bed of the river, to raise the surface level of the water, which is then conducted along canals, whose mouths are above the dams, to the lands requiring it. This system is necessarily confined to alluvial tracts, which have been formed by deposits from rivers in a state of flood. In the former case, it is necessary to go back to some point high up in the river's course, whence the water can be brought on to the high land by excavation of a moderate depth, and by which sufficient command of level may be obtained to overflow the surface.

The simplest kinds of canals are those which are generally known as Inundation Canals, many of which exist in the Punjab and in Sindh, and by which the low-lands adjoining the rivers in those provinces are irrigated. Cuts are made from the river inland, for a certain distance, and are then carried in a direction generally parallel to the fall of the country, or the course of the river. By these, when the latter is in flood, the autumn crop is watered, but in the cold season, when the river is low, the canals run dry, and the spring crop thus derives no benefit from them. There are no works at the head of such canals to control the supply of water, for the course of the river Indus is so uncertain that it may completely desert the head, and the water may have to be brought in by a new mouth excavated for one season, which again may be useless in the next.

The Lake system of Irrigation is common to the plains of Lombardy as well as to the Madras Presidency. Where its introduction is practicable, this is, no doubt, a far more economical method of applying artificial irrigation, than the construction of large canal works; the former requiring generally but small expenditure, whilst the cost of the latter is run up by the numerous subsidiary works required for their completion. It does not appear necessary to say more with reference to these works; we shall therefore conclude the present article with a further notice of those subterranean channels to which we have already referred. Wellsted, in his 'Travels in Arabia,' describes this method of irrigation, as it is practised in the Bediah and other oases of Omán. He says:—"The oases of Bediah, and nearly all those of the interior of Omán, owe their fertilty to the happy manner in which the inhabitants have availed themselves of a mode of conducting water to them, a mode, as far as I know, peculiar to this country. The greater part of the face of the country being destitute of running streams on the surface, the Arabs have sought in elevated places for springs or fountains beneath it. By what mode they discover these I know not, but it seems confined to a peculiar class of men who go about the country for the purpose; but I saw several which had been sunk to a depth of 40 feet. A channel from this fountain head is then, with a slight descent, bored in the direction in which it is to be conveyed, leaving apertures at regular distances, to afford light and air to those who are occasionally sent to keep it clean. In this manner water is frequently conducted from a distance of 6 to 8 miles, and an unlimited supply is thus obtained. These channels are usually about 4 feet broad and 2 deep, and contain a clear rapid stream. Few of the large towns or oases but had four or five of these rivulets, or *feleji*, running into them, The isolated spots to which water is thus conveyed possess a soil so fertile, that nearly every grain, fruit, or vegetable common to India, Arabia, or Persia, is produced almost spontaneously." In the 'Journal of the Asiatic Society of Bengal,' the same subterranean irrigating channels are referred to as being used in Affghanistan, where they are called *Kahrezas*. Cieza de Leon, writing between 1532 and 1550 A.D., says, "The Indians of Peru had, and still have, great works for drawing off the water, and making it flow through certain channels. Sometimes it has chanced that I have stopped near one of these channels, and before we had finished pitching the tent, the channel was dry, the water having been drawn off in another direction, for it is in the power of the Indians to do this at their pleasure." Markham, referring to these works of the Yncas of Peru, states, "Trenches are cut along the whole length of the valley, becoming tunnels at the upper end, and penetrating into the rocks until they come in contact with underground springs. They are some 4 feet in height, with the floor, sides, and roof lined with stones, and are called *huirca*. At intervals of 200 yards there are man-holes in the main tunnels."

Somewhat similar works are also referred to in Baird Smith's Italian Irrigation, under the designation of *Fontanili*, as existing throughout the irrigating districts of Piedmont.

REVIEWS OF SCIENTIFIC WORKS RECENTLY PUBLISHED.

A Journey in Brazil (Agassiz). *Rambles of a Naturalist on the Shores and Waters of the China Sea* (Collingwood). *Acadian Geology* (Dawson). *Coast Defence* (Von Scheliha). Minor Works and New Editions.

A JOURNEY IN BRAZIL.*

In the winter of 1865 Professor Agassiz found it necessary to seek a change of scene and climate, and rest from work. From early life he had possessed a desire to study the fauna of Brazil, and especially the fishes, in their own home. Single-handed he would have been able to make but slight use of the opportunities presented to him during a visit to that country, although he was certain that the Emperor and the head of his government would give him every facility for his investigations.

While brooding over his difficulty, Mr. Nathaniel Thayer expressed to the Professor an interest in his proposed journey, and said, " Take six assistants with you, and I will be responsible for all their expenses, personal and scientific." This princely generosity was carried out in its largest and most liberal sense; and thus we have the origin of Professor Agassiz's Scientific Expedition to Brazil.

The volume before us contains a sketch of the Journey in the form of a diary, with here and there statements of the results of the investigations of the party: it is well calculated to interest general readers who are curious in such matters as the manners and customs of a wandering naturalist.

The voyage out was occupied most instructively: the Professor gave lectures to his assistants on various Natural History subjects, including the Gulf Stream and its Inhabitants, the Physical features of South America, Embryology, the Glacial Period, the Art of Observation, and many other subjects bearing upon the work before them, concluding with a warning against Darwinian tendencies; brief reports of the lectures being here given by Mrs. Agassiz.

Landing at Rio de Janeiro, the route of the expedition was up the coast to Pará; up the Amazon to Manaos, and on to Tabatinga, the frontier-town between Brazil and Peru: having left one of their party at that place to make collections, and two at San Paolo, the

* 'A Journey in Brazil.' By Professor and Mrs. Louis Agassiz. 8vo, pp. 540. Boston: Ticknor and Fields; London: Trübner and Co., 60, Paternoster Row. 1868.

remainder returned down the river as far as Teffé, where they remained nearly a month, journeying back then to Manaos, which they made their head-quarters and general rendezvous. After the reassembling of the party, and after making some excursions on the river Ramos and the Rio Negro, their steps were retraced to Pará, and thence to Rio. Remaining in the capital, and exploring its neighbourhood, for about three months, the expedition returned to New York after a sojourn of fifteen months in Brazil.

The known results of this expedition are too numerous to mention even in a review, and many facts and conclusions of the highest importance still remain to be worked out and verified before any cautious naturalist would venture to publish them. The chief object of the expedition was to ascertain how the fresh-water fishes are distributed through the great river-systems of Brazil; and all the excursions and independent journeys were planned in reference to this idea. Professor Agassiz estimates the number of species of fresh-water fish collected by the members of the expedition at between 1800 and 2000, or nearly twice as many species as exist in the Mediterranean. The number, however, is not so astonishing as the distribution. From Tabatinga to Pará the river differs neither in the temperature of its waters, in the vegetation of its banks, nor in the nature of its bed; yet under these circumstances completely distinct assemblages of fish are met with from distance to distance. When we consider that all the rivers of Europe united have not yielded more than 150 species of fresh-water fish, and that Professor Agassiz found in one small pond, covering about 400 or 500 square yards, no less than 200 species, mostly peculiar to that spot, we are inclined to indulge in a little scepticism. We want to know how many genera and families are represented by these 200 species, and what degree of affinity there is between the species themselves. Remembering Professor Agassiz's extreme opinions in favour of the theory of special and direct creation of species, we cannot help regarding it as possible that his "species" are not all entitled to that dignity. If they are, and are closely related, the explanation may be that the process of variation is stimulated in a vast degree by the tropical climate and physical features of the region. If both these suppositions are erroneous, we have here a Natural History marvel entirely without precedent; for we presume that the majority of Mr. Lea's species of Unionidæ, the only comparable example we know of, would be regarded as varieties by most European conchologists.

Another "sensation" discovery is that of the evidences of the Glacial Period in tropical America. Every geologist knows that the crystalline rocks of South America are extensively decomposed at the surface; but Professor Agassiz states that although the received explanation is true to a great extent, yet that a considerable portion of this so-called decomposed rock is the equivalent of the Northern Drift, presenting, however, in its wider extension and in the immensity of the accompanying denudation, features which are different from those with which we are so familiar. In short, Professor Agassiz refers the most recent deposits of the valley of the Amazons and its most recent denudation, resulting in the formation of hills of denudation nearly 1000 feet high, to the action of an immense glacier which poured down the valley from the accumulations of snow in the Cordilleras, flowed in an easterly direction, became swollen laterally in its progress by the tributary glaciers which descended from the table-lands of Guiana and Brazil, and built up an immense sea-wall as a terminal moraine, which protected its basin from the action of the sea!

We have exhausted our space in describing two of the marvels we meet with in this book; but neither the book nor its marvels are exhausted by us. To the intelligent reader we commend a careful perusal of this diary, as containing many new observations and much interesting information on the Empire of Brazil, from scientific, political, and social points of view. The naturalist and the geologist we have already placed on the scent; and the ethnologist will find much food for reflection, and possibly matter for dispute, in Professor Agassiz's conclusions on the characters of the mixed races of men, which are met with in such numerous and diverse aspects throughout the continent of South America.

RAMBLES OF A NATURALIST ON THE SHORES AND WATERS OF THE CHINA SEA.*

A book written by an Oxford M.A., M.B., Naturalist, F.L.S., &c., describing rambles, in the prosecution of which he was "actuated solely by a desire of increasing his own information, and the hope of, in some measure, advancing science,"† naturally raises great expectations. Its perusal, in our own instance, was attended by a large amount of gratification, not, however, unmingled with disappointment.

The author in his preface explains that he has incorporated into his work two papers, on the "Pratas Island" and on "The Luminosity of the Sea," taken by permission from this Journal; and other papers from the Proceedings of the Linnæan, Geological, Ethnological, and Royal Geographical Societies, and from the

* 'Rambles of a Naturalist on the Shores and Waters of the China Sea: being Observations in Natural History during a Voyage to China, Formosa, Borneo, Singapore, &c., made in Her Majesty's Vessels in 1866 and 1867.' By Cuthbert Collingwood, M.A., M.B., Oxon., F.L.S., &c. John Murray, London.

† Preface.

Annals and Magazine of Natural History. This may account for the disconnected character of the work, successive chapters of which, in some cases, relate to distant countries, without even a reference to the intervening journey or voyage.

A large portion of the volume is occupied by descriptions of the manners and customs of the inhabitants of various countries visited by the author; and in all this there is no room for disappointment. Life in the far East is depicted with a graphic ability that makes familiar races more familiar, and renders, to certain tribes hitherto almost unknown, services resembling those of the photographer; we feel that we should recognize them if we were to fall in with them. An instance of the former kind occurs in the description of Singapore.

"Here we may see tropical vegetation in all its beauty and perfection; and here too we may meet representatives of various races, from the east and from the west, attracted by the same commercial magnet—Europeans and Asiatics all alike bringing with them their manners and customs, their religions, their costumes, unchanged—a picturesque combination, such as scarcely any other place can afford.* The foreign (Eastern) residents in Singapore mainly consist of two rival races, widely different in dress, habits, and religion, *viz.* Klings, from the Coromandel Coast of India, and Chinese."† The Klings are described as being "intensely black, not the shining black of a negro, but a dull, sooty colour, from which their eyes gleam out with great expression, half savage, half intelligent." "The Kling women are dark beauties, finely made, and dressed in flowing robes, which conceal the whole figure down to the feet, but leave the arms bare to the shoulder. Their dress sits on them gracefully, and their ornaments give them an air of barbaric splendour. Armlets of gold are worn above the elbow, and bracelets of gold upon their arms; golden rings encircle their ankles, and several finger-rings glitter on their hands; heavy ear-rings hang pendant from their ears, and one side of the nostril is pierced to give passage to a gold nose-ring, more or less chased in front. These ornaments are not unfrequently worn by one woman, and it appears to be a common practice to invest their money in these trinkets, so that a Kling woman carries a small fortune upon her person."‡

In striking contrast with these appear the small-footed Chinese ladies of Formosa. "Their dresses, consisting of a wide-sleeved tunic, cut in the formal style universal among Chinese ladies, were of the brightest scarlet, blue, or orange, embroidered with black, which contrasted well with the colour; and their full trousers were of some other equally strong material. In their hair, dressed in the elaborate Chinese teapot fashion, they wore artificial flowers

* P. 242. † P. 245. ‡ P. 246.

made of the pith of the rice-paper plant of Amoy manufacture; and as they walked painfully along with the hobbling gait peculiar to their hoof-like feet, their figures swaying to and fro, and their arms more or less outstretched to balance themselves, they had, to us, a most grotesque appearance—but in Chinese eyes the acme of grace and loveliness, which they figuratively liken to the waving of willows agitated by the breeze."*

Amongst the less-known tribes visited were certain natives of the Island of Formosa. "These people are called by themselves *Kibalan*, and are, I believe, known by the Chinese as the tame *aborigines*, in contradistinction to the raw savages who dwell on the mountains, and on the east coast more particularly. These latter are at deadly enmity with the Chinese, while the Kibalans live in close proximity, though isolated from them."† Both sexes are said to be friendly and good-natured, not given to cheating or stealing, nor treacherous like other Orientals. During the occupation of the island by the Dutch, the Kibalans were raised from a state of barbarism, educated, and instructed in the Christian religion. "The aborigines of Formosa are reputed still to have a traditional reverence and regard for white men; and it is much to be regretted that so firm and benignant a rule as the Dutch seem here to have inaugurated should have been cut short by an overpowering attack of the neighbouring half-civilized Chinese."‡ This portion of the volume is extremely interesting, and its value, as the result of diligent observation, is confirmed by the publication, in an appendix, of a vocabulary of words used by the natives of Sau-o Bay, east coast of Formosa.

In turning to details more especially connected with natural science, the materials are so ample, and are set forth in so attractive a style, that we can only say the work has again and again set us longing to explore for ourselves. As a specimen, we quote the description of a portion of the Fiery Cross coral reef, so called from the circumstance of the ship 'Fiery Cross' having been wrecked thereon.

"Taking a boat, with a couple of rowers, I left the ship and steered in search of the shallowest portions of the coral-strewn sea. A short row brought us upon a two-fathom patch, over which I allowed the boat to drift slowly; and leaning over the side and looking down into the mirror-like sea, I could admire at leisure the wonderful sight, undistorted as it was by the slightest ripple. Glorious masses of living coral strewed the bottom: immense globular madrepores—vast overhanging mushroom-shaped expansions, complicated ramifications of interweaving branches, mingled with smaller and more delicate species—round, finger-shaped, horn-like,

* P. 45. † P. 107. ‡ P. 36.

and umbrella-form—lay in wondrous confusion; and these painted with every shade of delicate and brilliant colouring—grass-green, deep blue, bright yellow, pure white, rich buff, and more sober brown—altogether forming a kaleidoscopic effect of form and colour unequalled by anything I had ever beheld. Here and there was a large clam shell (Chama) wedged in between masses of coral, the gaping, zigzag mouth covered with the projecting mantle of the deepest Prussian blue; beds of dark purple, long-spined Echini, and the thick black bodies of sea-cucumbers (Holothuriæ) varied the aspect of the sea bottom. In and out of these coral groves, like gorgeous birds in a forest of trees, swarm the most beautifully-coloured and grotesque fishes, some of intense blue, others bright red, others yellow, black, salmon-coloured, and every other colour of the rainbow, curiously barred and banded and bearded, swarming everywhere in little shoals which usually included the same species, though every moment new species, more striking than the last, came into view."*

But it is now necessary to explain the disappointment spoken of in the commencement of our remarks. We are surprised at the following passage in the chapter on the "Luminosity of the Sea:"—"Phosphorescence is here a misnomer, and an even greater misuse of terms it is to speak of phosphorescent matter. There is no phosphorus in the case, nor anything allied to it, except in the abstract meaning of the word."† This is likely to mislead. The term phosphorescence is constantly recognized by scientific men as applying to a large number of phenomena having nothing to do with the substance called phosphorus.

There is moreover a want of precision in the information supplied on some points of acknowledged interest in biology, treated of in the 'Rambles of a Naturalist.' For example, the performances of the so-called flying animals, Galeopithecus, Pteromys, &c., have been often described by observers whose accounts have tended only to increase the desire for more trustworthy details. The habits of Galeopithecus, witnessed in Borneo, are mentioned in the 'Rambles.' The account is too long for insertion, but the animal is said to have come "streaming through the air from a distant clump of trees,"‡ to have sailed from the top of one tree, and to have alighted on the lower third of the trunk of another tree, distant about 150 yards. Now the best authorities on the subject agree in representing the Galeopithecus as using its extended flank membranes only as a parachute; and the anatomical structure of the creature makes this more than probable. Its progress therefore from tree to tree, is simply by a leap, the duration of which is increased by the parachute action of the membranes; but by the laws of motion and

* P. 146. † P. 393. ‡ P. 210.

gravitation, the duration of the leap, if the initial direction be horizontal or even descending (as represented), cannot possibly be greater than the time in which, with expanded membranes, it would simply fall from the top to the bottom of the tree from which it springs. The velocity needed to carry the Galeopithecus a horizontal distance of 150 yards in such a time as this, would leave little chance that a bone of the creature would be unbroken on its arrival at the second tree. Retardation towards the close of the leap would be impossible, inasmuch as it would cause the force of gravity to act in bringing the animal at once to the ground. We must therefore conclude that the specified distance, *about* 150 yards, must be in excess of the fact, or that the Galeopithecus must have a true power of flight. The difficulty is apparently not recognized in the 'Rambles.'

A few points may be suggested for revision in a following edition. "Neritinæ," p. 25. Neritinæ are fresh-water molluscs, and are unlikely to be found on Pratas Island: should it be Neritæ? "Tryxalis," p. 40 (Truxalis?). "Modulus," p. 49 (Modiolus?), the small stony-shelled molluscs belonging to the genus Modulus seem very unlikely to have been an "article of considerable consumption by the people." "Certhosia Cyane," p. 185, should be Cethosia Cyane. The vignettes used as headings for some of the chapters are from drawings made by the author, and are nicely executed; but the plate of Nudibranchs from the China Sea is a failure, and conveys the idea of a vista showing the sea between cliffs at a distance from the beholder, with monsters many yards in length crawling on the rocks.

The work is scholarlike and engaging throughout, but will do more, by its pleasing style, to commend, than, by its original observations, to advance Natural Science.

MINOR WORKS AND NEW EDITIONS.

ACADIAN GEOLOGY.*

THE scope of this work is as extensive as its contents are varied. The author commences in anger and ends with enthusiasm. His indignation is directed, as a Nova Scotian, in the first place, against the Imperial legislation which has deprived his country "of their cherished provincial independence and direct connection with the mother-country;" and, secondly, against the Commissioners on

* 'Acadian Geology: the Geological Structure, Organic Remains, and Mineral Resources of Nova Scotia, New Brunswick, and Prince Edward's Island.' By John William Dawson, M.A., LL.D., F.R.S., F.G.S. 8vo, pp. 694. Second edition. London: Macmillan & Co., 1868.

the settlement of the north-eastern boundary, who have had the bad taste to suggest that "the old and beautiful name Acadia" had its origin in the Indian appellation of a kind of codfish.

Our author having thus given vent to his colonial indignation, settles down as a first-rate exponent of the Geology of the Acadian provinces. Commencing with the modern period, he gives a most interesting account of the Micmac "pre-historic" relics, belonging to a "stone-age" which existed in Acadia not more than 300 years ago; and he shows that, in the course of between two or three centuries, large areas have passed through the following phases:—(1) Primitive Forest; (2) Second-growth Forest; (3) Burned Barren; and (4) Cultivated Fields.

Dr. Dawson belongs to the straightest sect of the severely orthodox, and the moral that he draws is that man may not have made his first appearance on the earth at anything like so early a date as we "auld warld" folks believe.

The Post-pliocene period is represented by raised beaches, terraces, gravel ridges, marine clay, and, oldest of all, a wide-spread deposit of boulder-clay, the formation of which is, in the main, referred by Dr. Dawson to the action of floating ice; and he considers that glaciers played a very small part in bringing together these various drift-deposits.

The Acadian geologist then encounters a vast gap—a lapse of geological time of immense duration entirely unrepresented,—for the whole of the Pliocene, Miocene, and Eocene deposits are entirely absent, while the Cretaceous, Oolitic, and Liassic strata are equally wanting. The cause of this hiatus is debatable; probably it was that the Acadian region formed dry land during those immensely long and continuous epochs; but it is possible, though barely so, that they were buried at a great depth beneath an ocean over whose bottom no deposits were accumulated; it is also within the range of belief that strata of these periods were once formed in Acadia, and have since been entirely swept away.

Triassic rocks form almost the whole of Prince Edward's Island, and occur also as a narrow belt along the eastern shore of the Bay of Fundy; but the period immediately preceding it—the Permian—is another blank in the history of this region, unless we may regard the upheaval and contortion of the Carboniferous strata as preserving for it a species of illustration.

The Carboniferous period is richly represented both by rocks and by fossils; and the greater portion of Dr. Dawson's book is occupied with its description. Much of this material, however, has been previously published in the Quarterly Journal of the Geological Society, and has been noticed in our Chronicles of Geology. We need, therefore, only mention that the Carboniferous rocks of Acadia have yielded the first indications of reptiles of that age; and have produced the only known Enaliosaurian and Land-shells, and the first known Myriapod, of that ancient date.

The Devonian period of Acadia was remarkable for its rich vegetation, and for its ancient air-breathing insects,—the oldest of all known land-animals; while to the igneous outbursts of this era Dr. Dawson refers the formation and upheaval of the metallic riches of the region.

The Silurian rocks were spread out on the shores of the rocky lifeless continent which then stretched westward from Labrador; the commencement of the period being characterized by muddy shallows and coral-reefs in the deeper sea; the termination of it witnessed the breaking up of this sea-bed, and the production of greater inequalities by extensive processes of upheaval and disturbance, accompanied by a gradual but entire change in the animal life of the region, leading up to that assemblage which characterized the Devonian epoch.

At the base of all these deposits occur the great Laurentian and Huronian series,—the former deposited in an ocean of whose shores we are utterly ignorant, and the latter characterized by the disturbance of its quietude, the breaking up of its bed, the metamorphosis of its sediments, and the ejection of vast showers of lava, ashes, and scoriæ.

Thus, in a few words, we have a sketchy outline of the Geology of Acadia; and we have only now to ask, What new lesson does this wondrous history teach us? Does it explain anything of which we were formerly ignorant, or does it expose the naked pinchbeck which we once mistook for the gold of truth?

Dr. Dawson thinks he can infer something comparatively new; and he also tries to prove untrue something that is now comparatively old; and both these efforts relate to a kindred subject, perhaps we should say to the same. In other words, he reproduces his idea of Geological Cycles, regarding each great geological period as forming a geological cycle in which the diversified conditions of land and water were, to a certain extent, successive; and he strives to show that the theory of Homotaxis is utterly erroneous, and that, for instance, the Carboniferous formation is, as a whole, and to a great extent, division for division, the contemporaneous equivalent of the European Carboniferous system.

We ought to mention, in conclusion, that the work is illustrated by an excellent engraved geological map, printed in colours; and by a large number of woodcut views, sections, and figures of fossils.

DANA'S SYSTEM OF MINERALOGY.*

As the previous edition of this standard work was exhausted eight years ago, a re-issue has long been anxiously anticipated. Indeed, there is so deplorable a poverty of mineralogical literature in the English language, that the student can ill afford that any work of value should remain inaccessible. The failing health of Dr. Dana, coupled with a desire on his part to introduce certain improvements into the present edition, has tended to delay the publication from time to time. At length, however, with the co-operation of Professor Brush, he is enabled to give us the long-expected volume.

On opening the book—a bulky octavo of nearly 900 closely-printed pages—one feels somewhat disappointed to find that, with the exception of about fifty pages of introductory matter, the present edition embraces only the descriptive portion which formed the second volume of the earlier work. Although the preface is silent on this point, we understand that the author proposes to issue a new edition of his first volume in the shape of an independent treatise.

Among the many improvements noticeable in the volume before us, we may especially allude to the introduction of a system of historical synonymy,—a feature which greatly enhances the value of the work, since it forms a guide in tracing the history of any given species. The consultation of original authorities for these synonyms must have involved a considerable amount of literary research. This research has led the author to a revision of our mineralogical nomenclature, by which he attempts to recognize, as far as possible, the law of priority in selection of names. This has of course necessitated the revival of many obsolete names, whilst an attempt to secure uniformity of nomenclature has led to the introduction of many new ones.† Thus, for example, Rock Salt is described under the new name of *Halite*, whilst Zinc-blende is to be found under Glocker's old name of *Sphalerite*. In other cases, the terms are only modified by altering their terminations into *ite*, and in this way we get such names as *Galenite*, *Pyrrhotite*, *Castorite*, &c. Again, Kupfernickel is termed *Niccolite*, and our hybrid adjective *nickeliferous* assumes the more consistent latinized form of *niccoliferous*. Indeed "nickeliferous" is not a better word than "copperiferous." Nevertheless it is doubtful whether such innovations will hold their ground, in spite of their introduction under the prestige of so respected an authority as our author.

* 'A System of Mineralogy: Descriptive Mineralogy, comprising the most recent Discoveries.' By James Dwight Dana, aided by George Jarvis Brush. 5th edition. 8vo. New York, 1868.

† For an exposition of Dana's views on 'Nomenclature,' see 'Quarterly Journal of Science,' Jan., 1868, p. 105.

Writing at a time when chemistry is verging on a new phase, Dana very prudently effects a compromise between the new and the old theories by writing his formulæ in accordance with both. Another improvement in the present edition is the systematic recognition of the *varieties* of each species.

Although Professor Brush's name appears on the title-page of this edition, it would seem that his labours relate only to the pyrognostic characters of the minerals described. "Neither the consultation of original authorities, the drawing of conclusions, nor the putting of the results on paper, has been delegated to another. And being now," continues the author, "but half-way between the fifties and sixties, it is my hope that the future will afford another opportunity for similar work." In this hope, every mineralogist will heartily concur.

ENGINEERING WORKS.

A TREATISE on 'Coast Defence,' by Von Scheliha, Lieutenant-Colonel and Chief Engineer of the department of the Gulf of Mexico, of the army of the late Confederate States of America,* deserves more than a passing notice, containing as it does a very comprehensive account of the means for the attack and defence of coasts, as practised in modern warfare, backed by the experience gained during the late American war. Thus it forms a very valuable addition to works on Military Engineering, and will doubtless be found a useful text-book for the study of naval and military officers.

It will readily be admitted that the progress made in naval architecture, and in artillery, necessitates some modification of the principles heretofore observed in coast-defence. The increased power of the guns of the present day would knock to pieces any fort that was constructed twenty or even ten years ago, and the masonry walls of recent years must now give place to iron sheathing. Wherever practicable, a well-turfed earthen slope is, however, still a safe protection in many cases; but the recent invention of Lieutenant Moncrieff's elevating gun-carriage will, if found practicable in service, go far towards inverting the present practice of coast-defence, and pits will be dug for the guns instead of building forts; thus they would be entirely protected from all, except shells, and no doubt means will soon be devised for keeping them out also. In the work under our notice the advantages of railroad communication along the sea-shore are forcibly pointed out as a means whereby the scattering of forces by fortifying places of secondary importance may be avoided; on this point there can be

* London: E. & F. N. Spon, 1868.

no manner of doubt, but efficient training of a military railway staff would in all cases be desirable, and the railway itself should, as far as possible, be concealed or otherwise out of range of the attacking force, forming, as it were, a covered way of communication between the principal points of defence.

The effects of bombardments which took place during the American war on the different kinds of forts has furnished materials for a chapter on the relative advantages of masonry, earth, and sand works, as a means of protection against modern artillery. The disadvantage at which all forts stand before modern armour-clad fleets leads to a discussion of the necessity of blocking up the channels by which they may be approached, either by sunken or floating obstructions, or by torpedoes of various descriptions; the former preventing the too near approach of hostile vessels, and sometimes holding them in check at a point where they may be exposed to a cross-fire from masked batteries, whilst torpedoes are calculated to disable a vessel at once, and so place it at the mercy of the defenders. A considerable portion of the work is given to the consideration of this kind of obstructive defence, and in it is embodied much useful information on that point. The subject of lighting up channels has also engaged the author's attention. This may be turned to account, either for peaceful or hostile purposes, and if properly illuminated it would be impossible for a hostile crew to approach unseen within certain limits of the shore. Throughout, the work is liberally illustrated, and altogether forms a handsome, as well as very instructive volume.

Mr. Latimer Clark has recently given us 'An Elementary Treatise on Electrical Measurement for the use of Telegraph Inspectors and Operators.'* The author of this work is sufficiently well known as one of our leading telegraph engineers, to stamp any work emanating from his pen with a degree of authority, but unfortunately, for want of proper proof corrections, one or two grave mistakes occur in the formulæ, which will, however, doubtless be corrected in a future edition; as they are palpably merely typographical errors, we refrain from noticing them here more particularly. This volume is a work quite different from any book hitherto published on electrical subjects, and it contains a mass of useful and practical information relating to electrical tests, as well as the various properties of the materials used in telegraphy. It is doubtful whether it will ever become popular amongst casual students of electrical science, but it was clearly not written with that view; to those, however, who follow telegraphy as a profession, its value will no doubt be fully appreciated.

* London: E. & F. N. Spon, 1868.

Theoretical Astronomy, relating to the motions of the heavenly bodies, &c., embracing a systematic derivation of the formulæ for the calculation of the geocentric and heliocentric places, for the determination of the orbits of planets and comets, for the correction of approximate elements, and for the computation of special perturbations; together with the theory of the combination of observations, and the method of least squares, with numerical examples and auxiliary tables. By James C. Watson. Royal 8vo, cloth, pp. 662. Philadelphia, 1868. Trübner and Co.

This is a useful treatise, going over the same ground as Chauvenet's valuable Treatise on Astronomy. The latter work is, however, the more complete. We notice also some pages in Mr. Watson's work which require revision. On the whole, however, and considering the extent and difficulty of the subjects treated of, his work is a meritorious one.

Celestial Objects for Common Telescopes. By the Rev. T. W. Webb, M.A., F.R.A.S., Incumbent of Hardwick, Herefordshire. Second edition, revised and enlarged. Longmans.

We are glad to see a new edition of Mr. Webb's valuable treatise. As a convenient text-book for the advanced amateur observer, this work is likely to hold its ground for many years. In the new edition Mr. Webb has availed himself of the advice and experience of our leading astronomers. He is himself also in the front rank among observers, a circumstance which largely enhances the value of his work. His treatise is especially valuable for those who wish to take part in the investigation of the moon's surface. We notice a new appendix, in which all the chief lunar objects are arranged alphabetically. There are also two other new appendices; one containing a list of objects in the southern hemisphere, the other giving in their order of right ascension all the stars referred to in the body of the work. There are also one or two new illustrations in the present edition. Altogether the work is one which we can cordially recommend to all those who wish to become systematic observers of the heavens.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

MEETING AT NORWICH, August, 1868.

The President's Address.

Dr. Hooker referred at the commencement of his address to his own early career, which began thirty years since at the Meeting of the British Association at Newcastle. It was to his voyage then undertaken, in company with Sir James Ross, in the Antarctic seas, that his position as President on that evening, he felt, was due. He had not been able to find time to survey the rise of scientific Botany in this address, nor to discuss the relation of the allied sciences to Botany, as he had wished, but he proposed to touch on various matters which appeared to be of interest at the present time. First of all, it was necessary to introduce the International Congress of Pre-historic Archæology, who were to hold their meetings at the same time as those of the British Association. Sir John Lubbock was to preside over this meeting, and it would, Dr. Hooker hoped, receive the cordial sympathy and support of the scientific men then in Norwich. An important matter connected with the science of man had been lately under the consideration of the Council of the Association itself, which must interest equally the members of the Congress. This was the investigation of the habits, manners, form, &c., of the indigenous populations of India, especially those which erect megalithic monuments. In consequence of representations from the Council, the Government of India had set to work to obtain photographs and other information in regard to these people.

"It will, no doubt," said Dr. Hooker, "surprise many here to be told that there exists within 300 miles of the British capital of India, a tribe of semi-savages which habitually erects dolmens, menhirs, cysts, and cromlechs, almost as gigantic in their proportions, and very similar in appearance and construction, to the so-called Druidical remains of Western Europe; and what is still more curious, though described and figured nearly a quarter of a century ago by Col. Yule, the eminent oriental geographer, except by Sir John Lubbock they are scarely alluded to in the modern literature of pre-historic monuments. In the 'Bengal Asiatic Journal' for 1844, you will find Col. Yule's description of the Khasia people of East Bengal, an Indo-Chinese race, who keep cattle but drink no milk, estimate distances traversed by the mouthfuls of pawn chewed *en route*, and amongst whom the marriage tie is so loose that the son commonly forgets his father, while the sister's son inherits property and rank. Dr. Thomson and I dwelt for some months amongst the Khasia people, now eighteen years ago, and found Col. Yule's account to be correct in all particulars. The undulatory eminences of the country, some 4—6,000 feet above the level of the sea, are dotted with groups of huge unpolished squared pillars, and tabular slabs supported on three or four rude piers.

"In one spot, buried in a sacred grove, we found a nearly complete circle of menhirs, the tallest of which was 30 feet out of the ground, 6 feet broad, and 2 feet 8 inches thick; and in front of each was a dolmen or cromlech of proportionately gigantic pieces of rock.

"The largest slab hitherto measured is 32 feet high, 15 feet broad, and 2 feet thick. Several that we saw had been very recently erected, and we were informed that every year some are put up, but not in the rainy season, which we spent in the country. The method of separating the blocks is by cutting grooves, along which fires are lighted, and into which, when heated, cold water is run, which causes the rock to split along the groove; the lever and rope are the only mechanical aids used in transporting and erecting the blocks. The objects of their erection are various—sepulture, marking spots where public events had occurred, &c. It is a curious fact that the Khasian word for a stone, 'Mau,' as commonly occurs in the names of their villages and places, as that of Man, Maen, and Men, does in those of Brittany, Wales, Cornwall, &c.; thus Mausmia signifies in Khasai the Stone of Oath—Mamloo, the Stone of Salt—Mauflong, the Grassy Stone, just as in Wales, Penmaenmawr signifies the Hill of the Big Stone; and in Brittany a Menhir is a Standing Stone, and a Dolmen a Table Stone, &c."

Dr. Hooker then passed on to the question of the site and management of the British Museum, which also had been under the consideration of the Council, in consequence of a resolution passed by Section D. A deputation had been sent by the Association, consisting of distinguished naturalists who had drawn the attention of Mr. Disraeli's Government to the matter. A similar deputation had waited on Mr. Disraeli ten years since, but no action had resulted. Dr. Hooker considered there was a graver objection to the present system than those which Mr. Andrew Murray had last year dwelt on, namely, that out of the forty-five trustees there are only three who have any special knowledge of Natural History, although the national collections in their care are the most valuable in Europe.

With regard to provincial museums, Dr. Hooker considered that there should be in such a place a detailed instructional series of dissected animals and plants, clearly laid out and named; and, secondly, a distinct collection of the Natural History objects of the province. The curator should be able to give elementary demonstrations (not formal lectures) to schools and classes visiting the museum, for which a fee might be charged. The museum, too, should not be a dingy, ill-lighted place, but a bright, cheery building, placed if possible in a public park. Dr. Hooker never remembered to have heard of a provincial museum that was frequented by schools. He believed this did not arise from indifference to knowledge on the part of the upper classes, or of teachers, but to the generally uninstructive nature of the contents of these museums and their uninviting exterior and interior. He advocated strongly the removal of the Natural History collections of the British Museum to the townward end of the great parks, where persons might enjoy trees, flowers, and fountains after visiting the galleries, instead of as now being half stifled in the latter and then escaping only to still more dusty and choking streets.

The President now passed on to speak of recent progress in Botany. The researches of Unger on the Continent, and Dawson in Canada had greatly added to our knowledge of coal plants, but recently Binney and Carruthers had added still more by studying the intimate structure of these fossils. The Tertiary flora had been studied with great success by Heer, Saporta, Gaudin, and others. Dr. Hooker (evidently referring to our own Alum Bay leaf beds) did not think much importance could be attached to separated leaflets, which were abundant in many Tertiary strata. Three genera had been made by one botanist out of three leaflets of the single leaf of a plant allied to our blackberries. The greatest discoveries in Botany during the past ten years have been physiological. Dr. Hooker especially alluded to Darwin's researches on the Fertilization of Plants, and to his memoir on Climbing Plants, as also to a most important paper by Mr. Herbert Spencer "On the Circulation of the Sap and the Formation of Wood in Plants."

"The first-fruit of Darwin's labours was his volume on the 'Fertilization of Orchids,' undertaken to show that the same plant is never continuously fertilized by its own pollen, and that there are special provisions to favour the crossing of individuals. As his study of the British species advanced, he became so interested in the number, variety, and the complexity of the contrivances he met with, that he extended his survey to the whole family; and the result is a work, of which it is not too much to say, that it has thrown more light upon the structure and functions of the floral organs of this immense and anomalous family of plants, than had been shed by the labours of all previous botanical writers. It has further opened up entirely new fields of research, and discovered new and important principles, that apply to the whole vegetable kingdom.

"This was followed by his paper on the two well-known forms of the Primrose and Cowslip,* popularly known as the pin-eyed and thrum-eyed: these forms he showed to be sexual and complementary; their diverse functions being to secure, by their mutual action, full fertilization, which he proved could only take place through insect agency. In this paper he established the existence of homomorphic or legitimate, and heteromorphic or illegitimate unions amongst plants, and detailed some curious observations on the structure of the pollen. The results of this, perhaps more than any other of Mr. Darwin's papers, took botanists by surprise; the plants being so familiar, their two forms of flower so well known to every intelligent observer, and his explanation so simple. For my own part I felt that my botanical knowledge of these homely plants had been but little deeper than Peter Bell's, to whom

> 'A primrose by the river's brim
> A yellow primrose was to him,
> And it was nothing more.'

Analogous observations on the dimorphism of Flax and its allies,† formed a subsequent paper; during the course of which observations he made the wonderful discovery, that in the common flax, the pollen of one form of flower is absolutely impotent when applied to its own stigma, but invariably potent when applied to the stigma of the other form of flower; yet the pollens and stigmas of the two kinds are utterly undistinguishable under the highest powers of the microscope.

"His third investigation was a very long and laborious one on the Common Loosestrife‡ (Lythram Salicaria), which he showed to be trimorphic; this one species having three kinds of flowers, all annually abundantly produced, and as different as if they belonged to different species; each flower has, further, three kinds of stamens, differing in form and function. We have in this plant, then, six kinds of pollen, of which five at least are essential to complete fertility, and three distinct forms of style. To prove these various differences, and that the co-adaptation of all these stamens and pistils was essential to complete fertility, Mr. Darwin had to institute eighteen sets of observations, each consisting of twelve experiments, 216 in all. Of the labour, care, and delicacy required to guard such experiments against the possibility of error, those alone can tell who experimentally know how difficult it is to hybridize a large flowered plant of simple form and structure. The results in this case, and in those of a number of allied plants experimented on at the same time, are such as the author's sagacity had predicted; the

* 'Journal of the Linnean Society of London,' vol. vi., p. 77.
† 'Journal of the Linnean Society,' vol. vii., p. 69.
‡ Ib., vol. viii., p. 169.

rationale of the whole was demonstrated, and he finally showed, not only how nature might operate in bringing these complicated modifications into harmonious operation, but how through insect agency she does do this, and also why she does it.

"It is impossible even to enumerate here the many important generalizations that have followed from these and other papers of Mr. Darwin's on the fertilization of plants; some that appear to be commonplace at first sight, are really the most subtle, and like many other apparent commonplaces, are what, somehow, never occur to commonplace minds; as, for instance, that all plants with conspicuously coloured flowers, or powerful odours, or honeyed secretions, are fertilized by insects;—all with inconspicuous flowers and especially such as have pendulous anthers, or incoherent pollen, are fertilized by the wind: whence he infers that, before honey-feeding insects existed, the vegetation of our globe could not have been ornamented with bright-coloured flowers, but consisted of such plants as pines, oaks, grasses, nettles, &c."

Mr. Darwin's recent work on 'Animals and Plants under Domestication,' showed a wonderful power of utilizing the waste materials of other men's laboratories, as Mr. James Paget had remarked—and this power was, Dr. Hooker considered, most characteristic of the author. As to the theory of Pangenesis, Dr. Hooker endorsed the opinion of the President of the Linnæan Society, that this supposition "explains some facts and is not incompatible with others; it will be admitted by many as a provisional hypothesis to be further tested, and to be discarded only when a more plausible one shall be brought forward."

It was time to ask now, what progress the Darwinian theory had made in men's estimation, ten years having elapsed since the publication of the Origin of Species. 'The Athenæum' very recently assured its readers that the theory was a matter of the past, and that Mr. Darwin's last book only contained a reasseveration of his guesses founded on the variations of pigeons. Dr. Hooker emphatically denied the truth of these statements. He told how the work had been translated into every European language, and passed through many editions, and that the rising naturalists were, perhaps, rather too eager and ardent in their acceptance of the theory. The scientific writers who had publicly rejected the theory were few in number, and had been admirably controverted by Mr. Darwin's true knight, Alfred Wallace, in this Journal and elsewhere. Above all that noble man, Sir Charles Lyell, had adopted the theory in his tenth edition of the 'Principles,' not afraid to plant his work on this basis and yielding his old objections to what he now believed the truth.

After discussing the Astronomical objections urged against Darwin's theory in the 'North British Review,' and pointing out the grossly speculative character of many asserted facts in Astronomy, a science which did not rightly claim to be the Queen of Sciences, Dr. Hooker passed on to speak of Pre-historic Archæology. To this study he would accord the dignity of a science. It most clearly proclaimed to us that man himself inhabited this earth for many thousands of years before the historic period,—a result little expected less than thirty years ago, when the Rev. W. V. Harcourt, in his address to the Association at Birmingham, observed that "Geology points to the conclusion that the time during which mankind has existed on the globe cannot materially differ from that assigned by Scripture," "referring," Dr. Hooker added, "to the so-called Scripture chronology, which has no warrant in the Old Testament and which gives 5,874 years as the age of the inhabited globe."

A great deal had been recently said as to the connection between science and religion. It was most important that their attitude should be mutually considerate and friendly.

The religious teachers had not always shown this spirit, though there was a greater tendency to it now than formerly. Science and religion might work in harmony and with good will, if both parties remembered that the laws of mind are not yet relegated to the domain of the teachers of physical science, and that the laws of matter are not within the religious teachers' province.

"But," concluded the President, "if they would thus work in harmony, both parties must beware how they fence with that most dangerous of two-edged weapons, Natural Theology, a science falsely so called, when, not content with trustfully accepting truths hostile to any presumptuous standard it may set up, it seeks to weigh the infinite in the balance of the finite, and shifts its ground to meet the requirements of every new fact that science establishes, and every old error that science exposes. Thus pursued, Natural Theology is to the scientific man a delusion, and to the religious man a snare, leading too often to disordered intellects and to atheism.

"One of our deepest thinkers, Mr. Herbert Spencer, has said, 'If religion and science are to be reconciled, the basis of the reconciliation must be this deepest, widest, and most certain of facts, that the power which the universe manifests to us, is utterly inscrutable.' The bonds that unite the physical and spiritual history of man, and the forces which manifest themselves in the alternate victories of mind and of matter over the actions of the individual, are, of all the subjects that physics and psychology have revealed to us, the most absorbing, and are, perhaps, utterly inscrutable. In the investigation of their phenomena is wrapped up that of the past and the future, the whence and the whither, of his existence; and, after a knowledge of these the human soul still passionately yearns and cries."

Mathematical and Physical Science. (Section A.)

The proceedings in this Section were opened on Thursday, August 20th, by an inaugural address from the President, Professor Tyndall, F.R.S. Space will not allow us to give this admirable address in full, but in the following abstract we have endeavoured to place the substance of it before our readers, preserving as nearly as possible the sequence of argument and the language of the speaker. Quoting Fichte,—who in his lectures on the "Vocation of the Scholar," insisted that the culture for the scholar should not be one-sided but all-sided,—Professor Tyndall said that this idea was to some extent illustrated by the constitution and the labours of the British Association. We have here a body of men engaged in the pursuit of Natural Knowledge, but variously engaged. While sympathizing with each of its departments, and supplementing his culture by knowledge drawn from all of them, each student selects one subject for the exercise of his own original faculty—one line along which he may carry the light of his private intelligence a little way into the darkness by which all knowledge is surrounded. Thus, the geologist faces the rocks; the biologist fronts the conditions and phenomena of life; the astronomer, stellar masses and motions; the mathematician, the properties of space and number; the chemist pursues his atoms, while the physical investigator has his own large field in optical, thermal, electrical, acoustical, and other phenomena. The British Association, then, faces nature on all sides, and pushes knowledge centrifugally outwards, while through circumstances or natural bent each of its working members takes up a certain line of research in which he aspires to be an original producer, being content in all other directions to accept instruction from his fellow men. The sum of our labours constitutes what Fichte might call the *sphere* of natural knowledge. In the meetings of the Association it is found necessary to resolve this sphere into its component parts, which take concrete form under the respective letters of our Sections.

Partly through mathematical and partly through experimental research, physical science has of late years assumed a momentous position in the world. Both in a material and in an intellectual point of view it has produced, and it is destined to produce, immense changes,—vast social ameliorations, and vast alterations in the popular conception of the origin, rule, and governance of things. Miracles are wrought by science in the physical world, while philosophy is forsaking its ancient metaphysical channels and pursuing those opened or indicated by scientific research. This must become more and more the case as philosophic writers become more deeply imbued with the methods of science, better acquainted with the facts which scientific men have won, and with the great theories which they have elaborated.

If we look at the face of a watch, we see the hour- and minute-hands, and possibly also a second-hand, moving over the graduated dial. Why do these hands move? and why are their relative motions such as they are observed to be? These questions cannot be answered without opening the watch, mastering its various parts, and ascertaining their relationship to each other. When this is done, we find that the observed motion of the hands follows of necessity from the inner mechanism of the watch when acted upon by the force invested in the spring.

This motion of the hands may be called a phenomenon of art, but the case is similar with the phenomena of nature. These also have their inner mechanism, and their store of force to set that mechanism going. The ultimate problem of physical science is to reveal this mechanism, to discern this store, and to show that from the combined action of both the phenomena of which they constitute the basis must of necessity flow.

There have been writers who affirmed that the pyramids of Egypt were the productions of nature; and in his early youth Alexander von Humboldt wrote an essay with the express object of refuting this notion. We now regard the pyramids as the work of men's hands, aided probably by machinery of which no record remains. We picture to ourselves the swarming workers toiling at those vast erections, lifting the inert stones, and, guided by the volition, the skill, and possibly at times by the whip of the architect, placing the stones in their proper positions. The blocks in this case were moved by a power external to themselves, and the final form of the pyramid expressed the thought of its human builder.

Let us pass from this illustration of building power to another of a different kind. When a solution of common salt is slowly evaporated, the water which holds the salt in solution disappears, but the salt itself remains behind. At a certain stage of concentration the salt can no longer retain the liquid form; its particles, or molecules, as they are called, begin to deposit themselves as minute solids, so minute, indeed, as to defy all microscopic power. As evaporation continues solidification goes on, and we finally obtain, through the clustering together of innumerable molecules, a finite mass of salt of a definite form. What is this form? It sometimes seems a mimicry of the architecture of Egypt. We have little pyramids built by the salt, terrace above terrace from base to apex, forming thus a series of steps resembling those up which the Egyptian traveller is dragged by his guides. The human mind is as little disposed to look at these pyramidal salt-crystals without further question as to look at the pyramids of

Egypt without inquiring whence they came. How, then, are those salt-pyramids built up?

Guided by analogy, we may suppose that, swarming among the constituent molecules of the salt, there is an invisible population, guided and coerced by some invisible master, and placing the atomic blocks in their positions. This, however, is not the scientific idea. The scientific idea is, that the molecules act upon each other without the intervention of slave labour; that they attract each other and repel each other at certain definite points, and in certain definite directions; and that the pyramidal form is the result of this play of attraction and repulsion. While, then, the blocks of Egypt were laid down by a power external to themselves, these molecular blocks of salt are self-posited, being fixed in their places by the forces with which they act upon each other. Throughout inorganic nature, we have this formative power,—this structural energy ready to come into play, and build the ultimate particles of matter into definite shapes. It is present everywhere. The ice of our winters and of our polar regions is its handywork, and so equally are the quartz, felspar, and mica of our rocks.

Let us pass from what we are accustomed to regard as a dead mineral to a living grain of corn. In the corn the molecules are also set in definite positions. But what has built together the molecules of the corn? Regarding crystalline architecture, we may, if we please, consider the atoms and molecules to be placed in position by a power external to themselves. The same hypothesis is open to us now. But if in the case of crystals we have rejected this notion of an external architect, we are bound to reject it now, and to conclude that the molecules of the corn are self-posited by the forces with which they act upon each other. It would be poor philosophy to invoke an external agent in the one case and to reject it in the other.

Let us now place the grain of corn in the earth and subject it to a certain degree of warmth. In other words, let the molecules, both of the corn and of the surrounding earth, be kept in a state of agitation; for warmth is, in the eye of science, tremulous molecular motion. Under these circumstances, the grain and the substances which surround it interact, and a molecular architecture is the result of this interaction. A bud is formed; this bud reaches the surface, where it is exposed to the sun's rays, which are also to be regarded as a kind of vibratory motion. And as the common motion of heat with which the grain and the substances surrounding it were first endowed, enabled the grain and these substances to coalesce, so the specific motion of the sun's rays now enables the green bud to feed upon the carbonic acid and the aqueous vapour of the air, appropriating those constituents of both for which the blade has an elective attraction, and permitting the other constituent to resume its place in the air. Thus forces are active at the root, forces are active in the blade, the matter of the earth and the matter of the atmosphere are drawn towards the plant, and the plant augments in size. We have in succession the bud, the stalk, the ear, the full corn in the ear. For the forces here at play act in a cycle which is completed by the production of grains similar to that with which the process began.

Now there is nothing in this process which necessarily eludes the power of mind as we know it. An intellect the same in kind as our own would, if only sufficiently expanded, be able to follow the whole process from beginning to end. No entirely new intellectual faculty would be needed for this purpose. The duly expanded mind would see in the process and its consummation an instance of the play of molecular force. It would see every molecule placed in its position by the specific attractions and repulsions exerted between it and other molecules. Nay, given the grain and its environment, an intellect the same in kind as our own, but sufficiently expanded, might trace out *à priori* every step of the process, and by the application of mechanical principles would be able to demonstrate that the cycle of actions must end, as it is seen to end, in the reproduction of forms like that with which the operation began. A similar necessity rules here to that which rules the planets in their circuits round the sun.

In the eye of science *the animal body* is just as much the product of molecular force as the stalk and ear of corn, or as the crystal of salt or sugar. All that has been said regarding the plant may be restated with regard to the animal. Every particle that enters into the composition of a muscle, a nerve, or a bone, has been placed in its position by molecular force. And unless the existence of law in these matters be denied, and the element of caprice introduced, we must conclude that, given the relation of any molecule of the body to its environment, its position in the body might be predicted. Our difficulty is not with the *quality* of the problem, but with its *complexity*; and this difficulty might be met by the simple expansion of the faculties which man now possesses. Given this expansion, and given the necessary molecular data, and the chick might be deduced as rigorously and as logically from the egg, as the existence of Neptune was deduced from the disturbances of Uranus, or as conical refraction was deduced from the undulatory theory of light.

Associated with this wonderful mechanism of the animal body, we have phenomena no less certain than those of physics, but between which and the mechanism we discern no necessary connexion. A man, for example, can say *I feel, I think, I love*; but how does *consciousness* infuse itself into the problem? The human brain is said to be the organ of thought and feeling: when we are hurt, the brain feels it; when we ponder, it is the brain that thinks; when our passions or affections are excited, it is through the instrumentality of the brain. We may admit the extreme probability of the hypothesis, that for every fact of consciousness, whether in the domain of sense, of thought, or of emotion, a certain definite molecular condition is set up in the brain; that this relation of physics to consciousness is invariable, so that, given the state of the brain, the corresponding thought or feeling might be inferred; or given the thought or feeling, the corresponding state of the brain might be inferred. But granted that a definite thought and a definite molecular action in the brain occur simultaneously, we do not possess the intellectual organ, nor apparently any rudiment of the organ, which would enable us to pass by a process of reasoning from the one phenomenon to the other. They appear together, but we do not know why. Were our minds and senses so expanded, strengthened, and illuminated as to enable us to see and feel the very molecules of the brain; were we capable of following all their motions, all their groupings, all their electric discharges, if such there be; and were we intimately acquainted with the corresponding states of thought and feeling, we should be as far as ever from the solution of the problem, "How are these physical processes connected with the facts of consciousness?" The chasm between the two classes of phenomena would still remain intellectually impassable. The speaker concluded this address in the following eloquent words:—

"In affirming that the growth of the body is mechanical, and that thought, as exercised by us, has its correlative in the physics of the brain, I think the position of the 'Materialist' is stated as far as that position is a tenable one. I think the materialist will be able finally to maintain this position against all attacks; but I do not think, as the human mind is at present constituted, that he can pass beyond it. I do not think he is entitled to say that his molecular groupings and his molecular motions explain everything. In reality they explain nothing. The utmost he can affirm is the association of two classes of phenomena, of whose real bond of union he is in absolute ignorance. The problem of the connection of body and soul is as insoluble in its modern form as it was in the pre-scientific ages. Phosphorus is known to enter into the composition of the human brain, and a courageous writer has exclaimed, in his trenchant German, "Ohne Phosphor kein Gedanke." That may or may not be the case; but even if we knew it to be the case, the knowledge would not lighten our darkness. On both sides of the zone here assigned to the materialist he is equally helpless. If you ask him whence is this 'matter' of which we have been discoursing, who or what divided it into molecules, who or what impressed upon them this necessity of running into organic forms, he has no answer. Science also is mute in reply to these questions. But if the materialist is confounded and science rendered dumb, who else is entitled to answer? To whom has the secret been revealed? Let us lower our heads and acknowledge our ignorance one and all. Perhaps the mystery may resolve itself into knowledge at some future day. The process of things upon this earth has been one of amelioration. It is a long way from the Iguanodon and his contemporaries, to the President and Members of the British Association. And whether we regard the improvement from the scientific or from the theological point of view, as the result of progressive development, or as the result of successive exhibitions of creative energy, neither view entitles us to assume that man's present faculties end the series,—that the process of amelioration stops at him. A time may therefore come when this ultra-scientific region by which we are now enfolded may offer itself to terrestrial, if not to human investigation. Two-thirds of the rays emitted by the sun fail to arouse in the eye the sense of vision. The rays exist, but the visual organ requisite for their translation into light does not exist. And so from this region of darkness and mystery which surrounds us, rays may now be darting which require but the development of the proper intellectual organs to translate them into knowledge as far surpassing ours as ours does that of the wallowing reptiles which once held possession of this planet. Meanwhile the mystery is not without its uses. It certainly may be made a power in the human soul; but it is a power which has feeling, not knowledge, for its base. It may be, and will be, and we hope is turned to account, both in steadying and strengthening the intellect, and in rescuing man from that littleness to which, in the struggle for existence, or for precedence in the world, he is continually prone."

The papers brought before the Section were very numerous, and we shall follow the plan adopted on former occasions of confining our notices to those which appear of general interest. The first read was the "Report of the Lunar Committee," in which the Chairman, Mr. Glaisher, referred to the progress which had been made in mapping the surface of the moon. No less than thirty-three gentlemen are engaged either in systematically observing certain zones in accordance with instructions issued by the Committee, or in examining particular objects at its request, the instruments employed varying from 3 inches to 22 inches in aperture. Instances of *difference* between former delineations and the present state of the moon's surface are increasing, and although no decided instance of change has been detected, the greater the number of differences the nearer we approach the discovery of change. Let but one *undisputed* instance of physical change be fully established, and selenography acquires from that moment a new aspect. The study of the moon's surface will then no longer consist in recording features that are unalterable, or in seeking to explain differences of aspect by varying angles of illumination and changes dependent upon libration. It will at once take a standing at least equal to those branches of astronomy which have been of late years particularly fruitful in discovery.

The Report entered somewhat largely into the question of change on the moon's surface, which is still undecided. The uncertainty as to the accuracy of former delineations and records combined with the extraordinary changes which some objects undergo—changes not altogether new, as they have been observed previously by Schrötter—render it very difficult to decide as to whether any real change has taken place.

This Report was followed by two papers on an allied subject *viz.* by Baron Von Mädler "On Changes of the Moon's Surface;" and, W. R. Birt, Esq., "On the Extent of Evidence of Change on the Moon's Surface." Father Secchi then gave an elaborate account of his "Researches on Spectral Analysis of the Stars." Mr. W. F. Barrett gave two papers "On the Passage of Radiant Heat through Liquids," and "On a Simple Method of Exhibiting the Combination of Rectangular Vibrations."

On Friday the 21st, the first paper read was "On a Further Development of the Dynamo-Magneto-Electric Machine," by W. Ladd. In this machine the continuity of the electric current depends upon the armatures revolving with a rapidity of from 1,800 to 2,000 revolutions per minute; but as the armatures have to be magnetized and demagnetized twice during each revolution, there would be in the latter case 4,000 flashes of light per minute. Now, it has been shown that every time iron becomes magnetized it is elongated, and again shortened when demagnetized. At every alteration, therefore, of the condition of the iron some small amount of heat must be devolved, and would increase to such an extent that, if unchecked, it would in course of time be so great as to destroy the insulation of the wire. To obviate this Mr. Ladd has perforated the two poles of the electro-magnet as close as possible to the armatures, and a stream of cold water circulates twice round the machine. This carries off the heat in a most effective manner, and no appreciable detriment in its electrical results occurs.

In the discussion which followed, Mr. Ladd said he wished to make a remark or two about the heating of the armature. He did not wish it to be inferred that the sole cause of heat was the elongation of the iron. Doubtless the electric currents passing through the wire would produce heat; but he believed that the quantity of heat produced by that means was small as compared with that produced by the elongation of the iron itself. He entertained this opinion for the following reason. He had lately applied one of these magneto-machines, driven by steam-power, in connection with a large inductorium, giving about 18-inch sparks; and after a few hours' work it had been found that the copper or primary wire surrounding the core of the coil appeared to be quite cool, while the iron core itself was considerably heated. He therefore mainly assigned the production of the heat to the cause he had specified.

Colonel Strange next read a paper "On the Necessity for State Intervention to secure the Progress of Physical Science." The author stated that knowledge, of whatever kind, was promoted principally in three ways, *viz.* by teaching, by education, and by exhibition. Unless the young were instructed, unless the workers advanced beyond what they learned when young, and unless the world was reminded of what had been done, and of what remained to be achieved, knowledge must languish. The provision, such as it was, which had been made in England to meet these three main requirements, had grown up casually with the progress of society, and was not equally complete in all branches of knowledge. The period is gone by when science generally can be cultivated with simple and primitive means; and the required researches of the present day need for their successful prosecution buildings expressly constructed for the purpose, extensive and costly appliances, and the continuous employment of the highest skill. It is evident that these requirements cannot be met by private enterprise and munificence, and it follows of necessity that the resources of the State alone can adequately supply the existing want; and that unless these are so employed the progress of scientific knowledge and discovery must become slower and slower. Without entering into premature details, the paper proposes that there should be established a system of national institutions for the sole purpose of advancing science by practical research, quite apart from teaching it; that such institutions, provided with extensive appliances and skilled professors and operators, should be presided over by a governing body constituted with reference solely to the scientific eminence of its members; that this body should direct the labours of the executive into such fields as they may deem most worthy of being explored; and that they should also have the power of sanctioning experiments and investigations proposed by any person unconnected with them. The advantages which the nation derives from the results of science, cultivated even as it is at present, desultorily and inefficiently, would be enormously multiplied by the introduction of the principle of continuity in research, and by the employment of the highest skill and the most perfect appliances. Systematic investigation conducted in the comprehensive manner proposed must prove directly remunerative, whether applied to strictly State purposes, or whether utilized in the public works, the manufactures, and the general necessities of the nation.

A Committee was subsequently appointed to inquire into the best means of carrying out the object proposed by Colonel Strange.

The next paper was "On a new Correction to be applied to Observations made with Hadley's Sextant," by Mr. T. Dobson, B.A. It was explained that the sextant is rarely used, save to satisfy the practical requirements of nautical astronomy. One object of the paper was to show that the instrument might be safely employed in determining the angular distance of terrestrial as well as of celestial objects, by taking account of a certain correction which was here investigated.

A long paper "On Actinometry," by Mr. L. Bing, was then read. The instrument used in these researches consists mainly of a tube of non-actinic glass, with an arrangement to bring a strip of sensitive paper into contact with one side of the interior. This tube is placed in diffused light, with its open aperture towards the sky. Light entering the tube and falling upon the sensitive paper commences at once to blacken it, but its power of so blackening is, of course, only in the ratio of the quantity of light which enters, and which necessarily diminishes as it proceeds further into the tube. The following are the principles upon which this instrument is founded: 1st. That diffused light, on entering a tube at one end only, varies in intensity within the tube inversely as the square of the distances from the aperture where light enters. 2nd. That any number of tubes, whatever their magnitude, contain the same intensity of light if the ratios of their diameters to their lengths are equal, and if we absorb the light that may be reflected from their sides. A carefully-calculated scale is fixed inside the tube at the side where the sensitive paper is fixed, the divisions being marked by a portion of a faint standard tint. When the sensitive paper in the instrument has been exposed for (say) ten minutes, the upper portion is darkened, and the first two or three tinted marks on the scale look white in contrast with the darkened paper: as the darkening down the tube gradually becomes less, the sensitive paper and standard tint appear of the same colour, and below that the paper is seen to be white by contrast with the standard tint.

A paper "On the Value of the Hollow Prism in examining Absorption Spectra" was then read by Dr. J. H. Gladstone.—In the prismatic analysis of the light transmitted by coloured liquids or solutions, the author has suggested the use of a wedge-shaped trough, so as to produce a line of light that had traversed every thickness—from one that was almost opaque to one which was next to nothing, and therefore permitted the passage of every ray. He now insists on the value of this method, as giving a much fuller account of the absorption, and especially as enabling the observer to represent it in a characteristic diagram.

The last paper this day was "On a New Automatic Telegraphic Apparatus," by Professor C. Zenger.

On Saturday, the 22nd, the papers read before this Section were, with scarcely an exception, mathematical, and defy condensation.

On Monday several Reports of Committees and some meteorological papers were read. Professor Morren read a paper "On some Curious Reactions of Chloride of Silver when in presence of Chlorine." Moist chloride of silver recently prepared when enclosed in a glass tube with an aqueous solution of chlorine, gradually becomes blackened when exposed to light, silver being reduced and chlorine liberated. On the sealed tubes being placed in darkness, the liberated chlorine would re-combine with the silver, again forming white chloride of silver. This decomposition and recomposition might be effected indefinitely.

The proceedings on the last day on which this Section sat were opened by a description of "A Galvanometer for the Detection of small Electric Currents," by F. H. Varley, Esq. The author explained that the smaller the magnet used in a galvanometer, the greater would be the sensitiveness of the instrument. He employs two forms—both of which had been found to answer exceedingly well. The first consists in suspending, with a single filament of silk, a magnet made of the finest steel wire that can be obtained, and rendering its motion apparent by viewing it through a rectangular prism by means of a microscope, in the eye-piece of which is placed a small graduated scale, photographed on glass. The magnet appears to be a black bar bisecting the field of view; and, as the finest wire obtainable for this purpose appears as thick as a scaffold-pole when sufficiently magnified, it is obvious that the slightest motion of the magnet must be rendered conspicuous by the image moving to and fro over the graduated scale placed in the eye-piece. The second form is more sensitive than the first. A small magnet, made of flat steel, polished on one face, is suspended in the usual manner by a single filament of silk, and a small micro-photograph of a graduated scale is placed at such a distance from the reflecting surface that each of the photographed divisions shall equal two minutes of arc as nearly as possible. The image of the scale thus reflected is sent in a line with the optic axis of the microscope, and any deflection given to the magnet causes the photographed scale to appear to move across the field of view. The reflecting surface moving doubles the apparent motion, giving the amount due to the angle of incidence, plus that of reflection. A movement of one graduated division being produced by one minute of deflection, if magnified 60 times by the microscope, will render a motion equal to one second of arc apparent.

The Hon. J. W. Strutt then read a paper "On a Permanent Deflection of the Galvanometer-needle by a rapid Series of equal and opposite Induced Currents." This paper contained a short notice of some experiments which led to rather unexpected results, of which the author could find no notice in the methodical treatises on electricity, although they might seem to lie in the way of any experimenter on induced currents. Two thick copper wires were coiled together, the circuit of one being completed by the battery and make-and-break apparatus, and that of the other by an ordinary astatic galvanometer of moderate sensitiveness. When the handle of the instrument is turned there are generated in the second circuit a series of instantaneous currents, which are alternately opposite in sign, but whose magnitudes are equal, although that corresponding to the break of the battery circuit is the most condensed. When, then, the instrument is worked with such rapidity that the interval between the currents is very small, in comparison to the time of free oscillation of the needle, the needles might be expected to be sensibly unaffected. But so far was this from being the case, that, although the swing of the needle produced by a single impulse was only a few degrees, yet under the influence of the series of equal and opposite currents it remained steadily at 60 or 70, and that on either side of the zero point, which had, in fact, become a position of unstable equilibrium.

Chemical Science. (Section B.)

This Section is generally the least interesting to the general public, and is the most scantily attended. The papers brought forward were chiefly of interest to chemists only, and in the following abstracts we shall only notice the most important.

The President, Dr. Frankland, F.R.S., in his introductory address, delivered on August 20th, drew attention to the discouraging way in which scientific studies are being introduced into our older universities, the lack of the necessary funds for the proper endowment of professorships and for the provision of suitable buildings and apparatus in our modern institutions, and the insignificance of the rewards offered to successful students in science, which have naturally operated most injuriously upon the extension of chemical culture. Whilst in Heidelberg, Zürich, Bonn, Berlin, Leipzig, and Carlsruhe magnificent edifices have been raised, replete with all the newest contrivances for facilitating the prosecution of chemical studies, we are here still compelled to give instruction and conduct research in small and inconvenient buildings utterly inadequate to the requirements of modern chemistry. The large sums spent by the governments of Germany and Switzerland upon these establishments sufficiently testify to their opinion of the national value of chemistry in education. The laboratory at Zürich cost 14,000*l.*, that of Bonn 18,450*l.*, the one now nearly completed in Leipzig will cost 12,120*l.*, whilst the estimates for the Berlin laboratory, with its 74 rooms, amount to no less than 47,715*l.*

Dr. Phipson sent a note "On Sulphocyanide of Ammonium," a substance which he says exists in somewhat large quantities in commercial sulphate of ammonia, sometimes to the extent of 75 per cent. One of the most remarkable properties of this salt is its property of producing intense cold when dissolved in water; 500 grammes mixed with a litre of boiling water, reduced the temperature to near the freezing point in a few seconds.

Professor Abel, F.R.S., sent "An Account of the Great Cannon of Mohammed II., recently presented by the Sultan Aziz Khan to the British Government." The date of its casting is 1464. It has been applied to defensive purposes for four centuries. The composition was found to vary between copper 89·58, tin 10·15 per cent., and copper 95·20, tin 4·71 per cent.

Mr. Spiller gave "An Analysis of the Ancient Roman Mortar of the Castrum of Burgh, Suffolk." He finds, contrary to the generally received opinion, that the hydrate of lime becomes entirely recarbonated in course of time, and that the silica and lime have not united with each other in the long interval of fifteen centuries.

Dr. Matthiessen and S. P. Szczepanowski sent in "A Report on the Chemical Nature of Cast-iron." Although they have made seventy series of experiments, they have not been able to prepare iron free from sulphur. They are still prosecuting their search for a method of preparing pure iron.

Dr. Frankland, F.R.S., read a paper "On the Combustion of Gases under Pressure." The author finds that the increase of illuminating power is exactly in proportion to the increase of pressure. One of the most interesting experiments shown was that of sending an electric spark first through air under ordinary pressure, and then through air under doubled pressure. The result was, that the light of the spark due to ignition of the air was very much increased. The spark was sent also through many other gaseous and vapourized substances, showing most conclusively that the greater the density of the bodies the greater was the luminosity of their flames when submitted to ignition by the electric spark.

Dr. R. Angus Smith, F.R.S., made a verbal statement of the result of some experiments he had been conducting "On the Absorption of Gases by Charcoal." He finds that the gases are absorbed in whole volumes, or in volumes which are multiples of hydrogen. The following are some of the most curious and important results:—hydrogen 1, oxygen 7·99, carbonic acid 22·05.

Geology. (Section C.)

The Geological Section was presided over by Mr. Godwin-Austen, who opened its proceedings with an elaborate address. He remarked that some of the later stages of the earth's geological history were so abundantly illustrated in East Anglia, there had been so many labourers in the field, and there remained so many unsolved points, that he hoped the section would make local geology a prominent topic. The points alluded to belonged to the great Kainozoic period, and it was in East Anglia alone that the complete sequence of change, as it happened in this country, could be followed out.

The Crag-sea waters were expelled from the North Sea area by the rise of the land on the south, the elevation decreasing from Belgium to Norwich. The geologist found but little to guide him as to the details of the chronology of that vast period when the North Sea area was terrestrial and part of the general European land-surface. A long list of animals, from the Norfolk Mastodon to the Mammoth, had left their remains there, and some of them ranged over Central and Southern Europe; but how many of them co-existed remained undecided.

The "forest-bed" of Cromer gave a glimpse of the vegetation of the period—including the Norway spruce, Scotch fir, yew, and oak—but it was more than probable that it must be taken only as the facies of the flora of the last stage of terrestrial conditions prior to the next great physical change.

Just as the Crag-beds came in as breaks in the lapse of Tertiary terrestrial conditions, so did the accumulations of the great northern submergence as a second intercalation; but the physical change was greater and of a different order. The Arctic basin extended itself as low as to lat. 50° N., by a slow submergence from north to south.

Again the northern hemisphere emerged, apparently from south northward, till England as a whole had the same general arrangement of land and sea as in the Crag period.

Over the whole of the European and American areas there was a region of broad expanses of water-worn detritus, often placed at considerable elevations above the present water-levels, the superficial extent of which had caused them to be identified with the members of the "Glacial drift," peculiar to another area, and from which they were quite distinct. The conditions indicated were those of low winter temperature, terrestrial surfaces with alluvial and fluviatile accumulations, indicative of torrential and periodic rivers. They lay south of a line drawn across Europe, occasionally on one side or the other of the 51st parallel, and they were derived from the areas to which belonged the existing river-systems of the South and Mid-European continent.

North of this line the detrital accumulations were neither local as to composition, nor had they much reference to surface configuration. Their distribution showed that the expanse of water was continuous and marine. This Drift formation covered the whole of Norfolk, and afforded evidence of submergence to the extent of 600 feet and upwards. It might be accepted as certain that subaërial glaciation had long been at work prior to the submergence. The change of relative level was gradual, proceeded from north to south, and was greatest in the former direction.

Several "Reports" were laid before the Section. One of these was the "Fourth on the Fossil Crustacea," by Mr. H. Woodward, who stated that he had recently received from the Carboniferous shales of Carluke, specimens of a new form of crustacean allied to *Cyclus*, and that he had been enabled to add two new species of a family not hitherto known in a fossil state in Britain. They belonged to the genus *Callianassa*, and were found, one in the Greensand near Belfast, the other in the Eocene beds of Hempstead, in the Isle of Wight.

Dr. Duncan's "First Report on British Fossil Corals" dealt with the relations of Fossil Corals to those now living. It was followed by a paper, from the same author, on a new species of coral belonging to the genus *Clisiophyllum*, from the Scotch Coal-field.

A paper by Mr. Lobley "On the Range and Distribution of the British Fossil Brachispoda," showed, by the aid of diagrammatic tables, the number of species belonging to each genus and family, as well as to the class, found in the different systems of rock-formations and their principal divisions.

Dr. Otto Torell, of Lund, in Sweden, in illustration of his very important paper "On some New Fossils from the Longmynd Rocks of Sweden," exhibited a series of slabs marked by the impressions of various land plants, known to geologists as *Chondrites*. The rocks from which they were taken were of an age similar to those of the Longmynd rocks of Britain, and the author held that they had been deposited in shallow water. Sir C. Lyell said he looked on the specimens with the greatest interest as remains of the earliest land plants yet known, and he confirmed the author's determination of the age of the deposit. Mr. Carruthers stated that the only vegetable markings which had hitherto been found in Silurian rocks were produced by plants occupying the lowest position in the vegetable kingdom; but here, much lower geologically, were plants of a very much higher grade. They had all the characters of true monocotyledons, and very nearly resembled the common flag of the garden and river.

Mr. H. Hicks, in a paper "On Recent Discoveries of Fossils in Cambrian Rocks," stated that he had found in Lower Cambrian strata no fewer than ten genera of Brachiopods, Pteropods, and Phyllopods.

In a paper "On the Fossil Fishes of Cornwall," Mr. Peach reminded the Section that in 1841 he stated that he had found fish-remains in the Devonian slates near Fowey; that in 1843 he produced much finer specimens, which were acknowledged by all to be true ichthyolites until, in 1855, Professor M'Coy pronounced them merely sponges; that he had unwaveringly believed in their ichthyic character; and that early in the present year (1868) they had been again, and by the highest authorities, stated to be unmistakable fish.

Mr. C. Moore, in his paper "On the Fossil Contents of Mineral Veins in the Carboniferous Limestone," stated that out of 134 samples from the mines of Cumberland and Yorkshire, 80 had yielded organic remains more or less abundantly, including *Valvata* and other fresh-water shells, often in great abundance. He had also found teeth and scales of fish. *Foraminifera* were very rare, whilst *Entomostraca* and *Crinoidea* were prevalent.

Mr. J. Thomson read a paper on "Certain Reptilian Remains found in the Coal-measures of Lanarkshire." The fossils were Batrachian, and found in a stratum between ironstone and coal. They were associated with remains of fish believed to be peculiar to the Coal-measures.

Dr. Mann, in his communication "On the Coal-field of Natal," stated that the Natal coal occurred in seams from 2 to 6 feet thick; that, from experiments, it was found to give a pure gas, a higher percentage of coke than the best English coal, and when burnt in a furnace it had but little tendency to form clinkers; that under easy steam it was better than the Welsh coal; that it gave the steam more quickly, but that when steam was got up the Welsh coal gave more work out of the same amount of coal.

Mr. H. Clarke read a paper "On the Western Asia Minor Coal and Iron Basin," in which he pointed out the European extension of the deposit by way of Constantinople. This coal has not been worked, although covering so large an area.

A paper "On the Classification of the Secondary Strata" was read by Mr. H. G. Seeley, who remarked that from the denudation of cliffs, deposits near the shore would be shingle or conglomerates, then sand and clay, and still further seaward limestone. Supposing a depression of the area to take place, the conglomerates would be overlaid with sand and clay, and, should the depression be continued, eventually with limestone. With an upheaval, the reverse of this would occur.

The same author read a memoir "On the Relations between

Extinct and Living Reptiles." Having described the general characters and the classification of the Reptilia, he showed that the Pterodactyles stood at the head of the class, being more highly organized than any other reptiles, living or extinct. He wished it to be understood, not that they were birds, but that they possessed ornithic affinities.

In his paper "On the Skull and Bones of Iguanodon," the Rev. W. Fox detailed at some length the anatomical structure of the teeth and bones, and expressed his belief that the skull recently discovered in the Isle of Wight belonged to a new species.

The aim of Mr. Jeck's paper "On the Ferruginous Sandstone of the Lower Oolite near Northampton," was to make the following suggestion respecting its mode of formation:—that large rivers carried sand and mud and a solution of iron into a large estuary; that after some time subsidence carried the area into deep water, where shells characteristic of such conditions were deposited; that this was succeeded by upheaval, when shallow-water shells and ferruginous matters were accumulated, and that finally the whole was covered with sand.

M. Coquand's paper "On the Cretaceous Strata of England and the North of France, compared with those of the West, South-west, and South of France, and North Africa," contained a detailed account of the characters and fossils of the deposits in the localities named, and referred to their differences at some length.

Mr. Rose read a communication "On the Thickness of the Chalk in Norfolk," as indicated by well borings in various parts of the county.

A contribution by Mr. H. M. Jenkins, "On the Tertiary Deposits of Victoria," contained a careful description of the strata in various localities, and especially on the coast south-west of Port Philip. It may be stated generally that the Tertiary deposits were accumulated in a trough in Mesozoic beds, that they were afterwards contorted and denuded, and that the trough, now deeper and probably narrower, was refilled with Post-pliocene standstone. The Tertiary fossils were corals, echinoderms, and innumerable species of shells and polyzoa.

The suggestion of the President met with a full response in a large number of papers on local geology, which showed that East Anglia contains many unsolved problems. Amongst these communications were those by the Rev. O. Fisher "On the Denudations of West Norfolk," Messrs. Wood and Harmer "On the Glacial Structure of Norfolk and Suffolk," Mr. G. Maw "On the Sequence of Deposits in Norfolk and Suffolk," Mr. J. E. Taylor "On the Norwich Crags and their relation to the Mammaliferous Beds," Mr. A. Bell "On the Molluscan Fauna of the Red Crag," Mr. Rose "On the Crag at Aldeby, in Suffolk," the Rev. J. Gunn "On the Alternate Elevations and Subsidings of the Land, and the order of Succession of the Strata in Suffolk and Norfolk," Dr. Crisp "On the Skeleton of a Fossil Whale recently found on the East Coast of Suffolk," Mr. E. R. Lankester "On the Oldest Beds of the Crag," Dr. J. Lowe "On the Carstone of West Norfolk," and Mr. Evans "On some Cavities in the Gravel of the Valley of the Little Ouse."

Mr. Fisher stated that immediately upon the Chalk at Thorpe, where the Crag rested upon it, was a thick bed of angular flints, apparently the accumulated result of the removal of the Chalk intervening between several layers. Amongst the flints numerous bones, teeth, and tusks of Mastodon, *Elephas meridionalis*, and other mammalia occurred. He inclined to the view that the Chillesford Clay was below the "Forest-bed." At any rate the sequence of events introduced the deposition upon the Crag of a fine clay, probably formed in an estuary open to the Northern Ocean, and to which whales had access. This was in all probability the estuary of the Rhine, and of the Thames and other tributaries. Its sides became dry land so as to allow of the growth of the forest upon the old muddy bottom. This condition lasted for a long period, and synchronized with a climate warmer than that which preceded or followed it. As the land continued to sink, the "Laminated series" accumulated and extended westward. The "Lower Boulder Clay" overlaid the Laminated beds, but during the interval between them the sea must have been much deeper, and involved in a system of extensive tidal currents. After glancing at the evidence of iceberg-action towards the close of the "Lower drift," the author spoke of the "Middle drift," when large masses of chalk were dropped amongst the sand and mud in the deepening sea.

According to Mr. Maw, the whole of the beds above the "Red Crag" in the well-known Chillesford Crag-pit pertained to the "Chillesford Clay" series. This Red Crag was not the equivalent of the "Norwich Crag;" the upper part of the Chillesford beds probably graduated into the Drift underlying the Boulder Clay of High Suffolk. These were considerably older than the coast-beds of Cromer, including the Forest bed, the Laminated beds, and the overlying Boulder Till, and contorted Drift.

Mr. Taylor held that the whole of the "Mammaliferous bed" between the Chalk and Crag was quite distinct from the true Crag, and formed under more distinctly marked marine conditions. The abundance of northern shells in the upper beds as compared with the lower proved the increasing cold. The succeeding "Glacial series" was a result to which a study of the various Crags necessarily led.

Mr. Bell, having found many double bivalves in excellent condition in the deposit between Sutton and Waddingfield, could not accept the hypotheses that the Red Crag sea had been very turbulent, and that the fossils were largely derivative.

Mr. Rose expressed the opinion, based on an extensive series of careful investigations, that the Aldeby Crag belonged to the "Norwich Crag."

Mr. Gunn regarded the German Ocean as having been the vast trough into which many tributary rivers poured their waters on the right and left, but closed by chalk hills on the south so as to afford a communication between this country and the Continent, and a way for the mastodon, elephant, and other mammals to traverse. The soil of the forest bed was upheaved to the surface, and the forest grew upon it. A great change in the fauna took place,—different species of elephants and deer being introduced. Having remained stationary a long time, the land at length gradually subsided, and the laminated beds were formed: first, fresh-water beds; then, brackish beds; next, marine beds, including the Mammaliferous Crag and the Chillesford clays and sands, with shells of an increasingly arctic character.

The whale described by Dr. Crisp was 31 feet long, and found in the Chillesford Clay.

Mr. Lankester believed the bed to which he called attention, and which occurred in Suffolk, to have been derived from a deposit somewhere near at hand, and about the age of the Diestien, or Black Crag of Belgium. It contained remains of mastodon, rhinoceros, tapir, and whale.

Dr. Lowe described a series of perforations from a quarter of an inch to an inch in diameter, formed by some boring animal, in a sandstone deposit near Lynn. Each perforation commonly contained a nodule, which the author ascribed to the presence of the remains of the borer.

Mr. Evans gave reasons for believing that the cavities which he described, after a careful personal inspection of them, were connected with the well-known "pipes" in the chalk, and which had been formed by the agency of water containing carbonic acid; and that, contrary to the general rule, some of the overlying gravel beds, instead of subsiding into the hollow thus made, were sufficiently tenacious to remain intact. Some of the cavities were "large enough to hold a cart."

The Committee for exploring Kent's Cavern, Devonshire, presented their Fourth Report. The general results were similar to those stated in the previous Reports. The chief new feature was one of considerable interest and importance, being the discovery of a floor of stalagmite overlying a thick detrital accumulation, both of them older than those previously found: thus, in one branch of the cave there were in the same vertical section: first, or uppermost, the thick floor of stalagmite, which had been followed in unbroken continuity from the external entrances, and had yielded remains of extinct animals; second, the common red earth, replete with remnants of the ordinary extinct cave fauna, and containing flint implements; third, an older floor of stalagmite, very thick and crystalline; and, fourth, or lowest known, an extremely tough hard breccia, crowded with unbroken, ungnawed, unrolled bones, almost all of which were ursine, and lay together without reference to their anatomical relations.

Mr. Pengelly, in a paper "On the Conditions of some of the Bones found in Kent's Cavern," described a series of experiments which, as he held, showed that the "split bones" had not been divided by the spelæan carnivores, or by exposure to the weather, but that they could have been, and indeed were, split by Palæolithic man for the purpose of obtaining material for bone tools.

In his paper "On New Discoveries connected with Quaternary Deposits," Mr. C. Moore stated that he had found remains of mammals, extinct in this country, in Oolitic fissures, from the Cotswold to the lower part of Somersetshire. In a quarry near Frome, where the subject first caught his attention, the workmen had found, and unfortunately destroyed, a series of hut circles, said to have been unusually perfect, cut out of the solid rock, retaining indications of fire, and having steps connected with them. These, he believed, were older than the fissures, and carried back considerably the antiquity of man.

The Rev. J. Brodie, in a communication "On Geological Changes that have taken place on the Coast of Britain in recent Times," endeavoured to show that the last change of level in Scotland was an upheaval of about 30 feet, and was not more recent than a few centuries before the Christian era.

Mr. Grove read a paper "On Artificial Rocking Stones," in which, after describing the great rocking stones of Cornwall, he explained a set of ingenious experiments which he had made in order to show that the celebrated *logans* of the South-western Counties were purely natural. The results, which were exhibited, were examined with much interest.

Interesting papers were read by Mr. Rose "On the Conchoidal Fracture of Flints, as seen in old Buildings in Norwich;" Professor Tennant and Rev. C. Nicolay "On the Discovery of Diamonds in Cape Colony and Brazil;" and Mr. S. Sharp "On a Remarkable Incrustation."

We regret that we cannot do more than mention the Reports by Mr. E. Whymper "On the Fossil Plants of Greenland," and by Mr. W. S. Mitchell "On the Leaf-beds of the Lower Bagshot Series of Hampshire."

BIOLOGY. Section (D.)

This section formed itself into a department of Zoology and Botany and a department of Anatomy and Physiology, as on previous occasions. The Rev. M. J. Berkeley, the distinguished writer on Cryptogamic Botany, was President of the Section, and sat in the department of Zoology and Botany, where also the other botanists, among them Dr. Hooker, Professors Balfour, Dickson, Lawson, and Perceval Wright, and the general zoologists congregated. Mr. Flower, F.R.S., of the Royal College of Surgeons' Museum, presided in the other department, and was supported by many anatomists and doctors; amongst them were Professor Rolleston, Dr. Hughes Bennett, Dr. Benjamin Richardson, Professor Humphrey, Professor Huxley, and also the distinguished continental physiologists, Heynsius, Paul Broca, and Béhier.

Mr. Berkeley opened the proceedings of the Section with a remarkably interesting address. He directed his remarks, first, to recent researches and speculations in Cryptogamic Botany, on which he is so well qualified to speak judicially, and then to the theory of Pangenesis. He alluded to the observations of De Bary and Cienkowski on organisms which appear to be intermediate between plants and animals, such as Myxomycetes and some forms of Monads, and confirmed the deductions which they drew from their observations. He then noticed Hallier's views as to the fungoid origin of certain diseases. At first Hallier had merely observed fungi in Asiatic cholera, but recently he had stated that in typhus, typhoid, and measles (in the blood), in variola and in vaccinia (in the exanthemes), he had found certain minute organisms which he termed Micrococci, which, when cultivated in the way known to students of moulds, &c., produced each a constant and characteristic fungus. He did not consider that Hallier had proved his case; his experiments were far from conclusive, and he drew conclusions hastily. It was quite possible that certain fungi might occur constantly in substances of a certain chemical and molecular constitution, but this might be a case of effect instead of cause. The matter had been taken up by De Bary and our own Army Medical Department, some of whose able officers had been commissioned to investigate the question fully.

The recent researches of Mr. Herbert Spencer had shown, by the introduction of coloured fluids into the tissues of the living plant, that the sap not only ascends by the vascular tissue of plants, but that the same tissue returns and distributes the sap after it has been modified in the leaves.

After making some observations on the morphology of leaves, and on the subject of free-cell formation, the President referred to Darwin's theory of Pangenesis. Others, he said, as Owen and Herbert Spencer, had broached something of the kind, but not to such an extent, for Darwin's theory included Atavism, Reversion, and Inheritance, and embraced mental peculiarities as well as physical. The whole matter was at once so complicated, and the theory so startling, that the mind at first naturally shrank from the reception of so bold a statement. Like everything, however, which came from the pen of a writer whom he had no hesitation, as far as his judgment went, in regarding as by far the greatest observer of the age, whatever might be thought of his theories when carried out to their extreme results, the subject demanded a careful and impartial consideration. Like the doctrine of natural selection, it was sure to modify more or less their modes of thought. Even supposing the theory unsound, it was to be observed, as Whewell remarked, as quoted by their author, "Hypotheses may often be of service to science when they involve a certain portion of incompleteness and even of error." Mr. Darwin said himself that he had not made histology an especial branch of study, and he (Mr. Berkeley) had, therefore, less hesitation in expressing an individual opinion that he had laid too much stress on free-cell formation, which was rather the exception than the rule. Assuming the general truth of the theory that molecules endowed with certain attributes were cast off by the component cells, of such infinitesimal minuteness as to be capable of circulating with the fluids, and in the end to be present in the unimpregnated embryo cell and spermatozoid, capable either of lying dormant and inactive for a time, or, when present in sufficient potency, of producing certain definite effects,—it seemed far more probable that they should be capable, under favourable circumstances, of exercising an influence analogous to that which is exercised by the contents of the pollen tube or spermatozoid on the embryo sac, than that these particles should be themselves developed into cells; and under some such modification the theory was far more likely to meet with anything like a general acceptation. Be this as it might, its comprehensiveness would still remain the same. They must still take it as a compendium of an enormous mass of facts, comprised in the most marvellous manner within an extremely narrow compass. In conclusion, he said it was obvious how open such a theory was to the charge of materialism. It was an undoubted fact, however, that mental peculiarities and endowments, together with mere habits, were handed down and subject to the same laws of reversion, atavism, and inheritance, as mere structural accidents, and there must be some reason for one class of facts as well as the other, and whatever the explanation might be, the hand of God was equally visible and equally essential in all. They could not now refer every indication of thought and reasoning beyond the pale of humanity to blind instinct, as was once the fashion, from a fear of the inferences which might be made. Should any one, however, be still afraid of any theory like that before them, he would suggest that Man was represented in Scripture as differing from the other members of the animal world by possessing a Spirit as well as a reasoning Mind. The distinction between *psyche* and *pneuma*, which was recognized by the Germans in their familiar words *seele* and *geist*, but which we had no words in our own language to express properly,—or, in other terms, between mere mental powers, which the rest of the creation possessed in greater or less degree in common with mankind, and an immortal spirit,—if rightly weighed, would, perhaps, lead some to look upon the matter with less fear and prejudice. Nothing could be more unfair and unwise than to stamp at once this and cognate speculations with the charge of irreligion. Of this, however, he felt assured, that the members of the Association would unite with him in bidding its great and conscientious author God speed, and join in expressing a hope that his health might be preserved, to enrich science with the results of his great powers of mind and unwearied observation.

Of Zoological papers, we must notice first Mr. Gwyn Jeffreys' "Dredging Report." It is a matter for much regret that the smaller income of the Association this year has rendered it necessary to withhold any further large grants for dredging at present. This year Mr. Jeffreys dredged off the Shetlands, having very bad weather; he, however, made some interesting discoveries. In this report he summarized the results of five years' dredging on these coasts. As a rule, he found that the mollusca of northern seas were much larger than the same species occurring in southern seas. He did not consider that the various zones of depth usually adopted by naturalists were of any real value. Two, he considered, were sufficient besides the abyssal or marine, namely, the littoral and the submarine. The various animals dredged other than mollusca had been entrusted to other naturalists for examination, and their reports in previous years showed how many new and interesting forms had been thus added to science.

In a paper "On Shetland Sponges," the Rev. A. M. Norman described and exhibited a vast number of the forms of Sponges dredged by Mr. Jeffreys. One of these was especially interesting from its peculiar form and history. Three years since when dredging off Shetland, they had brought up long tube-like bits of sponge which Dr. Bowerbank described as a new species, thinking that the specimens were perfect; but this year Mr. Jeffreys had dredged up great spherical sponges with these little tubes standing out from them, and they were thus seen to be quite different to what was at first supposed. The spherical sponges were bigger than one's fist, and when opened were found to be filled with jelly-like sarcode, which could be poured out. This was quite an unprecedented structure, and, in fact, was only paralleled by the great hollow sponges found in the chalk formation. Mr. Norman called this new sponge *Oceanapia*, or Sea Turnip. In another paper, Mr. Norman described a sponge which had been thought by the Scandinavian naturalist, Lovén, to be like the celebrated Glass-rope Sponge of Japan. Mr. Norman, however, showed that there was an essential difference in their structure, and described some other sponges which had an *external* resemblance of form only to Lovén's supposed boreal Hyalonema.

"On some Organisms living at a Depth of 15,000 feet in the North Atlantic," was the title of a paper read by Professor Huxley. In 1859, specimens of the deep-sea soundings, obtained by Captain Drayton in the North Atlantic, had been submitted to Professor Huxley for examination, and he had then reported to the Government on the microscopic organisms contained therein. Besides the Foraminifers (*Globigerinæ*), he had discovered little bodies which he called Coccoliths. Mr. Sorby had since discovered these little Coccoliths in the chalk, together with the Globigerinæ, which made it so much like the Atlantic mud. In 1862, Dr. Wallich redescribed the Atlantic Coccoliths, and also bodies which he called Coccospheres, and from the breaking up of which he believed the Coccoliths to arise. Professor Huxley had now re-examined his specimens with a much better object-glass than he used previously, namely a $\frac{1}{12}$th of Ross, and he had some new statements to make as to the Coccoliths. They have nothing to do with the Coccospheres. In the slimy ooze, which is dredged up from the Atlantic, soft gelatinous masses about the $\frac{1}{400}$th of an inch long occur, in which are scattered small masses of granules, and in which also are disposed little oval bodies of carbonate of lime, $\frac{1}{10000}$th of an inch long at most. These last are the Coccoliths; they are of two sorts, one more complex than the other. The gelatinous mass is considered by Professor Huxley to be formed by the running together of a number of separate organisms, each represented by a mass of granules, and having, when alive, its own pseudopodia. The Coccoliths are to these animals what the Spiculæ of Radiolaria, or Sponges, are to them. Professor Huxley could not say whether this organism was animal or vegetable. In answer to some remarks by Dr. Hughes Bennett, he stated that the facts recorded above do not confirm in the least the doctrine of Heterogenesis,—he wished

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they did. They only proved the existence of a vast sheet of organized matter at this great depth, which he suggestively had spoken of as "Urschleim."

In a very detailed communication "On the Boring of certain Annelids," Dr. McIntosh controverted the chemical theory of erosion suggested last year, at Dundee, by Mr. Lankester in reference to these animals. He exhibited specimens of shale which he asserted were not calcareous, nor subject to erosion by acids, and which were yet perforated by *Leucodore.* Mr. Ray Lankester in commenting on this paper, maintained that his inference from the evidence which had come before him last year, was at the time a just one.* The presence of an acid must be an important auxiliary in the erosion of limestone rocks, though loose shales could be bored mechanically. Dr. McIntosh's figures of the bristles of *Leucodore,* he showed, were erroneous.

Dr. McIntosh also gave a short account of the Annelids dredged by Mr. Gwyn Jeffreys in Shetland.

Among anatomical papers, that of Mr. Flower "On the Homologies and Notation of the Teeth of the Mammalia" was one of great importance. He had discovered that some of the so-called monophyodont mammals, namely the Armadilloes, had a complete set of milk teeth preceding those with which they were provided when adult; further he had shown, recently, that in marsupials only one tooth, the so-called fourth premolar, has a successor, whilst in dogs only one or two at most of the premolars have predecessors. In seals, the first set of teeth were extremely minute, mere points of tooth substance, and this led to the belief that they were evanescent. From these facts and others of a similar nature, Mr. Flower concluded that the so-called milk or first set of teeth is by no means to be regarded as the typical or chief series as Professor Owen had supposed, to which the second set are a super-addition; but on the contrary, the milk-teeth are something added to the normal dentition in the higher mammalia, and more especially in those groups which require teeth when young. In the discussion on this paper, in which Professors Huxley and Rolleston took part, an interesting question was raised as to whether the evanescent condition of the milk-series of teeth in the seals did or did not indicate an approach to the condition of the Cetacea, which have but one set, that is are Monophyodont.

Professor Rolleston, in a paper "On the Pectoral Muscles," gave his conclusions as to the homologies of the muscles of the upper arm and chest in Mammals, Birds, and Reptiles. He also dis-

* See 'Quarterly Journal of Science,' October, 1867.

cussed the serial homology of the muscles of the fore and hind limb, making use, in both cases, of the distribution of the nerves to the muscles as an index of homology.

Dr. Edward Crisp drew attention to "Some Points in the Anatomy of the Gorilla" which led him to regard it as less anthropomorphous than the Chimpanzee; also to the "Intestinal Canal of the *Thylacinus*," which he stated was the shortest and simplest amongst either Mammals or Birds.

Professor Cleland answered the question, "Is the Eustachian tube open in the act of swallowing?" in the negative: Mr. Toynbee had held that it was open; but Dr. Cleland had had an opportunity of witnessing its closure during swallowing in a patient in whom ulceration had exposed the part to view.

Physiology was largely represented, if the number of papers may be held to furnish an index. Dr. Richardson read a "Report on the Physiological Action of the Methyl Series." The object of his researches during the year had been to bring into actual practice some of the substances, the physiological action of which he had ascertained, and on which he had previously reported; secondly, to examine more carefully the mode of action of those bodies of the series (anæsthetics) which produce sleep and insensibility to pain; thirdly, to investigate the action of some other bodies of the series previously unstudied; and fourthly, to test the antidotal influence of some of the substances against the action of certain alkaloidal poisons. Bichloride of Methylene had been introduced as an anæsthetic; nitrate of amyl was used to relieve the spasm of *angina pectoris;* and iodide of methyl promised to be useful in the cure of cancer. The iodides of ethyl and methyl and their nitrites had been found to be efficient antidotes to strychnia and nicotine in cases of poisoning, the difficulty was to properly apportion the dose. In one case, an animal experimented on had completely recovered.

Dr. Richardson also related experiments "On the Action of Extreme Cold on the Nervous Function," from which it appeared that frogs might be so far frozen as to become hard and stiff, and yet recover by slow thawing. The freezing of parts of the brain in birds had also given interesting results.

The same observer described an attempt at the transmission of light through animals whilst living, which did not appear a very hopeful method of obtaining knowledge of their structure.

Dr. Anstie read a most valuable paper "On the Influence of Alcohol on the Pulse," in which the importance of the use of the sphygmograph was shown. By its means Dr. Anstie had been able most clearly to diagnose cases of fever, &c., in which it was right, and others in which it was not right, to administer alcohol.

Three papers relating to the question of the existence of a special organ of language in the brain were read: one by Dr. Paul Broca, who was the first to point to the left third frontal convolution of the cerebrum as the seat of disease in cases of Aphasia; the second by Dr. Hughlings Jackson, who has studied most carefully and successfully the pathology of the brain; and the third by Mr. Dunn. Dr. Broca classified the various forms of loss of power of speech according to their causes, whether paralysis of the muscles, loss of general intelligence, or loss of the special power of the use of words. It was this last power, the loss of which is called Aphasia, for which he claimed a special organ in the left frontal convolutions. In the discussion many cases were brought forward by the various physicians present, which tended on the whole to show that the evidence for localizing the power of articulate speech or verbification in a particular frontal convolution was not sufficiently satisfactory. The subject is one which must still occupy the attention of physiologists, but the direction of opinion seems to be against M. Broca's theory.

The Edinburgh committee appointed to experiment and report on the "Influence of Mercury on the Secretion of the Bile," gave an account of their researches, being represented by Dr. Arthur Gamgee and Dr. Hughes Bennett. The experiments had been performed on dogs and were of the most careful and satisfactory character, so as to elicit the highest praise from all the members of the Section. Fistulæ had been made into the bile ducts, and thus the amount of bile secreted was observed. It was found from these researches to be in a normal condition much less than has been usually supposed, and it was definitely proved that the administration of small doses of mercury did not increase its flow. Dr. Gross of New York wished the experiments had been made on men, but was reminded that it was not possible to make fistulæ in human subjects at will, and that the action of the drug on the dog was in all other respects identical with the action on man, and hence warranted the conclusion that in the particular of bile-secretion the action was the same.

Dr. Thompson Dickson read an essay "On Vitality as a Mode of Motion," in which the old views of the correlation of the vital and physical forces were reiterated, the objectionable word vitality being, however, used, and the formative or plastic force of living matter being confused with the modes of motion of which it is the seat.

Botany was of course in full vigour at this meeting. Many papers on the occurrence of rare or new plants were read, as also some important ones on structural Botany.

Dr. Karl Koch gave an interesting sketch of his researches on

"The Origin of our Fruit Trees." He had travelled in Asia Minor and Persia for the purpose of investigating this question, and was led to conclude that the Apricot, and perhaps the Peach, had no wild representative in these countries, though perhaps they might have in China. The Prunes of our fruit-gardens were not derived from the common wild Plum of Europe, but from another stock which occurs wild in the East. Many gardeners and botanists hold that the Peach and Nectarine are merely varieties of the Almond, in which the green rind has become fleshy and sweet. Dr. Koch adduced facts in favour of this view, amongst others the production of almond-like fruits by a peach-tree through atavism, and the existence of an inferior form of peach-tree in gardens known as Peach-almonds. Such a plant Dr. Koch had found growing wild in many parts of Persia.

Mr. Moggridge described and exhibited specimens of the "Muffa," a remarkable cryptogamic growth which is found in the sulphurous springs of Valdieri, and which is used in the medicinal baths as an external application.

A most interesting paper relating to Ethnology, was that of Mr. E. B. Tylor "On Language and Mythology as Departments of Biological Science." The author pointed out, by examples, how definite laws of the development of the human mind might be traced by the examination of the rudest languages in different parts of the globe, and by the study of the origin of myths. We must, he said, look for laws of independent similar development in civilization, as in vegetable and animal structure, and the backward state in which the science of culture still remains, seems mainly due to the systematic methods so familiar to the naturalist having hitherto been so imperfectly worked.

Of practical matters, the importance of "Arboriculture" was again brought before the Section by Mr. Brown. Dr. Cleghorn also discussed the subject of "Forestry in India." Professor Alfred Newton, in a paper "On the Zoological Aspects of the Game Laws," urged the necessity of a "close time" being enforced by the Government in this country for all birds and other animals during which it should be illegal to carry a gun. Such a period was adopted both on the Continent and in America during the breeding season of birds, and was a very right measure; for at present in this country thousands of birds are shot when nesting, especially sea-gulls, and their young are allowed to perish of hunger. Professor Newton also deprecated the indiscriminate slaughter of what keepers are pleased to call vermin, which are really most useful animals in destroying smaller creatures, such as rats and mice, which do act injuriously by feeding on the eggs of game and other birds. Miss Lydia Becker, of Manchester, replied to Professor Newton's accusation against her sex. If Professors would instruct ladies on the habits of these birds, and let them know that the birds were killed when tending their young, no lady, she was sure, would wear the feathers in question. Several members spoke in support of the proposition for a "close season."

Geography and Ethnology. (Section E.)

Under the able presidency of Captain Richards, R.N., F.R.S., hydrographer to the Admiralty, Section E met in St. Peter's Hall on four days,—Thursday, Friday, Monday, and Tuesday. Saturday was a *dies non*, owing to the excursions. Including the President's address, there were in all twenty-two communications made to the Section, and a large proportion of them were from persons who have attained much distinction as travellers or scientific geographers, or both. The meeting of 1868 was destitute of the personal interest which has attached to many former meetings of the British Association, more especially in the Geographical Section, on account of the decease of Mr. John Crawfurd, and of the absence through illness of Sir Roderick Murchison. Mr. Crawfurd, notwithstanding his great age,—he was an octogenarian at his death,—had of late years contributed so largely to the business of this Section, both by his papers and his remarks in the discussions, that for some years to come his familiar form and cheery voice will be missed by the members who take a special interest in the geographical proceedings of the Association. His old friend and associate, Sir Roderick Murchison, still survives him; but even he is so fast approaching octogenarianism that he cannot be expected to make much further active exertion in the business of the British Association.

The meetings of the geographers in St. Peter's Hall were not wholly destitute of "lions," for there were present two of the most distinguished of the Abyssinian captives, Dr. H. Blanc and Mr. Rassam. The subjects discussed in this Section were more exclusively geographical than has been the case at some former meetings. Those that partook more of an ethnological character were taken up in the International Congress of Pre-historic Archæology, the fourth annual meeting of which was held this year at Norwich, under the presidency of Sir John Lubbock, simultaneously with the thirty-eighth meeting of the British Association. Henceforth the term "Ethnology" will not be continued in the title of Section E, a resolution to that effect having been passed by the General Committee, in accordance with a recommendation from the Council of the Association. Section D (Biology) will probably, in subsequent years, as at Nottingham in 1866, undergo fission, so that there may be a department of Ethnology or Anthropology, as there is now a department of Physiology, while there is also one of Zoology and Botany.

Captain Richards, in his opening address, briefly reviewed the present state of geographical knowledge, adverting to those blanks on the surface of the earth which appeared to him to merit the labour and attention of future explorers, and dwelling briefly on the results which are certain to follow in the interests of science and the interests of humanity. He confined his attention to the present and the future rather than to the past. Amongst the dark spots on which the traveller and navigator have yet to throw light, Captain Richards referred specially to Africa, Australia, New Guinea, Borneo, and the Arctic regions. The fate of Dr. Livingstone, and Dr. Neumeyer's proposal for an organized exploration of the interior of Australia were both noticed, and regret was expressed that the desire on the part of a number of geographers for the prosecution of further polar search had not been reciprocated by the public and the Admiralty.

The Norwich meeting following close upon the successful result of the Abyssinian expedition, it was naturally expected that Abyssinian topics would bulk largely among the subjects of discussion. There were only two papers, however, on Abyssinia. One of these was "On the Physical Geography of Abyssinia," by Mr. Clements R. Markham (Secretary, Roy. Geog. Soc.), geographer to the recent expedition. The author divided that portion of the country traversed by the expeditionary forces into three regions, according to the principal rivers draining them—the Mareb, the Atbara, and the Abai, or Blue Nile. In the northern region, that drained by the Mareb, Mr. Markham found plateaux 8,000 feet high, mountain-masses, and ridges from 9,000 to 11,000 feet high, wide valleys surrounded by the plateaux at a height of 7,000 feet, and deep ravines and river-beds varying in height from 4,500 to 6,000 feet. The plateaux consist of sandstone overlying a schistose rock 4,000 feet thick, and this again rests on gneiss. In the region of the Atbara the most striking physical feature is the flat-topped sandstone cliffs,—the famous *ambas*. The southern region is entirely composed of volcanic rock, and is wholly mountainous. After describing these three regions in a somewhat detailed manner, Mr. Markham concluded as follows:—"It will be seen that the region which I traversed with the expeditionary field-force from the sea-coast to Magdala, a distance of more than 300 miles, is one of considerable geographical interest; and the operations of the expedition have added much to our knowledge. On the coast, the great system of eastern drainage comprised in the Ragolay and its tributaries has been discovered; and old Father Lobo's story of one of the pleasantest rivers in the world, with sweet herbs growing along its banks, flowing through a country which has always hitherto been believed to consist of a salt desert, has thus been explained. The remarkable passes from the coast to the highlands of Abyssinia have been thoroughly explored; the mountain chains forming the watershed of a vast region have been examined; and the numerous sources of the great fertilizing tributaries of the Nile have been accurately surveyed. Besides the observations which I have taken, that most zealous and indefatigable of quartermaster-generals, Colonel Phayre, has completed a rough, but at the same time a most useful, survey of the whole country that has been traversed. Dr. Cooke, in spite of severe illness, which would have disabled a less zealous inquirer, has done much valuable meteorological work; and the officers of the Indian Trigonometrical Survey have completed the mapping of the Abyssinian highlands."

Mr. Markham's paper was followed by one from Dr. H. Blanc "On the Native Races of Abyssinia." In it the author mentioned the characteristics of the Amharas, the Tigre people, the people of Lasto, the Shoas, the Falashas, the Kainawnts, the Agaws, the Zalas, the Waitos, the Figens, and the Wallo Gallas. He spoke of the last-mentioned tribe as having come from equatorial Africa, and as being, before Theodore's rise, the most powerful people in Abyssinia. They are a brave and handsome race, and now that their great enemy is no more, they bid fair, should they, burying in oblivion all internal rivalries and petty jealousies, once more unite, to overrun Abyssinia and impose on the debauched and sensual Christians of that country the false creed of the Koran. Mr. Rassam appeared before the audience at the request of the President after Dr. Blanc had done reading his paper, but he could not be prevailed upon to make a speech.

A paper "On the Topography of Sinai," by the Rev. F. W. Holland, followed by a discussion, finished the first day's proceedings.

On the second day (Friday), Mr. W. Hepworth Dixon, editor of the 'Athenæum,' read a long paper "On the Great Prairies and the Prairie Indians." This was the most attractive and interesting paper of the day, and drew together a crowded audience. It was graphic and picturesque in the extreme, and excited frequent outbursts of applause and laughter. The points to which Mr. Dixon seemed to desire to direct most attention were two. There was, first, the fact that the great prairie land is not a desert, but is, instead, a land teeming with life, both animal and vegetable; and, secondly, the illustration afforded by the condition of the tribes of prairie Indians of the philosophy of progress in civilization. Mr. Dixon's opinion is that the prairie Indian is in the first stage of civilization, that of a hunter of wild game, and that in passing into the third stage, such as that of a Norfolk farmer, he must pass through the condition of a herder of goats and kine. The three grand stages are illustrated by a prairie Indian, a Bedouin Arab, and a Norfolk farmer. A hunter is a wild man; a herdsman is a tame man; and a husbandman is a social man. The experience gained among the Kirghees of Central Asia by M. Vambery, the famous Hungarian traveller, enabled that gentleman to speak in support of Mr. Dixon's views; and the Bishop of Labuan, with twenty years' experience in Borneo, considered himself justified in supporting those views. The Bishop had found in Borneo the hunting savage, the herding savage, and the farming savage. He said the farming savage was so debased that he would only be raised to the scale of a Norfolk farmer in three or four generations.

In a paper "On the Inhabitants of Cyrenaica and Western Libya," Captain Lindesay Brine, R.N., mentioned some interesting facts which he had learned in the spring of the present year while examining the African coast between Berenice on the west, and Egypt on the east. "The Rivers and Territories of the Rio de la Plata" formed the subject of the following paper, the author of which was Mr. T. J. Hutchinson, consul at Rosario. Mr. Hutchinson's remarks referred to the physical geography of La Plata, to the prospects of the Centro-Argentine Railway Company, the seat of war in Paraguay, and to the sources of the Paraguay and the Amazon in the diamond mine territory of Matto Grosso in Brazil.

The last paper read on Friday was by Mr. A. Waddington, a North American colonist, who most enthusiastically advocated the construction of an overland railway route through British territory, from the Atlantic to the Pacific, from Ottawa to the head of Bute Inlet, opposite Vancouver's Island. He carefully described the character of the whole route in exploring and surveying which he had spent many years and sunk a large fortune. The length of the railway would be 2,885 miles, and the estimated total cost 27,000,000*l*. Captain Richards said that we should soon have a railway carried across to British Columbia if it were only possible to shift Great Britain across the Atlantic to the entrance of the river St. Lawrence. Notwithstanding the fact that people in this country could scarcely be expected to take the same amount of interest in the project as Mr. Waddington took in it, he (Captain Richards) believed that sooner or later it would be carried out. (It may be mentioned that Mr. Waddington has also had this subject before the Royal Geographical Society.)

The proceedings on Monday opened with a paper "On Explorations in Greenland," by Mr. Edward Whymper, a gentleman whose reputation as an adventurous and scientific traveller has rapidly reached the highest rank. This paper proved to be highly interesting to the *savans*. It may be remembered that Mr. Whymper was commissioned a year or two ago, by the British Association and the Royal Society, to make a series of expeditions into the interior of Greenland, for the purpose of collecting such natural history data as might be available for use in determining the former climatic conditions of the country. The first of these expeditions was made during the summer of 1867, and the paper read by Mr. Whymper gave an interesting account of the present flora as compared with that of the miocene period, of the animals which at present inhabit the country, and of the modern Greenlanders, both from a physical and a moral point of view. The former flora embraced firs, birches, poplars, oaks, beeches, chesnuts, planes, walnuts, hazels, the vine, and the magnolia, while the largest shrubs now found in the country have a maximum diameter of scarcely an inch. The rich collection of plants brought home by Mr. Whymper is now in the hands of Professor Heer, of Zurich. Glacial action has been so great in Greenland that the whole surface has been worn and polished in such a manner that it is impossible to walk in other than native boots; European boots are quite useless. It is gratifying to learn from Mr. Whymper that the morality of the Greenlander stands very high. Honesty is scarcely a virtue with him, *it is a habit*. An interesting discussion followed the reading of this paper, Sir Charles Lyell, Admiral Ommancy, Sir E. Belcher, and Professor Rolleston taking part in it. The last-named gentleman said that he had examined sixteen skulls brought home by Mr. Whymper, and his conclusions were that they had been the skulls of savage people of carnivorous habits. They were quite destitute of sutures, as is the case in the *carnivora*. Admiral Sir E. Belcher would not consent to have the Greenlanders called Esquimaux; there is no communication between them, and the same is true of the Esquimaux and the Red Indian.

On the subject of "Overland Communication between India and China," General Sir A. Scott Waugh read a report on behalf of the Committee appointed at the Dundee Meeting of the British Association; and the business of the day was concluded by an interesting paper from Dr. E. Perceval Wright "On the Seychelles Islands," unless we mention one by Sir Walter Elliott, "On Sepultural Remains in Southern India," which was not read from want of time, and its general scope only was indicated by the author.

No fewer than eight papers were set down for reading in Section E on Tuesday. Of course, it would scarcely have been possible to persuade their authors that the papers were uninteresting, even though the attempt had been made to do so; and from sheer necessity the papers had in one or two instances to be read in snatches or their details to be mentioned in abstract. Not the least valuable of the papers was the first on the list. Its subject was "The North-east Turkish Frontier and its Tribes," by Mr. W. G. Palgrave, the gentleman whose picturesque and interesting description of his Arabian experiences is so fresh in the public mind. The paper in question contained an account of a visit paid by Mr. Palgrave to the north-east part of the Turkish empire in the summer of last year. The region lies to the south of the Caucasian mountains, with Mount Ararat in its centre. It is very fertile, admirably adapted for human habitation and increase, and difficult of access, owing to the nature of the mountain passes which surround it on all sides and render it a kind of natural citadel. Mr. Palgrave's account of the people occupying this densely populated region, their physical, intellectual, moral, and social character, whence they came, the rapid increase in their numbers, &c., greatly interested the audience. Grants of land are given to all persons who come from without and settle in this part of Turkish territory, and the fullest civil and religious liberty is enjoyed by them. The population is composed of Turcoman tribes, who are discontented with the Russian government, of Kurdish tribes; the victims of anarchical rule in Persia; and of Georgians and Circassians. The commingling and intermarriage of these various races are producing the very best examples of the Georgian type of the human species. Mr. Palgrave is very hopeful of these people forming an effectual barrier to the further encroachments of Russia, and that they may in course of time form a separate and independent nationality, and, as the allies and friends of Britain, help to develop the great means of communication between Europe and India by the valley of the Tigris and the Euphrates, of which they hold the key.

Much curious information was mentioned in a paper by M. Vambery "On the Uigurs," the most ancient Turkish tribe which settled in Chinese Tartary, a people who had a literature, and were very fond of books, at a time when the western world was profoundly ignorant and barbarous. In a paper by Mr. H. H. Howorth, "On the Nomade Races of European Russia," some opinions were expressed regarding the origin of the Hungarian race, which M. Vambery regarded as being very heterodox and not based upon reliable data. That learned gentleman stated that the chief object which he had in visiting Central Asia was to discover, if possible, the true origin of the Hungarian race. He had come to the conclusion that it was neither Uigurian nor Turkish, and that the question must, in the meantime, remain undecided, from want of sufficient materials bearing upon it.

Dr. R. J. Mann, special commissioner from the colony of Natal, read a paper "On the Gold-fields of South Africa," in which he communicated much information obtained from private sources regarding those newly-discovered gold-fields. From some remarks, by Mr. Tennant, the mineralogist, it would seem that South Africa is almost as rich in diamonds as it is in gold. Two diamonds which he had seen from the Orange river district he valued at 400*l*. and 200*l*. respectively, and he had received a model of another diamond which was worth from 350*l*. to 400*l*.

The only other paper calling for special notice on account of its great interest, was "On the Victoria and Albert Rivers, North Australia," by Mr. T. Baines, the well-known artist and traveller, and it now remains for us simply to mention the titles of the other papers which, in whole or in part, were brought under the notice of the Section:—"Topography of Vesuvius, with an Account of the recent Eruption," by Mr. J. Loglan Lobley; "On the Tehuelche Indians of Patagonia," by Mr. Consul Hutchinson; and "Description of Hong Kong," by Mr. Granville Sharp.

It cannot be said that there was anything so peculiarly and superlatively interesting in the proceedings of Section E, as to make the Norwich Meeting one to be specially remembered. The origin of man, the unity or plurality of the human species, the characteristics of the negro, the origin of civilization, and other cognate subjects, on which the theological polemic and the man of science are so prone to differ, and the debates upon which are always keenly relished by the general audience and by the general public, were almost entirely absent from the discussions; still a considerable amount of good and satisfactory work was done.

Mechanical Science. (Section G.)

The proceedings of this Section were inaugurated by an address from the President, Mr. G. P. Bidder, in which he touched on several topics which are occupying public attention. First among these was the question of the supply of water to towns, its utilization for manufacturing and other purposes, and the requisite means to prevent its pollution by refuse and sewage, a subject which he illustrated by a reference to the rivers of the Norwich district, and their influence in forming and preserving the harbours on the sea-coast. As the engineer employed in extending and improving the harbour of Lowestoft, Mr. Bidder can speak with authority on this subject; indeed to him it is due that that town can in some branches of trade compete with Yarmouth as a landing-place and depôt. As connected with the water-question, he referred to the undertaking of the Suez Canal, and to the enormous evaporation, amounting to one inch per diem, in the district through which it runs: in the course of this work the Bitter Lake, a surface of about 150 square miles, which is now dry, will have to be filled from the waters of the Red Sea, and it will be curious to note the influence on the surrounding atmosphere of the evaporation from this source, which on the above supposition must nearly reach the astounding quantity of 360,000,000 cubic feet per diem, or 250,000 feet per minute.

Adverting to our armour-clads, the President argued that, in order to render the combined operations of a fleet effective, the vessels constituting it ought to be as nearly as possible of the same speed, and that the protection to be afforded to a ship by armour-plating should be made subservient to speed and steadiness. He deprecated the reception of the performance of a ship in smooth water as any test of her speed and behaviour when at sea. Turning to the question of our coast defences, Mr. Bidder expressed his opinion that the advance in the science of gunnery had put an end to the embrasure system; he considered that men were really better protected in the open country than when crowded together behind embrasures and exposed to the fire of a powerful artillery. His address concluded with some remarks on the improvements in telegraphy, expressing a hope that this country might before long possess an independent line of telegraphic communication with India, by way of Gibraltar and the Cape.

With two or three remarkable exceptions, the papers read in the Mechanical Section were neither so able nor so interesting as those which have been contribnted at former meetings of the British Association. The Section, though fairly, was never very numerously attended, and we missed the presence of several men eminent in the engineering world, who are generally with us at our annual congress. Norwich being the capital of a strictly agricultural county, the town selected for this year's meeting presented few attractions to mechanical engineers. To the civil branch of the profession the drainage of the low-lying lands of Norfolk is a question of some importance; and a paper was read by Mr. R. B. Grantham "On the Broads of East Norfolk, having reference to Water-Supply, Storage, and Drainage," possessing some local interest, but which without maps of the district to which it relates would be unintelligible to the general reader.

The paper which perhaps more than any other attracted attention, and gave rise to an interesting discussion, was that by Mr. Whitworth, "On the Proper Form of Projectiles for Penetration through Water." His object was to show that a flat-headed shot when fired at a small angle of depression is better calculated to penetrate an object aimed at under water than one with a hemispherical or conical head. The author exhibited to the meeting the photograph of a plate which had been placed with its bull's-eye under water and fired at with a one-pounder gun, of which the angle of depression was 7° 7′; the projectiles used being, 1, the Whitworth steel-shot with a flat head; 2, a hemispherical-headed shot; 3, a shot with a head of the form advocated by Major Palliser. While in the first case the shot which struck close to the spot aimed at, in the second case it struck considerably, and in the third very much above that point. Mr. Whitworth, however, went rather out of his way, and certainly beyond the scope of his paper, to attack the material as well as the form of the chilled-iron shot. His objections to that projectile were: 1, that when fired at a considerable angle against an armour-plate its form causes it to glance off, while owing to the brittleness of the metal of which it is composed it breaks up; 2, that the consequent weakness of the metal necessitates a greater thickness of the sides and reduces its internal capacity as a shell.

In the discussion which followed, Mr. Bramwell defended the Palliser shell, and on the point of economy alone placed it far above a steel one. A steel shot he estimated to cost five times as much as one on the principle of Major Palliser. Its efficiency as a projectile he illustrated by the observation that a fragment of a steel shell after being fired against an armour-plate would be found to be quite hot, while in the case of one of chilled-iron no appreciable heat was developed.

In supporting Mr. Whitworth's claims for the superiority of a flat-headed shot in penetrating water, Mr. Hawksley argued, that on the principle of a flat stone selected by boys in playing "duck and drake," it seemed more probable that a projectile with a conical head would be deflected upwards from the surface of the water—in fact it would tend to ricochet. The smaller the angle between the direction of the shot and the surface of the water, the greater would be this tendency. It seemed to be also admitted by more than one speaker, that although a conical-headed shot might be superior to one with a flat head when striking at right angles, it was decidedly inferior when the angle was oblique.

Mr. Mallet called the attention of the meeting to some experiments conducted by the Russian General, Mayevski, which seem to show that the ogival-headed projectile is superior to the flat-headed, both for direct and oblique penetration. When a flat-headed shot strikes obliquely, it has a tendency to slew round and fly off backwards. On the contrary, while the ogival-headed shot also has a tendency to slew round, the result is to bury the point in the face of the armour, whereupon the shot proceeds to force its way into the plate almost the same as if it had been fired at right angles. A certain amount of power is lost even in the case of the ogive, but that which remains is exercised usefully.

Considering the national importance of the manufacture of iron and steel, the great improvements which have been lately introduced into it, and the necessity of still further reducing the consumption of coal, which, on good authority, threatens at no very distant period to outstrip our resources; it was not surprising that the papers on this subject read before the mechanical section were looked forward to and listened to with the greatest possible interest. The paper, by Mr. C. W. Siemens, "On Puddling Iron," was an attempt to trace the course of the chemical action which takes place during the puddling process; and the deduction drawn was, that the present method, which has now been maintained for many years without change or improvement, involves great loss of metal, waste of fuel and human labour, and an imperfect separation of the two noxious ingredients, sulphur and phosphorus. Experiments on a large scale, and a series of analyses of the iron in different stages of the process of puddling, appear to show that the molten metal is mixed intimately, in the first place, with a molten portion of the oxide or cinder (technically called the fettling) which forms the lining to the iron tray of the puddling chamber; that the silicon is first separated from the iron, that the carbon only leaves the iron during the "boil," and that the sulphur and phosphorus separate last of all while the iron is "coming to nature." The object of Mr. Siemens was to show that much of the waste which takes place during this complicated action could be avoided by the use of a puddling hearth, heated by means of one of his regenerative furnaces, to the advantages of which he drew particular attention. These are, that the heat can be raised to an almost unlimited degree, that the flame can be made at will—oxidizing, neutral, or reducing—without interfering with the temperature, that draughts of air and cutting flames are avoided, and that the gas-fuel is free from pyrites and other impurities which are carried into the puddling-chamber from an ordinary grate. A furnace erected, on this principle, which has been in operation at the Bolton Steel and Ironworks for eighteen months, has given most excellent results; and the process is about being adopted by Messrs. Kitson, of Leeds, and others in this country.

The production of steel by means of the mutual reaction of pig-iron, and wrought or other decarbonized iron, has been often attempted, but in consequence of the insufficient means of ensuring a very high temperature, without any practical success. Lately, however, Messrs. Martin, of Paris, have succeeded by means of the Siemens' regenerative furnace in obviating this defect, and it was to their process under the name of the Siemens-Martin process, that Mr. Ferdinand Kohn drew attention in his paper "On the Recent Progress of Steel Manufacture."

To the Messrs. B. Samuelson and Co., of the Newport Works, Middlesborough-on-Tees, is due the credit of being the first in the United Kingdom to manufacture steel for commercial purposes by this method, and, as yet, these are the only works established solely for this purpose in the country. One of the great advantages of the process, and that which fits it more particularly for the Middlesborough district, is that by it a comparatively impure metal, as the Cleveland iron is known to be, can be converted into steel at a price inferior to that of the Bessemer steel, which requires tolerably pure hæmatite iron. The process, as described by Mr. Kohn, consists in adding to a bath of pig-iron, kept at a high temperature by means of the regenerative furnace, measured doses of wrought-iron, until the stage of complete decarbonization is arrived at; the operation is then completed by the addition of a certain percentage of pig-iron, or of the well-known alloys of iron and manganese. Generally, the Siemens-Martin process appears to have a wide range of applicability: it can work up the waste of other modes of steel manufacture, it can utilize old materials, especially wrought-iron and steel, and it is applicable to white pig-iron, or pig-iron poor in carbon.

Mr. J. Jones, Secretary to the North of England Iron Trade, read a paper "On some Points affecting the Economical Manufacture of Iron," in which he introduced to the notice of the meeting the Wilson Fire-Grate and the Newport Furnace, both of which, he submitted, effected a considerable saving of material and fuel in the puddling process. Without diagrams or a longer description than our space admits of, it would be difficult to convey any clear idea of the manner in which these inventions work. The principle of the Wilson-grate is the complete combustion of the fuel before it comes to the furnace chamber, and, as has been proved from results obtained by working for a considerable length of time, the quantity of fuel required per ton of puddled iron is from 20 to 25 per cent. less than in the ordinary furnace. In the Newport furnace attention has been paid to the utilization of heat, and the waste heat is again made available: in principle, it partakes somewhat of the regenerative character of Mr. Siemens' invention. By the use of this furnace it is stated that a saving of from 25 to 30 per cent. of fuel is effected. Mr. Jones also referred to the Radcliffe process of puddling, by which five or more balls are withdrawn simultaneously from the furnace, and treated together under a heavy steam-hammer with a quick action. He claims for this method the advantage of producing homogeneous iron, not liable to lamination, in a time considerably less than that required under the process ordinarily adopted.

A paper of the greatest possible public importance was read by Mr. L. E. Fletcher "On Coroners' Inquests and Boiler Explosions." Starting from the fact that since the commencement of 1855 up to the 31st July last, 464 boiler explosions, by which 789 persons were killed and 924 injured, had occurred in different parts of the kingdom, he showed how necessary it was for the preservation of life that in every case the strictest possible investigation should take place as to the cause of the catastrophe. He urged more particularly the granting of power to the coroner to call in professional engineers to investigate and report on the condition of the boiler. Frequently the most frivolous and absurd reasons for the explosion are given and accepted by the jury, resulting in most cases in a verdict of "Accidental death," while the boiler, which in many instances, owing to defective construction, or wear and tear, is really the root of the evil, is left unexamined. In such cases, it would be possible, if the course pointed out were adopted, for the relatives of the dead or injured persons to recover pecuniary damages from the party really in fault; whether the manufacturer who has put bad material into the boiler, or the owner who has neglected to have it periodically inspected and reported sound. Especial reference was made to the Association for the Prevention of Steam-boiler Explosions, by means of which every owner could assure himself, at a moderate cost, that his boiler is in a condition fit for working without endangering the lives of all in its neighbourhood. In the discussion which followed this paper, Mr. Fletcher's arguments were illustrated by reference to a boiler explosion which occurred in the city of Norwich about two years ago. The cause of this disaster was simply that the boiler was a bad one, though new, and made under a special contract as to the quality of the plates; and this was recognized by the jury in their verdict, resulting in the recovery of heavy damages from the maker to the amount of 2,000*l*.

Professor Rankine contributed a paper "On the Probable Connection between the Resistance of Ships and their Mean Depth of Immersion;" and Mr. Merrifield one "On the Necessity for further Experimental Knowledge respecting the Propulsion of Ships." Both of these papers referred to unknown elements in the resistance which vessels meet with in their passage through the water, though those elements may be due to different causes; and urged the adoption of experimental researches for the purpose of determining them.

Interesting papers were also read by Captain Douglas Galton "On a New Ventilating Fireplace;" by Mr. P. Le Neve Foster, jun., "On the Irrigation of Upper Lombardy by Canals, to be derived from the Lakes Lugano and Maggiore;" and by Mr. J. H. Gwynne, "On an Improved Centrifugal Pump."

INTERNATIONAL CONGRESS OF PRE-HISTORIC ARCHÆOLOGY.

The third meeting of this Congress was held at Norwich, simultaneously with the Meetings of the British Association for the Advancement of Science. It was commenced on August 20th, by the President (Sir John Lubbock, Bart.) reading the opening address, which was chiefly remarkable for containing a brief reply to the articles in 'Good Words' by the Duke of Argyll, wherein His Grace endeavours to show that there is no proof whatever that such ages as the Palæolithic, Neolithic, Bronze, and Iron, ever existed in the world, chiefly, it would seem, because archæologists cannot show that they were universal, as the same age which was an age of stone in one part of the world was an age of metal in another. This fact is perfectly true, and has always been admitted by Pre-historic Archæologists. Sir John asks, Would the Duke of Argyll object to the use of the term "Christian Era," because we have Heathens existing now as well as Christians? This is an unfortunate reply, and its fallacy will certainly be exposed by so rigorous a logician as the Duke of Argyll. We denominate this the "Christian Era," because it succeeded the birth of Christ, not because it is characterized by the prevalence of Christianity. The remainder of the address was a good popular exposition of the leading facts and principles of Pre-historic Archæology.

On the 21st (Friday), after a paper by E. B. Tylor, Esq., "On Pre-historic Races and Modern Savages," a great part of the day was occupied with reading and discussing two papers "On Stone Circles," &c.: the first, on those of Scotland, being by J. Stuart, Esq.; and the second, on the Sarsden Stones, &c., of Berkshire, by A. L. Lewis, Esq. The former author inferred that stone circles were monuments of the dead, and the latter, that they were temples. The question of temples *versus* tombs produced an animated debate. Post-historic Archæologists may some day quarrel over this question applied to our churches. They will find sepulchral remains in most of them, but not in all, and other evidence of the same nature as that we possess about Stonehenge, Carnac, &c. The probability to our mind is that such places were *always* temples and *sometimes* tombs. The other papers read this day were, "On Rock Sculptures," by H. M. Westropp, Esq.; and "On the Antiquities of the Pacific Islands" (which are not at all ancient), by J. W. Lamprey, Esq.

On Saturday, Mr. Busk exhibited an interesting collection of stone implements from South Africa, some of which had received a beautiful polish from the shifting sand in which they had been buried. Pritchard was of opinion that there had been no stone age in Africa, and until recently the abundance of iron tools and the absence of stone implements was a very remarkable fact. The question—Was there a bronze age in Africa?—still remains open. Mr. Boyd Dawkins exhibited some mammalian remains from bone-caves in Portugal;* and two other papers of very little importance terminated the day's proceedings.

The greater portion of Monday was occupied by Professor Huxley's lecture "On the Races of Mankind," and the discussion thereon. He stated that it matters very little whether we call the great groups of mankind "races" or "species." He recognized: (1) the Australoid race, having long heads, smooth soft wavy hair, and dark complexion and eyes; (2) the Negroid race, having long heads, very dark skins, and crisp woolly hair; (3) the Mongoloid type, having black eyes, black hair (usually straight and lanky), and skin of an olive to a yellowish tint, the skull varying considerably; (4) the Blonde or Xanthochroid type, characterized by fair delicate skins, yellow hair, and blue eyes, usually of tall stature, the skull varying very much.

With the Australians, Professor Huxley includes the hill-tribes of the Deccan, and the natives of Abyssinia and the valley of Egypt. The Mongoloid type is found in Central Asia, westward as far as Lapland, along the whole of the Polar regions, and through the two Americas. The Negroid type extends through the southern portion of Africa, Madagascar, the Malacca Peninsula, and includes the Abetes of the Philippines; beyond the Natural History boundary, which he termed Wallace's line, the negro becomes abundant in New Guinea, and exists in New Caledonia and Tasmania. In connection with this paper, we would refer our readers to the abstract of Dr. Haekel's pamphlet, given in the Chronicle of Archæology and Ethnology.

On Tuesday several papers were read, but we can only notice two of the most important. The first was Mr. George Rolleston's communication "On Modes of Early Sepulture in England," of which he described two of Romano-British origin, and three of Anglo-Saxon. They were, of the former: (1) in oak coffins, with nails and hoops; and (2) in leaden coffins, made like a tray, with turned-up edges, on which the lid was placed. The Anglo-Saxon methods were: (1) cremation, and the burial of the ashes in urns; this mode was practised from the time of Hengist to that of Augustine; (2) burial in shallow graves, not more than 18 inches deep; with the women were buried fibulæ in pairs, ornaments, pins, knives, and beads; and with the men were buried spears,

* See Chronicle of 'Archæology' in our July number.

buckles, knives, &c.; (3) burial in deep graves, in imitation of the Romano-British style.

The other important paper was by John Evans, Esq., "On Stone Implements in Pre-historic Times," in which the author described the result of his attempts to discover, by imitation-experiments, the mode of manufacture of flint and stone implements without the use of metal tools. He recognized four epochs in this manufacture, namely: (1) the Palæolithic period, in which the implements were fashioned by chipping only, and were always of flint; (2) the Reindeer period, of Central France, in which greater skill in flaking flint was possessed, and other hard stones were worked, though not for cutting purposes; (3) the Neolithic period, in which other materials than flint were used, and when grinding on the edge and surface was generally practised, though the hatchets were not perforated; (4) the Bronze period, in which such stone implements as remained in use were highly finished, many of the axes being perforated.

On Wednesday, the last sitting of the Congress, A. W. Franks, Esq., read a paper "On Ancient Stone Implements in Japan." They consist of barbed arrow-heads, either with or without tangs, spindle-formed spear-heads, knives or scrapers, and axes or celts, all of forms similar to the implements of Europe and America. The axes are either of basalt or jade, and the arrow-heads of flint, chert, jasper, or obsidian. The author described the popular legends relating to these objects, and remarked that the general belief in their supernatural origin shows them to be Pre-historic, and older than the existing civilization.

A paper by W. Boyd Dawkins, Esq., "On Mammalia associated with Pre-historic Man;" and one by H. Woodward, Esq., "On the Tusks of the Mammoth, from Ilford," were more Palæontological than Archæological.

The Ogham Monuments formed the subject of a paper by R. R. Brash, Esq., in which the author stated his belief that some of them were of a memorial character, and that others were boundary stones; he regarded them as Pre-Christian in date, and the people who raised them as having come from Spain.

On Thursday the members of the Congress made an excursion to Cambridge; and on Friday a Council Meeting was held at Somerset House, London.

CHRONICLES OF SCIENCE.

1. AGRICULTURE.

There is but little to record in an agricultural Chronicle of the quarter beyond the effect of the universal drought of the past summer upon our field crops. The maxim that "Drought never breeds dearth" appears likely to prove true of 1868 so far as food for man is concerned; but every kind of succulent growth on which we depend for our winter's supply of food for the live stock of the farm has been checked so severely that food for beast will be scarce and costly. The hay crop and the root crop are both much below an average. The wheat crop is unusually productive, excepting only on light and shallow soils; but all spring-sown grain crops are deficient. There has probably never been a summer less helpful to the grass lands of the country which were, over all the Southern and Midland Counties during July and August, bleached and dried up so completely that a sheep was to be noticed on its pasture rather by its shadow than anything else; the ground it stood on being the exact colour of its wool.

Under these circumstances green crops have been possible only by the aid of artificial watering; and land irrigated, whether by spring and river water, or by sewage, has yielded extraordinary crops. On the Metropolis Sewage Company's farm near Barking, a poor thin soil on gravel, which had been in wheat last year, has produced 6 quarters of white wheat per acre with the aid of sewage only; land naturally fertile, but which had had 60 tons of grass taken from it last year under sewage dressings, is now covered with a very heavy crop of mangold wurzel, having received four dressings of sewage during the past summer. And on other fields the power of the waste drainage water of the metropolis, unaided by any other fertilizer, to produce rapid growth of grass, roots, cabbages, and potatoes, has been amply proved. Great crops also of strawberries have been grown on the sewage farm: 160*l.* worth were sold off 1¼ acre, having received no other dressing.

An unusually early harvest, got in four or five weeks before the usual time, has enabled the early autumn cultivation of a large extent of stubble land in most parts of the country; and the advantages of deep steam-cultivation will no doubt appear next year. The opportunity for a much greater extent than is commonly sown of so-called "catch crops," between the main crops of successive years, has been generally taken, and we shall have for the advantage of our sheep and cattle during winter, rape, common turnips, mustard, and winter-cabbages, to take the place of a lost Swedish turnip crop; and for early spring use, to eke out a deficient mangold crop, there is an extraordinary quantity of rye and winter vetches, Italian rye-grass, and Trifolium incarnatum, sown.

The Prize Essay of Mr. Gibbs "On Harvesting Corn in Wet Weather," has been published under the auspices of the Society of Arts,* by whom the prize was offered; and, though singularly unserviceable during the present summer, it will, no doubt, be of use in ordinary seasons. In wet summers it may indeed be the means of introducing artificial drying for many other purposes besides corn harvesting. Half-dried grass in difficult weather, and sugar-beet and chicory in the short days of October and November, may be dried by Mr. Gibbs's artificial hot-air blast at a cost which will not exceed the limits imposed upon the harvest process by the ultimate value of the crop.

Among the agricultural events of the season have been the successful Annual Meetings of the Royal Agricultural Societies of England, Scotland, and Ireland, at which cattle have once more been allowed a place, the restrictions on the home trade imposed against the spread of the cattle plague having been at length wholly removed. The attempt of the Government to pass a Bill for the establishment of separate Water-side Markets for Foreign Cattle, which should diminish the risk of a re-introduction of the plague, was defeated by the jealousy of any restriction upon the trade in food entertained by a resolute minority of the House of Commons. Whether their refusal of this kind of protection of the home interests may not, by permitting the re-introduction of foreign diseases, diminish the supply of animal food, and so increase the cost of it at least as much as the opponents of the measure feared, remains to be seen. While we write, cargoes of foreign sheep are arriving suffering from the small-pox; and we hear of rinderpest within easy reach of us upon the continent. Let us hope that the new Parliament will reconsider the decision of the last, and that every care may be taken so to regulate the importation of live-stock to our shores, that the risk of introducing the deadly plagues of the last few years may be reduced to a minimum.

2. ARCHÆOLOGY AND ETHNOLOGY.

The proposal to publish a translation of Dr. Haekel's great work, made at the Annual Meeting of the Ray Society, was not favourably received, as many portions of it were considered likely to prove dis-

* Bell and Daldy.

tasteful to English readers. Be this as it may, whether the fact be true and the argument legitimate, or not, it is now our duty to record the publication by that author of two Essays collectively entitled 'Ueber die Entstehung und den Stammbaum des Menschengeschlechts.'*

In the first Essay, "On the Origin of Mankind," the author gives his reasons for inferring that Man has come into being by a process of development from the lower animals; and he regards the importance of the "Lamarck-Darwin" hypothesis as precisely equivalent to that of the "Copernicus-Newton" system of Astronomy, for while the latter proved the error of the old geocentric system, so the former shows the falsity of the "Anthropocentric" belief that looks upon man as the centre of an animate world created only to supply his wants.

The second Essay, "On the Pedigree of Mankind," contains the author's opinion of the line in which man's development from the lower animals took place, commencing with *Amphioxus*, and proceeding through the Lampreys and the extinct allies of the Sharks to the Lepidosirens, thence through *Proteus* and its congeners to the Tritons and Salamanders, and thus to the Monotremata (*Ornithorhynchus*). The line then passes through the Marsupials, the Lemurs, the Old World Monkeys (*Semnopithecus*, &c.), and the Anthropoid Apes (Orang, Gorilla, &c.). All the existing varieties of man the author regards as having come from one stock, but that original race he considers to be now extinct. He also believes that the various races have the same value as Natural History species, and as species he describes them. They are the following:—

I. *Homines ulotrichi:* Men with woolly hair and long heads.

1. *Homo primigenius.* Ape-like men, now extinct.
2. *H. papua.* Papuan species.
3. *H. hottentottus.* South African species.
4. *H. afer.* Central African species.

II. *Homines lissotrichi:* Men with smooth hair; heads long, short, and of medium proportions.

5. *Homo alfurus.* New Holland species.
6. *H. polynesius.* Malayan species.
7. *H. arcticus.* Polar species.
8. *H. mongolicus.* Yellow species.
9. *H. americanus.* Red species.
10. *H. caucasicus.* White species.

* 'Sammlung gemeinverständlicher wissenschaftlicher Vorträge,' herausgegeben von Rud. Virchow und Fr. v. Holtzendorff. Serie III. Hefte 52 & 53. 1868.

He does not deny that it is sometimes difficult to draw the line between these groups, but observes that the same difficulty exists in treating of species belonging to other groups of the animate world.

The 'Anthropological Review and Journal of the Anthropological Society' for July contains nothing that we need notice at any length. There are but two descriptive papers in the number, both being in the 'Journal' portion, and both printed in abstract. One is "On Vocal and other Influences upon Mankind from Pendency of the Epiglottis," by Sir Duncan Gibb, Bart., and the other by Lieut. Oliver "On the Hovas of Madagascar," who are described as having a Mongol physiognomy, with affinities to the Malays.

The 'Norfolk News' tells its readers that Anthropologists "consider subjects of much the same kind as those which come under the notice of the Ethnological Society, except that they confine themselves to the study of man, whilst the Ethnologists deal also with the migrations of plants, and things not directly connected with man!"

In M. Fouqué's 'Premier Rapport sur une mission scientifique à l'île de Santorin,' is a description of the remains of buildings which have been found buried beneath the "Tuf ponceux" forming the uppermost volcanic deposit on the south-east coast of Therasia, and which he regards as of Pre-historic date. The walls consist of irregular unworked blocks of lava, irregularly placed, the interspaces being filled up with an earthy material mixed with vegetable matter, but devoid of any calcareous admixture. In the interior of the chambers (which were numerous, and some of which were furnished with windows) the explorers found a quantity of obsidian knives, vases of turned pottery and lava, a human skeleton, bones of ruminants, &c. Under similar Tuff on the Island of Santorin M. Fouqué found a bed of volcanic cinder containing obsidian knives and two gold rings; and at a neighbouring locality a similar cinder-bed contained two tombs, which yielded to his search nothing but a *Byzantine coin*, regarded by the author as having been placed therein at some period subsequent to the formation of the tombs. In other tombs, but above the Tuff, he found pottery (turned) exactly like that from the buildings at Therasia.

M. Fouqué believes that we have in the structures last mentioned the remains of dwellings (as shown by the existence of windows), which were built on the scoriaceous lava which underlies the Tuff *prior* to the eruption of the latter. As no implements of the ordinary metals have been discovered, he refers the whole of the remains found at Therasia to the Stone age. He suggests that the obsidian knives, the pottery (some of which is remarkable for the elegance of its form and the beauty of its decoration), and the gold rings were all imported, because the materials are not to be found either on Therasia or Santorin. The antiquity of this "Stone age" M. Fouqué illustrates by showing that *since* the eruption of the Tuff the foundering of the bay took place, because the Tuff and the subjacent lavas are similarly scarped. In certain localities the Tuff is overlain by a bed of rolled pebbles containing marine shells, showing that these points have been submerged since its eruption. Now, previous to all these events M. Fouqué believes that the stone walls of Therasia were built, and that the inhabitants imported their obsidian implements, pottery, &c.; and he explains the discovery of similar objects in tombs belonging to a date subsequent to these occurrences by suggesting that the trade, which was interrupted by the eruptions and the foundering of the bay, was subsequently renewed when the islands were re-peopled. The foundering of the bay is the most recent event with which we have to deal; and M. Fouqué considers that it must have occurred not later than the fifteenth century before Christ.

This is a wonderful history, and, if confirmed, it will overturn our previous ideas of the "Stone age;" but although M. Fouqué states that the Tuff is not *remanié*, he does not advance one single fact in support of his statement; and when we consider the difficulty of proving it in such a region, and the discovery of similar pottery and obsidian implements in tombs more recent than the Tuff, we feel inclined to believe that the Stone Houses of Therasia have been buried by a land-slip, and are equally more recent than the date which M. Fouqué assigns to them.

The 'Rapport sur les découvertes géologiques et archéologiques faites à Spiennes en 1867,' by Messrs. A. Briart, F. Cornet, and A. Houzeau de Lehaie, has precisely the opposite tendency to M. Fouqué's report just noticed, as it seems to show that the Stone age continued to a period subsequent to the last modifications of the surface in Belgium. It appears that near Spiennes there occur two horizons which have yielded flint implements. The older of these is a Quaternary gravel resting upon Eocene sands, and yielding remains of the Mammoth, *Rhinoceros tichorhinus*, *Ursus spelæus*, *Felis spelæa*, and other extinct animals; about its age there is no question whatever. Above this is a freshwater deposit locally termed Ergeron, the lower portion of which has yielded bones of the Mammoth and of *Rhinoceros tichorhinus*, with a fragment of a shell of *Unio pictorum;* and in its upper portion shells of terrestrial and freshwater mollusca belonging to existing species. Above this bed, and covering it and all the other formations of the district like a vast mantle, is the Brick-earth, on the *surface* of which, at Spiennes, have been found flint implements, pottery, bone tools, &c., which the late M. Tolliez originally referred to the position now assigned to them by the authors of this report. M. Tolliez's opinion had been contravened by M. Malaise, who regarded the worked flints, &c., as of older date than the Brick-earth, and as therefore belonging to the Quaternary period. The construction of a railway having exposed some sections and rendered probable a solution of the problem, a commission was charged with the duty of attempting it, and the result is that the authors of this report confirm M. Tolliez's original conclusion, and refer these newer implements to the Polished Stone period; but, with one exception, the implements are not polished.

M. S. Chavannes has edited a pamphlet, by the late M. Morlot, entitled 'L'Archéologie du Mecklenbourg, d'après les travaux du Dr. Lisch, comparée à celle de l'Europe centrale. Première Partie. Age de la Pierre.' It appears that this was to have formed one chapter in a general work which the lamented author was preparing previous to his last illness, and it is the only one left in a sufficiently forward state for publication. It contains descriptions of the tombs known as "Hünenbett," or "Reisenbett" (Giants' bed) and the Hünengrab, or Giants' tombs; they consist of a mass of earth containing a kind of chamber formed of large unworked blocks of stone, the earth being raised nearly to the upper surface of the horizontal roof-blocks, and the mound is ornamented by a circle of upright stones placed at its circumference. These structures are popularly believed to contain immense treasures. Other tombs, each consisting of three upright blocks at right angles (forming three sides of a rectangle) covered by a horizontal roof-block, which are usually termed Dolmens, are known to the people of the country as "Steinkisten" and "Steinhäuser." Cromlechs also occur in Mecklenbourg, and are known to the inhabitants by the name of "Steintanz." The implements consist of flint-knives, flakes, arrow-heads, &c., and a few implements of quartzite and diorite. The author also mentions pieces of amber pierced and much ornamented, and some tools of deer's horn.

3. ASTRONOMY.

(Including Proceedings of the Royal Astronomical Society.)

As we write, intelligence has been received from three of the expeditions sent out to view the eclipse of August 18th.

Major Tennant reports that the sky was covered with light fleecy clouds, but the eclipse was in the main successfully observed. As Major Tennant's party had had assigned to them the task of photographing the eclipse, we may assume from his account that several photographs have been taken. This is important. We shall not be able to judge of the value of the photographs until the enlarged pictures have been examined, but from the quality of the instrument, constructed for the party by Mr. Browning, we may safely assume that the views will prove valuable and instructive.

Dr. Janssen, who was at the head of the French expedition, has telegraphed to Paris that the spectrum of the red prominences has been observed. The result he describes as "remarkable and unexpected." He does not state what is the exact nature of the spectrum; but as he adds that the protuberances are gaseous, we are enabled to conclude that it consists of bright lines. The protuberances had never before been submitted to spectroscopic analysis, and considerable doubts had existed among astronomers respecting their real nature. For the most part, however, astronomers had supposed the protuberances to consist of matter resembling our terrestrial clouds; that is, formed by the condensation of invisible vapours into minute liquid globules. This opinion will now have to be abandoned. These enormous masses, many of which exceed the planet Jupiter in volume, must now be recognzied as consisting principally of luminous gas. They are, in fact, flames—in reality as in appearance. This result is one of the most interesting which has for a long time been obtained by astronomers.

Lieut. Herschel sends a telegram confirmatory of Dr. Janssen's. He appears to have had unfavourable weather, but one protuberance was caught in the spectroscope, and the spectrum found to consist of bright lines. He adds, that no bright lines were seen in the spectrum of the corona. He found the polarization of the corona to be solar.

We shall await with interest the publication of fuller reports of these observations.

Mr. Huggins has made a very important series of observations upon the second comet of the year. This object was discovered by Winnecke, at Carlsruhe, on June 18, and also independently on the same night by M. Béquet, Assistant-Astronomer at the Observatory of Marseilles. Mr. Huggins found the comet to consist of a nearly circular coma, which became rather suddenly brighter towards the centre, where there was a nearly round spot of light, from which a tail could be traced for nearly a degree. The spectroscope resolved the light of the comet into three very broad bands, which do not correspond either in appearance or in position with the bands seen in the spectrum of Brorsen's comet. The brightest is in the middle. Its least refrangible end is the brightest, and is somewhat less refrangible than the double line *b*. The more refrangible end of the band lies about one-third of the way from F towards *b*. For about two-thirds of its length from the brightest end this band is almost uniformly bright; but from thence towards its more refrangible end it diminishes considerably in brightness and in apparent breadth. The more refrangible of the other two bands is considerably more refrangible than F. Like the former, its least refrangible end is the brightest, and it diminishes almost uniformly both in brightness and in breadth from that end uniformly to the other. The least refrangible band lies between D and E, and is faintest towards its extremities. The bands could not be resolved into lines. All of them were brightest in the middle of their breadth—an appearance due, of course, to the superior brilliancy of the comet's nucleus. But the apparent diminution of the breadth of the two more refrangible bands must not be ascribed to any difference in the spectra of the coma and nucleus, since it is clearly due to the diminution of the comet's light from the centre towards the circumference. The effect of this diminution would be to render the edges of the fainter parts of the spectrum invisible. The marginal portions of the coma were found to give the same spectrum; but when the light became very feeble Mr. Huggins imagined that he could trace a continuous spectrum underlying, so to speak, the discontinuous one. The tail was too faint to exhibit any spectrum.

But the most remarkable part of Mr. Huggins' researches remains to be mentioned. He found that the spectrum of the comet presented so close a resemblance to diagrams he had formed in 1864 of the spectrum of carbon, that he was induced to make a more exact comparison. Dr. Miller was present while the requisite observations were being made, and took part in them. Our space will not permit us to enter as we could wish into a full account of the arrangements made use of by Mr. Huggins. It must suffice for us to state that the spectrum of carbon, as seen (in combination with the hydrogen spectrum) when the spark from an induction coil is taken through olefiant gas, was brought into direct comparison with the spectrum of the comet. Mr. Huggins and Dr. Miller were both satisfied that within the limits of the instrument's power of indication the two spectra were coincident, not only in the position of their bands, but also in their general character and their relative brightness. The observations subsequently made by Mr. Huggins confirmed this impression. The lines due to hydrogen were not seen in the spectrum of the comet.

Mr. Huggins speculates with his usual acumen and caution on the remarkable discovery above recorded. The great difficulty is to understand how a substance so fixed as carbon should be volatized when at considerable distance from the sun. In the case of a comet which approaches the sun very nearly, one can understand that effects should be produced differing wholly in character from anything we are familiar with on earth; but at the time of observation Winnecke's comet was not near to the sun. However, as Mr. Huggins remarks, we can only regard the difficulty as one of degree. We are presented, in the case of the gaseous nebulæ, with instances of gas maintained permanently in a luminous state,—a phenomenon wholly inexplicable by any of the relations which terrestrial physics bring under our notice. Therefore we are forced to acknowledge that beyond the limits of our atmosphere, relations may subsist with which we are as yet, and perhaps may for ever remain, unfamilar.

M. Otto Struve has twice been able to observe the spectrum of the Aurora Borealis. He finds that it consists of one line, so that the light is monochromatic. The line falls near the margin of the yellow and green, about th position 1259 on Kirchhoff's map.

In the 'Comptes Rendus' for 3rd August there is an account of a fall of meteorites which took place on February 29th, 1868, in Piedmont, at about half-past ten in the morning. A violent detonation was heard in the *arrondissement* of Casale, and was immediately followed by another explosion and several minor discharges. While the noise continued a strange irregular mass of matter, enveloped in smoke, was observed at a considerable height above the ground. Other observers saw several masses moving from N.W. to S.E. Some labourers noticed the fall of a shower of fragments. Some of them which fell near Mount Conti were examined, and found to contain silica, sulphur, phosphorus, copper, metallic iron, oxide of iron, nickel, manganese, chromate of iron, aluminium, magnesia, and potash. Others which fell at Villeneuve contained also lime and soda.

The number of the asteroids has now been raised to one hundred, the ninety-ninth asteroid having been discovered at the Marseilles Observatory, and the hundredth by Professor Watson, of Detroit, Michigan.

The planet Jupiter is now favourably situated for observation. His belts are at present very distinctly marked. We have had some magnificent views of the planet with one of Mr. Browning's 12-inch silvered-glass reflectors; and should wish to call the special attention of observers to the corrugations of the principal northern belt (they have remained visible for a long time, and will doubtless continue to be seen for some months), and to the strangely-shaped clouds which streak the principal southern belt.

There will be a transit of Mercury on the morning of November 5th. The transit begins an hour-and-three-quarters before sunrise (which takes place at three minutes past seven), and ends two hours after sunrise. The planet will pass from east to west across the sun's disc, the point of ingress being 165° towards the east from the North Pole; and the point of egress 113° towards the west.

There is little probability that the shooting-stars of November 14th will be seen in any part of Europe this year. The calculated period of maximum display is about half-past one in the afternoon of November 14th. The display will probably be seen in New Zealand, and possibly a few Europeans who may find themselves at that time in parts of the Pacific nearly on the meridian of New Zealand may send us accounts of phenomena observed on the occasion; but there is reason to fear that the display will nowhere be properly watched by experienced observers.

Proceedings of the Royal Astronomical Society.

We mentioned in our last Chronicle the statements made by Mr. Abbott respecting the nebula round η Argûs. We must now consider them somewhat more in detail, and examine at the same time Sir John Herschel's views respecting the supposed changes in the figure and aspect of the nebula.

In the first place a remarkable change would seem to have taken place in the luminosity of the nebula itself. On a clear fine night the object is twice as bright as the Nubecula Major, and three times as bright as the Nubecula Minor. In twilight it is seen as soon as a star of the second or third magnitude, the light being white and more diffuse; very like a small woolly cloud on a blue sky, seen in sunlight. Now Sir J. Herschel states that in 1832 no nebulosity could be perceived with the naked eye, even on a dark night, and "assuredly not in twilight such as just to allow stars of 2–3 magnitude to become visible." Both the nubeculæ are completely obliterated in twilight of this sort.

Then the arrangement of the nebulous masses would seem, if Mr. Abbott's diagrams can be trusted, to have undergone the most remarkable variations, not merely since the date of Sir J. Herschel's observations, but even during the last few years. The instrument made use of by Mr. Abbott was a 5-feet equatorial, by Dallmeyer. The light-gathering power of such an instrument is of course not comparable with that of Sir J. Herschel's 18-inch reflector; but it seems impossible to imagine that a mere difference in the amount of light should cause an object resèmbling that figured by Sir J. Herschel to assume the appearance presented in either of Mr. Abbott's drawings. These drawings also bear not the least resemblance to each other; and Mr. Abbott states that the position and figure of the nebula presented in the two drawings he has sent to the Society, are far from being the only ones in which the object has appeared. "A system of photographs would be the only means," he says, "of assisting materially the recognition of the principles of irregularity which pervade the whole structure of the nebula."

On this point Sir J. Herschel remarks that "there is no phenomenon in nebulous or sidereal astronomy, that has yet turned up, presenting anything like the interest of this, or calculated to raise so many and such momentous points for inquiry and speculation. The question here is not one of minute variations in subordinate features, which may or may not be attributable to differences of optical power in the instruments used by different observers, as in the case of the nebula in Orion, but of a total change of form and character—a complete subversion of all the greatest and most striking features—accompanied with an amount of relative movement between the star and the nebula, and of the brighter portions of the latter *inter se*, which reminds us more of the capricious changes of form and place in a cloud drifted by the wind, than of anything heretofore witnessed in the sidereal heavens."

Not less remarkable is the change which, according to Mr. Abbott's diagrams, would seem to have taken place in the arrangement of the fixed stars which are strewn over the nebula. Sir John Herschel determined during 1834–7 the position of no less than 1,200 of these; and during all the course of his observations never found reason to suspect the situations of any of these to be variable *inter se* or with respect to the star η. Mr. Abbott's drawing shows 150 stars of various magnitudes, and Sir J. Herschel has been unable to identify any one individual with any one in his catalogue. "What then," he says, "are we to conclude? Not only the nebulous masses would appear to have drifted away from their situations in 1835, but the stars of the whole region over an area of nearly two-thirds of a square degree, including stars of the 6th, 7th, and 8th magnitudes, to have either assumed new configurations *inter se*, or to have bodily fled away and given place to a new set."

Sir J. Herschel concludes his paper on Mr. Abbott's statements by expressing the hope that some southern observer furnished with an equatorially mounted telescope would without further delay set to work in earnest, and map down the stars visible in this most interesting area, down at least to the 10th or 11th magnitude. The questions raised by Mr. Abbott's paper "are of the last importance," says Herschel, "and *must* be settled."

Father Secchi, in a letter addressed to Admiral Manners, describes the spectra of fifty red stars. He examined these with a spectroscope, the construction of which had been improved (in the Padre's opinion) by the use of cylindrical lenses (only) for the eye-piece, which was made by M. Merz, and worked admirably. He points out that a new type of stars appears in the list, *viz.* that of stars having a spectrum of three large coloured zones. He has already found several of that type. He is particularly surprised "to see some zones always at the same places, so that there is a great cosmical law which is about to come forth; but for the present," he adds, "we must wait until the review of all the stars has been accomplished." It is to be wished that the good Padre would make use of apparatus comparable in power and accuracy with that which Mr. Huggins has applied to spectroscopic analysis. We should then be better able to form an opinion of the value of his researches. At present it is impossible to avoid entertaining a suspicion that the apparatus employed by him is not powerful enough for researches of such extreme delicacy as those in which he is engaged.

Mr. Brothers, to whom we owe the valuable catalogue of double stars, published by the Manchester Literary and Philosophical Society, supplies a paper on the name of the star ξ Scorpii. In Flamsteed's catalogue this star is called 51 Libræ. This was undoubtedly a blunder on Flamsteed's part, as the star belongs to the set of stars which form the northern claw of the Scorpion. But we doubt very much whether it would now be wise to attempt to alter Flamsteed's nomenclature. Mr. Brothers thinks it would, and he quotes Mr. Dawes's opinion in favour of the change. "Libra already has three ξ's," says Dawes, "and without this star Scorpio has no ξ at all." But there is, in truth, no particular force in this reasoning. Pegasus has no δ (Bayer's δ Pegasi being also called α Andromedæ) and Auriga has no γ (Bayer's γ Aurigæ being also called β Tauri); yet no inconvenience results from either defect. On the other hand Flamsteed's nomenclature has been so generally adopted in scientific treatises on the stars, that inconvenience would follow if a star to which he had assigned a number under one constellation, were to be included in another. The nomenclature suggested by Mr. Brothers, "ξ Scorpii (= Fl. 51 Libræ)" is far too clumsy for general use.

Mr. Brothers complains with some justice of the use made by Mr. Chambers of the catalogue mentioned in the preceding paragraph.

Major Drayson supplies an interesting paper on the longitudes assigned to fixed stars by Ptolemy. He is disposed to attribute the uniform error of about 1°, noticed in Ptolemy's longitudes, to that astronomer's ignorance of the laws of refraction. Assuming that Ptolemy fixed the positions of stars by a reference to the moon, and that he determined the position of the moon with reference to the sun by observations made when the moon was near the zenith and the sun on the horizon, we obtain an error of about 1° (one-half due to the apparent diminution of the moon's distance from the sun, and the other due to the apparent diminution of the stars' distance from the moon). We believe, however, that the opinion of Delambre, that Ptolemy formed his catalogue from that of Hipparchus by applying a correction for precession, and that the correction was 1° in 100 years, instead of the true value $50' \cdot 1$, is far more probable than Captain Drayson's. The uniformity of the error suggests that some such explanation as Delambre's is the true one.

If Ptolemy had made all his observations in the manner suggested by Captain Drayson, an uniform error would have appeared in the resulting longitudes. But that method must be looked on as exceptional, being (as Captain Drayson admits) "an extreme case, and one giving the greatest amount of error." In ordinary cases refraction would not produce nearly so large an error as 1° in longitude.

Mr. Cooke describes a new driving-clock for equatorials. In this arrangement the pendulum is a half-second's one, with a heavy bob, adjusted by sliding the suspension through a fixed slit. The scape-wheel is a double one, each wheel having four teeth: the teeth of one wheel strike on one pallet, those of the other wheel on the other pallet. The wheels are arranged in the form of the letter U. At the end of one branch is the scape-wheel, at the end of the other is an air-fan. The large driving-wheel and barrel are situated at the bottom or bend of the U. The scape-wheel and the two next wheels have an intermittent motion; all the others have a continuous motion. We have not space to describe how the change from one motion to the other is effected. It appears, however, that the arrangement is perfectly satisfactory. Mr. Cooke considers that a clock constructed on the same principle, connected with and giving motion to a cylinder, would make an excellent chronograph.

Mr. Browning describes two drawings of Jupiter, one made on September 12, 1867, with a 10¼-inch reflector, and the other on December 22, 1867, with his own 12¼-inch reflector; in each case the power was 200. On both drawings a dark belt, to the north of the bright equatorial cloud-belt, is seen to have a rather uniformly corrugated appearance on the lower or northern edge. As a similar marking appears in Mr. De la Rue's well-known drawing of Jupiter, taken in October, 1856, Mr. Browning is inclined to think that the mark may possibly indicate the conformation of the actual surface of the planet, or at least some peculiar condition of the planet's atmosphere over a particular portion of Jupiter's globe.

Major Tennant supplies some interesting particulars respecting the Zodiacal Light as seen at Calcutta. He has always found the shape to be a portion of a long ellipse or parabola, ill-defined at the outlines, and fading away, with a marked condensation of light towards the axis and horizon.

Linné still continues to attract the notice of observers. We have papers from Messrs. Webb, Prince, and Birt, on the appearance of this crater. The opinion seems to be gaining ground, however, that no change has really taken place on this part of the moon's surface.

Mr. Stone supplies an important paper "On a Determination of the Constant of Nutation from the Observations in North Polar Distance of Polaris, Cephei 51, and δ Ursæ Minoris made with the

Transit Circle of the Royal Observatory, Greenwich, 1851–1865." The result is as follows:—

Supposing δp, δc, and δm to be the respective errors in the assumed values ($0''\cdot00$, $+ 0''\cdot08$, and $- 0''\cdot03$, respectively) of the proper motion of Polaris, 51 Cephei, and δ Ursæ Minoris, in North Polar distance, the expression for the Nutation Constant comes out—

$$9''\cdot133 + 3\cdot05\,\delta p + 0\cdot44\,\delta m - 0\cdot90\,\delta c.$$

Mr. Proctor points out that no notice is taken in the Nautical Almanacs of certain partial Lunar Eclipses—those, *viz.*, in which the moon passes within the earth's penumbra, but not within the umbra. This seems to be a defect, because penumbral passages have now an evident value on account of the application of spectroscopic analysis. There seems to be something defective also in the theory of eclipses as usually presented in works on astronomy, in which no notice whatever is taken of penumbral lunar eclipses. Mr. Proctor gives the elements of a penumbral eclipse of the moon which took place on the morning of September 2nd of the present year.

4. BOTANY, VEGETABLE PHYSIOLOGY, AND MORPHOLOGY.

AMERICA.—*Diatoms, &c., in Hot Springs.*—Mr. A. M. Edwards draws attention in a recent paper to the occurrence of Diatomaceæ belonging to the genera *Orthosira*, *Fragillaria*, and *Cocconema*, together with the hairs of insects, in some fine sandy deposit obtained from a Geyser. Dr. Lauder Lindsay enumerates seven genera of Confervæ and Diatomaceæ from the Geysers of Iceland; and observes that the abundance of Diatoms in the thermal waters of Central and Southern Europe warrants us in expecting large additions to the Icelandic Flora from this source alone. Dr. Cohn has described Oscillatoriæ from hot springs containing sulphates, and ascribes the elimination of sulphuretted hydrogen to the action of these organisms. Mr. Edwards, in the paper above referred to, suggests the importance of an examination of the hot sulphureous springs of California for these organisms and for Diatomaceæ. It would, he remarks, be exceedingly interesting to ascertain by comparison of specimens from sulphureous and neighbouring freshwater springs, what modifying effect the thermal conditions have had on the form of the various species. This is a most important method of inquiry, and one which must be fully followed up; for, by its means, we may hope ultimately to arrive at a definite knowledge of the exact relations of living *forms* to the *conditions* of their existence.

Flora of Carolina.—Dr. Curtis has lately issued an important and neatly printed catalogue relating to this subject. Its greatest interest is in the Cryptogamic part, which occupies considerably more than half of the volume. The Flowering plants enumerated are 1873, the Flowerless 2924, of which 2392 are *Fungi;* that is, of the order to which Mr. Curtis has devoted the greater part of his scientific life. Acknowledgments are made to Mr. Sullivant for assistance in arranging the list of Musci and Hepaticæ, and to Professor Tuckerman in that of the Lichenes. This assistance, it would appear, was rendered several years ago, as the arrangement does not in all respects represent Professor Tuckerman's later views. The catalogue is undoubtedly by far the most extensive list of plants ever published in North America; and from the central position of North Carolina in the line of the Atlantic States, and from its including the most developed portion of the Alleghanies, it is very important to botanists in the illustration of geographical distribution and range of species. As regards the *Fungi*, that State may be supposed to contain all the species of the Atlantic States. It is much to be wished that Dr. Curtis would now seriously devote himself to the elaboration of a manual of the *Fungi* of the United States; otherwise, a vast amount of knowledge of these obscure plants may be one of these days lost to the world, and a great want long remain unsupplied.

ENGLAND.—*Professorship of Botany at Oxford.*—The professorship which became vacant by the death of Dr. Daubeny has at length been filled up by the election of Mr. M. A. Lawson, to whom we are indebted for the following account of the *Flora of the Isle of Skye:*—"During the last month I spent a fortnight in this island in investigating its Flora. I had for companions, Professor Oliver and Mr. Fox of Great Bardfield, and with their assistance I have drawn up a list of all the plants we found in our various excursions. This list contains 389 species, including the Ferns, Equisetaceæ, and Lycopodiaceæ. Of this number 51 species are new to sub-province 33 in Mr. Watson's Supplement to his 'Cybele Britannica,' 31 are new to his sub-province 32, 120 are new to his sub-province 38, while 51 species are recorded from his sub-province 38, which we did not find in Skye. I propose here to mention only those plants which are in common use by the inhabitants.

First, those which are used for medicinal purposes:—

Achillæa millefolium is a supposed specific for jaundice.

Gentiana campestris and *Menyanthus trifoliata* are extensively collected, and taken as tonics.

Mercurialis perennis, it is said, is largely used for a purgative. Many species of seaweed also are used variously; sometimes simply boiled into a pulp it forms a poultice, at other times it is steeped in whisky and the mixture drunk, in which condition it is considered a universal specific, and the people view it in the same light that the rustics in England view Holloway's pills; and accordingly they take it freely.

"Secondly, those plants which are used in the arts:—

"*Potentilla tormentilla* is often used for tanning nets, instead of bark. The flowers of the *common gorse* are in common use as a dye; but the most important of all to the islanders is the *common ling;* of this they make the roofs of their houses, and bind them together by ropes made of the same material; while their beds and floors are frequently formed of the same plants. The only plants generally cultivated are oats and potatoes. Barley is sometimes grown in more sheltered spots; but the oats, and especially the potatoes, are what the islanders depend upon. Each family has its oat ground and potato patch, and upon the produce of these patches and a barrel of herrings they chiefly subsist. For the manuring of their patches, they use seaweed, which they gather from the shores of the lochs; but besides this they use the roofs and floors of their huts. A man about to marry seeks out a level piece of ground, pares the grass off it, and round this clearing heaps up stones, which are left either loose or cemented with mud; on the top of this half wall, half heap, he stretches a skeleton roof, and covers it with heather to the thickness of a foot or more; and to make this quite secure he binds it together with a network of ropes made from the ling; a large flat stone is placed in the middle of the hut, and a peat fire lighted. There are two apertures; the door, and a hole in one corner of the roof for the chickens to enter in at. This done all is completed, and the man brings in his wife, cow, goat, pig, dog, and cat, and commences the manufacture of a patent manure for their oat and potato patches. The roof, impregnated with smoke, is taken off one year and given to the oats, while the floor is dug up the next and given to the potatoes. This, strange as it may sound to your English ears, is by no means uncommon, especially in the north-eastern part of the island. Among the more interesting plants we found were the following:—*Ribes spicatum*, Robs., abundant on the rocks about Uig and Dunngan Head. *Chrysanthemum segetum*, which fills every patch of cultivated ground. *Mimulus luteus*, which has established itself in many parts of the island, covering a considerable extent of ground, and spreading rapidly both by seed and runners. *Listera cordata*, growing in dense woods about Ryle Akin. *Eriocaulon septangulari*, which is not confined to one loch at Sligachan, as we were told, and as is generally supposed, but which grows abundantly in many of the lochs in the neighbourhood."

Blights and Cholera.—The Rev. M. J. Berkeley thus replies in the 'Gardener's Chronicle' to a number of questions recently put to him by Dr. Gavin Mibroy on behalf of the Epidemiological Society. He remarks, "I do not believe in Hallier's views of the connection of cholera with parasites on rice. I am taking great pains to ascertain what are the rice parasites. I believe Hallier's notions to be entirely theoretical. That some cutaneous disorders arise from fungi is pretty evident; but there is nothing to show that fever or other infectious or contagious diseases arise from the same cause. It was supposed that diphtheria depended on a fungus, but I have examined diphtheritic membranes in which there was no fungus." In reference to the mode of entrance of the parasite fungus, Mr. Berkeley writes, "In the bunt the whole process is traceable, the parasite obtains admission from without, and the spawn traverses the young plant. In plants impregnated by myself, I have seen the stem as well as the grain affected; but I never saw this in the fields. The potato murrain, again, is distinctly traceable in affected tubers, the threads seeming to have a power of decomposing the cell walls, so as to gain admission to the tissues very deeply. In some cases the effect of the presence of the parasite is to produce a hypertrophy of the tissues, in bunt an intensity in the colour of the chlorophyll, or at least such an alteration of colour that a practised eye will at once detect a bunted plant. In many cases, however, I doubt whether the best microscopes will always detect fungus spawn, and such investigations require great caution, as the junctures of the cell walls are very deceptive.

FRANCE.—*Morphology of the Pistil and Ovary.*—M. Van Tieghem has received the French Academy's Bordin prize for 1867 for an essay on this subject. He considers that before examining the distribution of the vascular bundles of the stem and ovary, it is necessary to understand exactly what is meant by the term axis and what by the term appendicular. He then draws this distinction: when the vascular bundles are arranged in such a manner that in transverse section they form a complete circle, or, in other words, surround an ideal line, we have an illustration of an axis; when, on the other hand, the vascular bundles are coordinated in relation to a plane, we have an instance of an appendicular organ. Starting with these definitions, the author proceeds to a minute anatomical analysis of over fifty-five families of plants, selected to illustrate all the combinations of the organs whose morphology he desired to investigate. In order to avoid ambiguity, he has substituted for the term *axile placentation*, the term *angular placentation:* since the former is associated with an hypothesis, while the latter is not. Some of M. Van Tieghem's conclusions will strike botanical readers as singular. For instance, he says that there are double appendicular organs, which spring from the axis under the form of a simple handle, and divide at a certain distance from the point of emergence into simple super-imposed appendices, and which may be said to be inserted one upon the other. Again he explains the adhesion of the ovary by assuming the original coalescence with all the floral whorls which are external to it; a coalescence of the same kind as that which unites the separate carpels into the compound pistil, or the petals and stamens into the monopetalous corolla. The Academy's commissioners do not quite concur in the opinions of M. Van Tieghem, but they think his conclusions worthy of all attention, and regard them as at least extremely ingenious. The memoir extends over 200 pages, and is illustrated by an atlas containing 500 carefully drawn figures, illustrative of the plants examined and of the dissections. As showing how carefully the French conduct their awards of prizes, it may be mentioned that the commissioners repeated several of M. Van Tieghem's dissections, and found his statements absolutely correct.

Antherozoids of Mosses.—M. E. Roze has been studying these. His first investigations led him to express the opinion that these organs are composed of a biciliated filament with two spiral turns, to which a mass of amylaceous granules adhered, but only during their motility. In the spring of this year he ascertained that these granules, instead of being affixed directly to the spiral, are contained in a hyaline plasmic vesicle, which is attached to the filament by a sort of tangential adhesion. Under a power of 1,500 diameters, this vesicle is clearly discerned, both by its spheroidal outline and by the very brisk molecular movements of its contents. It swells in water immediately after the quiescence of the ciliated spiral, then it suddenly bursts, and the amylaceous granules continue in the liquid the lively molecular trepidation which seems normally, in the vesicle, to coincide with the cessation of the ciliary movement. Except as regards the existence of this vesicle, the facts previously indicated by the author are by no means modified. From this new fact it appears that the antherozoids of all classes of Cryptogamia present not only an organ of locomotion, but also a vesicular appendage filled with a plasmic liquid, suspending either non-analyzable grains or amylaceous granules. This fact was foreseen by M. Ad. Brongniart. The author's recent observations were made upon the antherozoids of various genera of Polytrichaceæ (*Atrichum, Pogonatum, Polytrichum*), still contained in their mother cells, and upon the free antherozoids of *Bryum capillare* and *B. pseudo-triquetrum, Mnium hornum* and *Hypnum cupressiforme.*

5. CHEMISTRY.

M. MARTIN has made some experiments upon the preservation of meat by means of ether. He placed in six tin boxes uncooked beef, surrounded by little tufts of cotton wool soaked in sulphuric ether; the boxes were then soldered tight, and exposed to the rays of the sun. Every three months, a box was opened. Each piece of meat weighed a kilogramme. At the end of three months there was no alteration either in weight or form. The meat thus preserved does not undergo the putrid fermentation; it is strongly impregnated with ether, and the odour remains after numerous washings with cold water. When cooked the meat possesses a peculiar savour, probably due, M. Martin says, to the formation of a new ether: the fibre is disintegrated. The process is not applicable to the preservation of food, but other animal matters might perhaps be advantageously treated by it.

An ingenious method of testing fatty matters, founded upon the solubility of rosaniline in certain fatty acids, has been devised by M. Jacobsen; it is applicable, among other things, to the examination of cod-liver oil. A little piece of dry rosaniline placed in a sample of perfectly neutral oil, agitated and heated upon the water-bath, remains undissolved, but if placed in a rancid oil, a red tint is rapidly developed. Oleic acid and the other fatty acids dissolve rosaniline in large quantity, and become opaque from the depth of the tint, because oleate of rosaniline is soluble, in all proportions, in oils and other fatty substances. This property enables the presence of fatty acids in oils to be detected. For instance in commerce we have had, for some years, pretended white cod-liver oils, which are only fatty fluids from very young animals, or veritable cod-liver oil which has been agitated with potash, allowed to repose, and filtered. Since the therapeutic effects of cod-liver oil depend essentially upon the amount of free fatty acids which it contains, neither of these white oils can be valuable. Genuine cod-liver oil agitated with a little rosaniline is promptly coloured red in the cold, and if heated upon the sand-bath the colour is very deep, while the bad specimens already referred to remain perfectly uncoloured.

When an oil which is only slightly rancid contains but a small amount of fatty acids, the coloration often does not become sensible at first. In this case it is better to prepare a solution of rosaniline in absolute alcohol, add a few drops of this to the oil to be examined, and heat on the water-bath until all the alcohol has been evaporated. If no fatty acid exist, the rosaniline soon separates and rises to the surface, or when the oil is too thick, rests in suspension as a brown powder. Samples of ordinary oil occurring in commerce have given the following results:—Olive oil and that of sweet almonds remained uncoloured by rosaniline; poppy oil became slightly red; linseed oil became strongly coloured, its natural colour rendering the tint brownish; palm-oil gave a coloration still more intense. It is sufficient to mix olive oil with 5 per cent. of oleic acid to obtain with rosaniline a tint equal to that of raspberry juice.

Mr. E. Smith has given the following very simple test for the presence of a free acid:—Dissolve chloride of silver in just sufficient ammonia to make a clear solution. If a little of the test be added to ordinary spring water, the carbonic acid present in the latter will neutralize the ammonia and precipitate the chloride. This forms a good lecture experiment, the test being a very delicate one.

We hear that a new source of thallium has been discovered in the flue dust obtained from a sulphuric acid works in Holland, where pyrites from Suhrort is burned. This flue dust contains about 1 per cent. of thallium.

Drs. Crum Brown and T. R. Fraser have made an interesting discovery upon the influence of direct chemical addition upon the physiological action of substances. The bodies which they have chosen for examination are the more active of the vegetable alkaloids, and the chemical operation of which they have studied the effect has been the direct addition of iodide of methyl. It was shown by How, that when iodide of methyl acts upon strychnine, brucine, morphia, and other alkaloids, it adds itself to them, and beautiful crystalline bodies are produced, which differ considerably in character from the salts of the alkaloids. The authors have already examined the physiological action of the bodies produced by the addition of iodide of methyl to strychnine, brucine, morphia, thebaia, codein, and nicotine.

It is well known that doses of strychnine, varying from one-twentieth to one-thirtieth of a grain, rapidly produce in rabbits most violent convulsions, and in a few minutes kill the animal; the phenomena produced being due to a localization of its action on the cord. It was found that twelve grains of iodide of methyl-strychnine, when administered (by subcutaneous injection) to rabbits weighing three pounds, produced no effect whatever. Fifteen grains produced symptoms, and twenty killed; but the animal died with symptoms altogether different from those produced by strychnine. In place of violent and spasmodic convulsions and muscular rigidity, the appearances were those of paralysis with complete general flaccidity. The spinal motor nerves were either paralysed or speedily became so; and, instead of the speedy occurrence of muscular rigidity, the muscles remained flaccid, contractile, and alkaline for several hours. In short, by the addition of methyl to strychnine the toxic properties of the latter are diminished about 140 times; and the body produced possesses the physiological action of curare, *viz.* paralysis of the end organs of the motor nerves. Similarly, Brown and Fraser have discovered that the toxic properties of brucine, thebaia, and codeine are immensely diminished by the addition of methyl; and that the bodies produced, instead of being, as all three of these alkaloids are, strongly convulsent, possess, on the contrary, the physiological action of curare. Morphine, as is well known, possesses both soporific and convulsent properties; its toxic action is much diminished by the addition of methyl; its convulsent action is destroyed, but its soporific action remains.

We may appropriately conclude our Chronicles of Chemistry by quoting the following very apposite remarks made by M. Dumas, the secretary of the Academy of Sciences, and one of the leading French chemists:—If every one of us took the fancy of combining with his name that of his great-grandfather, of his grandfather, of his father, and his mother, a singular complication would be found in our registers of births. A lifetime would be passed in learning the names of the persons with whom we were acquainted in our own neighbourhood. As to knowing the names of the inhabitants of a town, that would be an utter impossibility. This is, however, what our *savants* who pursue organic chemistry have to accomplish, so that their language has now arrived at a point of barbarism that cannot be surpassed. Now, would it not be desirable, in all points of view, to adopt a generic word, and to group around such word the names of species in proportion as science extends her conquests? I am particularly interested in organic chemistry, but I declare that time is entirely wanting to me to peruse, while comprehending them, the various memoirs on the science which come under my notice. The complication and insupportable length of the names employed are the sole causes of this.

6. ENGINEERING—CIVIL AND MECHANICAL.

Notwithstanding the partial revival of trade since the last panic, the progress of public works in this country can hardly be said to have kept pace with the times; but it need scarcely be here stated that the only check has been caused by the unwillingness of capitalists to embark in such enterprises. Nevertheless we have, during the past year, witnessed a succession of railway loans being brought out on account of Russian lines, and other foreign loans appear at present to be more in favour than public works at home.

Shipbuilding.—The revival of commerce has naturally led to a demand for ships; but in this branch of industry the Mersey and more northern ports have enjoyed almost a monopoly; the high rate of wages consequent upon the greater cost of living in London, together with the working of the Trades Unions there, having almost succeeded in driving shipbuilding away from the Thames.

Docks and Harbours.—The extension of dock and harbour accommodation is perhaps the best possible sign of the prosperity of any nation, as it naturally indicates a demand for increased facilities for its external trade. Judged from this standard, the great mineral producing districts of South Wales bear testimony to the prosperity of this land; new docks are in course of construction at Newport and Cardiff; a second dock is about to be commenced at Llanelly; and the new harbour works at Pautcaul have recently been completed and opened. At Liverpool the new corn dock, which has been constructed on the site of the old Waterloo Dock, was opened on 4th July. On Friday the 9th June, the River Wear Commissioners opened their new docks, eleven acres in extent, by running in a fine steamer of 2,000 tons burden, and other large vessels were subsequently passed in, shortly after low water, showing what deep-water accommodation would be afforded at high water. At Blyth considerable improvements have been effected in the harbour by dredging operations, which have been going on for some months; the dredgers have now been placed over the bar in the entrance channel, with the view of facilitating the dispatch of vessels at neap tides.

A magnificent hydraulic-lift graving-dock, upon Mr. Edwin Clark's patent, is now under construction for the Indian Government, for the port of Bombay. It is intended principally for docking the East India transport vessels, and the pontoon provided for this purpose covers more than three-quarters of an acre in area. Another smaller dock of the same description is also about to be constructed for a company, who propose its erection at Jamaica, where accommodation of that sort is at present sadly wanted.

The Egyptian Government has recently signed a contract with an English company for the construction of important works in the harbour of Alexandria, comprising a breakwater, a mole, a line of quay, and a dry dock of sufficient dimensions to accommodate the largest class of vessels.

Railways.—The most important works recently undertaken in connection with railway extension in England are certainly those of the Midland Railway, between Bedford and London, which terminate at St. Pancras, close to the King's Cross Terminus of the Great Northern. It will be remembered that until recently the Midland Railway had its approach to the metropolis over the Great Northern line from Hitchin, at which point it was connected with the latter by a branch from Bedford. Starting from Bedford, the new line passes through Luton, St. Alban's, Hendon, and

Kentish Town to the Euston Road, a distance of about fifty miles. Along the last section of about 6¾ miles the line is laid with four sets of rails, by which means the passenger and goods traffic will be kept distinct; and along the whole distance from Bedford sufficient land has been taken up to admit of the same number of rails being laid all the way. It is, however, the immediate entrance to London, and the terminal works, which demand the chief notice. The entrance into the terminus is on a high level, and advantage has been taken of this in the construction of works connected with the coal traffic, which is likely to become a very large source of income to the company. Beneath the viaduct on which the railway runs, use has been made of the space afforded for storeage accommodation, the construction of stabling, &c., and the arches fronting the road have been fitted up as shops for the purpose of letting. In order to join the Metropolitan Railway it has been necessary also to construct a low-level line, which, running partly in cuttings and partly in tunnels, passes under the main line near the terminus, and runs into the Metropolitan at its King's Cross station. This line was opened for traffic on 13th July last, and it is expected that the main line will be opened in the course of October. The terminus consists of one huge span, in the shape of a pointed arch, no less than 240 feet wide, 100 feet high, and 700 feet long, covering altogether rather more than four acres of ground.

The Brecon and Merthyr Railway has at length been opened as far as the town of Merthyr Tydfil, and a junction for minerals and goods traffic has been made with the Taff Vale Railway. The Bala and Dolgelly line has also been formally opened. This line is in continuation of that between Bala and Corwen, and will form the nearest route from Liverpool, Chester, Manchester, &c., to Merionethshire, Carnarvonshire, and part of Cardiganshire.

The great engineering works in connection with the enlargement and improvement of Lime Street station at Liverpool, are being pushed forward. The immense roof, in one span, will stretch across the station to the width of 214 feet, its height will be 75 feet, and length 385 feet.

The Queensferry branch of the North British railway system has recently been opened throughout for passengers.

In India the Bhore Ghaut section of the Great Indian Peninsula Railway was reopened in sound and perfect condition on the 30th June.

The Eastern and Western sections of the Pacific Railway in America have been brought within 900 miles of each other, and it is expected that the whole will be opened for through traffic from New York to San Francisco on the 4th July next.

On the continent we have to note the opening of the Voltri and Savona section of the Genoa and Nice Railway, which has been carried almost entirely through rock; there being in the 18⅜ miles of its course no less than thirty-nine tunnels, the longest of which is 3,920 feet. The railway from Foggia to Candela was also opened to the public on 4th May last.

Bridges, &c.—The viaduct which has for some time past been in course of construction over the Solway Firth, as a part of the Solway Junction Railway, was practically completed on the 27th June. The bridge over the Dee at Kirkcudbright was formally opened on the 9th July.

A light roadway bridge, chiefly for foot-passengers and for the accommodation of visitors, is now being erected just below the Niagara Falls, the clear distance between the centres of towers being 1,268 feet. A commencement has also been made for the construction of a trussed girder-bridge, with three spans, across the Mississippi river at St. Louis, where it is about 1,500 feet wide.

The new suspension-bridge across the Moldau, at Prague, was formally opened in person by the Emperor Franz Joseph, on 21st June. The length between abutments is 820 feet, which is divided into one centre span and two half-spans.

The Mont Cenis Tunnel had, up to 21st August last, been driven 8,647 mètres, leaving 3,573 mètres yet to be completed, and it is thought that the tunnel will certainly be opened in 1870.

The subway under the Chicago river, which is now more than half completed, points to a method of crossing rivers with an extensive navigation hitherto but little adopted, but the advantages of which are gradually becoming better appreciated. This tunnel, which is an experimental one, will connect the east and west sides of Washington Street; and should it be found successful, the bridge communication between the main streets in Chicago will gradually be superseded by this form of crossing. The drift under the river Indus at Attock, in the East Indies, was completed in June last, and it has now been determined to complete the tunnel as a means of communication across the river at that point.

Water Supply, Drainage, &c.—The works for providing an additional supply of water for St. Andrew's were formally opened on 5th June. The supply now obtained will, it is expected, be more than sufficient to meet the wants of the city for fifty years to come. The new waterworks at Paisley are making good progress, and it is expected that the Rowbank water will be flowing to Paisley before the end of September.

The first instalment of the drainage works at Douglas, Isle of Man, has been finished, consisting of a main intercepting sewer running along the shore, and an outfall sewer emptying itself into the bay.

Telegraphs.—The cable for the Anglo [illegible] Company is expected to be laid by the middle of September. As soon as this portion is completed, the Company intends to commence the construction of the Anglo-Indian line.

A concession for the privilege of laying a telegraphic cable between France and America was, on 6th July last, adjudicated to Baron Emile d'Erlanger and Mr. Julius Reuter, for twenty years, by the French Government. The order for the cable has already been given to the Telegraph Construction and Maintenance Company, who are advertising for coals for the 'Great Eastern,' which is to be brought into requisition for laying the cable.

Miscellaneous.—Amongst miscellaneous metropolitan improvements may be noted the opening of the first portion of the Holborn Valley works, on 25th June; the rapid approach towards completion of the great central Metropolitan Meat Market at Smithfield; and the acceptance of a tender for the extension of the Thames Embankment from the eastern boundary of the Temple precincts to the west abutment of Blackfriars Bridge.

On 30th July the foundation stone was laid of a lighthouse to be erected on Scurdyness, near Montrose. The height of the tower will be 100 feet, and its diameter 23 ft. 2 in. at the base, and 15 ft. 10 in. at the top.

The Havre Maritime Exhibition, which opened in June last, and was originally intended for the display of objects of special interest to the naval architect, marine engineer, or shipowner, turned out to be in no great degree different from other exhibitions in the miscellaneous character of its exhibits. Coming, however, so soon after the great Paris Exhibition of last year, the show at Havre indicated no distinctive progress either in invention or manufacture.

Mechanical.—Perhaps the most important branch of mechanical engineering at the present day, is that devoted to the construction of agricultural implements, which are now being largely exported to the continent, Egypt, and India. Amongst recent improvements in other branches may be briefly noticed Messrs. Deas and Rapier's switch-boxes and indicators, which exhibit a full danger-signal for the least opening of the switches. A mowing-machine, by Mr. G. M. Gerrard, presents several new features of improvement, which space, however, will not allow of being further noticed here. A steam road-hammer has recently been patented by Messrs. Gore and Green, which is intended to supersede rollers for the purpose of consolidating road surfaces. A new rock-boring machine, by Captain Penrice, by the use of which the employment of powder is obviated; it attacks the whole gallery at once, and operating by means of cutters with bevelled edges, it acts in such a way as to disintegrate the rock by a series of blows. A locomotive cotton-press, by Messrs. Appleby, Brothers, is likely to supply a want long felt, and will no doubt be fully appreciated, as soon as known, in all cotton-growing districts.

7. GEOLOGY AND PALÆONTOLOGY.

(Including the Proceedings of the Geological Society.)

The volume of the Palæontographical Society's publication for 1867 has been issued during the quarter. It contains portions of five memoirs, namely: (1) the first part of Mr. Binney's monograph of the structure of Fossil Plants found in the Carboniferous strata, including a description of the genus *Calamodendron*, being the plant of which we have casts of the pith in the well-known Calamites. (2) The second part of the Liassic portion of Dr. Duncan's supplement to the original monograph of the Fossil Corals, containing the conclusion of the description of Corals from the zones of *Ammonites angulatus*, *A. planorbis*, &c.; and descriptions of those from the Lower and Middle Lias. (3) The second instalment of Dr. Wright's monograph of the Cretaceous Echinodermata. (4) The Cephalaspidæ of the Old Red Sandstone, by Mr. Lankester. And (5) another portion of the apparently interminable description of *Felis spelæa*, by Messrs. Boyd Dawkins and W. A. Sanford.

Mr. Busk's long-expected memoir on the Elephant remains of the Zebbug cavern, in the Island of Malta, has at length been published in the 'Transactions of the Zoological Society.'* The examination of these remains was commenced by the late Dr. Falconer, whose notes Mr. Busk has included in his memoir. Dr. Falconer had in conversations, and in speeches made at the meetings of the Geological Society, aroused great interest in this cave by stating that it had yielded abundant evidence of the previous existence of a pigmy elephant on the Island of Malta, which he proposed to call *Elephas Melitensis*; but, stranger still, Mr. Busk has discovered in the collection under description remains of a second and still smaller species, which he proposes to name *E. Falconeri*. The former of these is computed to have been about 4 ft. 3 in. to 4 ft. 6 in. in height, and the latter not to have exceeded from 2½ to 3 feet. When we remember that an average full-grown Indian or African elephant has a height of about 9 feet, the diminutive size of these fossil forms is something remarkable.

An exhaustive account of the Volcanoes of the Hawaiian Islands, with a history of their various eruptions, has just been published by Mr. W. T. Brigham in the Memoirs of the Boston Society of

* Vol vi., part 5.

Natural History.* The frightful destruction caused by the eruptions of Mauna Lòa has on several occasions drawn public attention to this group of volcanoes, so that Mr. Brigham's admirable essay possesses a more than geological interest. Two conclusions of a purely scientific nature are, however, especially worthy of record. The author observed that although the craters of the group occur along a line supposed to be a line of fissure, as in other regions, yet that the major axes, or directions, of the craters were parallel to one another at an angle of 26° from the trend of the group; in other words, the supposed volcanic fissure trends N. 64° W., the major axes being N. and S. On following out the idea suggested by this circumstance the author found that the major axes of craters are always at right angles to the mountain chains in which they are situated. Thus he was led to reconsider the whole theory of volcanoes, and his conclusion is that the theory of an unequally contracting crust, causing certain portions to fall below the general level, opening rents at the boundaries, and forcing up molten matter to the surface, seems to satisfy the known condition of volcanoes better than any other.

Mr. R. D. Darbishire has published in the memoirs of the Literary and Philosophical Society of Manchester † a paper on some superficial deposits at Great Orme's Head, in which he describes "Pholas-burrows" as still discernible in the limestone rock at various heights up to 570 feet, and the legitimate conclusion which he draws is that the district has been under water since it was covered with ice. He has also discovered similar "Pholas-holes" near Buxton at a height of about 1,400 feet. If these holes are really the borings of *Pholades*, the fact is of the greatest interest; and the photographs of the specimens, by which the paper is illustrated, certainly lend great probability to the author's inference.

In a paper read before the Royal Geological Society of Ireland last November, "On Parts of South Devon and Cornwall, with Remarks on the true Relations of the Old Red Sandstone to the Devonian Formation," Mr. Jukes comes to the conclusion that the former "lies wholly below the Devonian slates and limestones, which contain marine fossils, both in Munster and Devon." As to the Devonian formation and the Carboniferous Limestone, he does not wish to "dogmatize," but it is evidently his belief that they are contemporaneous. We should mention that while Mr. Jukes's geological statements are always read with respect and attention, his onslaughts on Palæontology weaken the force of what would otherwise be regarded as a resonably good case, as it makes one suspect that the difference between his views and those of other geologists must there also be attributed to the want of power of observation.

* Vol. i., part 3. † 3rd series, vol. iv.

The Tyneside Naturalists' Field Club has long been known as one of the foremost in the country; and in having encouraged the working-out of the natural history of the district over which its labours extend, it is decidedly in advance of any other local society in Great Britain. The last volume of the new series of its publication * is entirely occupied with "A New Flora of Northumberland and Durham," of a very comprehensive character. We must leave the Botany to other judges, and shall merely mention that the preliminary essay on the Geology of the district, by Mr. George Tate, is remarkably good, although it contains reference to a division of the Carboniferous Limestone (*Tuedian*) which is not usually recognized. Perhaps Mr. Jukes would call it Carboniferous Slate. Mr. Baker's observations on the influence of the subjacent rocks on plant-distribution are extremly good, and we are glad to notice that Thurmann's division of rocks into Dysgeogenous (or bad producers of soil) and Eugeogenous (or good producers of soil) has been adopted by the author.

In the 'Annals and Magazine of Natural History,' for July and August, Professor W. King and Dr. Carpenter have returned to their old battle-ground, the structure of *Spirifer cuspidatus*. The former author regards the so-called "perforated" and "imperforate" forms as belonging to one and the same species, the absence of perforations being the result of metamorphism; while Dr. Carpenter avers that the imperforate form has a continuous shell-structure, which would not be the case had it once been perforated and the tubes subsequently obliterated by metamorphism.

In the July number of the same Magazine Dr. Nicholson describes a new genus of Graptolites (*Helicograpsus*); and Professor Rupert Jones and Dr. Holl publish another instalment of their "Notes on the Palæozoic Bivalved Entomostraca," including descriptions of Lower Silurian species from the Chair of Kildare.

The Cretaceous deposits of Spain have more importance than their representatives in other countries, as they yield the chief supplies of coal in the eastern part of the peninsula. Of these coal-bearing strata those of Utrillas, near Montalban, occupy the first rank, and the memoir on their Fossils, "Description des fossiles du Néocomien Supérieur de Utrillas et ses Environs (Province de Teruel)," by Messrs. de Verneuil and de Lorière will be of great importance in future searches for combustible minerals in that country, as all the Spanish productive coal-beds of Secondary age are shown to correspond in date with those of Utrillas. It is also worthy of note that the fossils include several species of *Vicarya*,—a genus which was first described from the Eocene beds of India, where it is represented by only one species, and of which, until

* 'Natural History Transactions of Northumberland and Durham,' vol ix.

now, only a second representative was known, namely, from the Miocene beds of Java.

The Report of the Dundee Meeting of the British Association has been issued during the past quarter; but we need only state that it contains the third Report of the Committee for exploring Kent's Cavern, Devonshire; and Mr. Henry Woodward's third Report on the Structure and Classification of the Fossil Crustacea.

Professor Heer's great work on the Miocene Flora of the Arctic regions* has been published within the last few months. A synopsis of its contents would be identical with the account of his paper read before the Royal Dublin Society, which we gave in a former Chronicle.

The absolute duration of geological time is a question which is now exciting the attention of physicists and geologists, owing chiefly to Mr. Croll's numerous papers bearing more or less directly on the subject. In the May and August numbers of the 'Philosophical Magazine' are two instalments of a paper by him "On Geological Time, and the probable Date of the Glacial and the Upper Miocene Period;" but we shall reserve our record of his conclusions until its completion. From another point of view Mr. Geikie has computed, in a paper in the 'Geological Magazine' for June, that "such a continent as Europe will, at the present rate of subaërial waste, be worn away in about 4,000,000 years."

The only other paper in the 'Geological Magazine' for the quarter which we have space to notice is one by Mr. Davidson, "On the Earliest Forms of Brachiopoda discovered in Britain." In the lowest beds of the Lower Cambrian (Sedgwick) there are no Brachiopods; in the Harlech Group above is a *Lingulella*, which passes up into the overlying Menevian Group, or Lower Lingula Flags, and is associated probably in the former, and certainly in the latter, with a *Discina* and an *Obolella*. The genus *Orthis* also makes its first appearance in the Menevian beds. In the Middle Lingula Flags we have *Lingulella, Lingula,* and *Kutorgina* (*Obolella*); and in the upper beds, in addition to a species of each of those genera, there occurs another *Orthis*. In the upper division of the Primordial zone (Tremadoc slates) the same genera occur, with the exception of *Orthis*, which, however, becomes abundant in the Lower Llandeilo. This paper is an interesting contribution to the facts relative to the first appearance of life.

* Flora fossilis arctica. Die fossile Flora der Polarländer; von Dr. Oswald Heer. Mit einem Anhang über versteinerte Hölzer der arctischen Zone, von Dr. Carl Cromer.

Proceedings of the Geological Society.

A large proportion of the Society's Proceedings during the last Session has been published in the August number of the 'Quarterly Journal;' but we shall content ourselves with a notice of a few of the papers of more general interest.

In a paper "On the Speeton Clay," the author, Mr. J. W. Judd, has very ably sustained the reputation which he gained by his first communication to the Society "On the Strata which form the Base of the Lincolnshire Wolds." Under the name "Speeton Clay" he includes all the beds of clay exposed in Filey Bay intermediate between the Hunstanton Limestone and the Coralline Oolite, a series of deposits of very great thickness and importance. He regards it as certainly *not* the equivalent of the Gault, either as a whole or in part, no portion of it being referable, in his opinion, to that formation. He divides it into seven stages, well marked lithologically, and even better defined palæontologically. They are:—(1) the Upper Neocomian, having its equivalent in the Lower Greensand of the south of England; (2) the Middle Neocomian, of which the Tealby series of Lincolnshire is the equivalent; (3) the Lower Neocomian, now recognized for the first time in England; (4) the Portlandian, agreeing, however, much more closely with some of the continental representatives of that formation than with the limestone and sand of Portland; and (5), (6), and (7) the Upper, Middle, and Lower Kimmeridge. This classification is a very great advance on our previous knowledge, and is the more welcome as the reference of the upper portion of the Speeton Clay to the Gault, made many years ago by Professor Phillips, has too frequently been regarded as a proved fact instead of, what it really was, merely a suggestion,—no doubt of great value in the then imperfect state of our knowledge.

The Duke of Argyll, whose ability as a scientific critic is of the highest rank, has a paper "On the Physical Geography of Argyllshire in connection with its Geological Structure;" but the title is scarcely an accurate index of its contents. In point of fact it is a criticism on the subaërial denudation theories, as set forth in Mr. Geikie's work upon 'The Scenery of Scotland viewed in connection with its Physical Geology.' It is impossible in a few words to review an elaborate criticism, the value and force of which depend in a great measure on its being thorough and elaborate; we must therefore content ourselves with stating that the author's opinions are those of the older school of geologists,—that subterranean movements have had the greater influence in producing the most prominent features of Highland scenery, instead of the very minute effect which the "Erosionists" ascribe to them.

In a paper "On the Affinities and Probable Habits of the

Extinct Australian Marsupial, *Thylacoleo carnifex*, Owen," Mr. W. H. Flower combats Professor Owen's reference of that animal to the carnivorous type of Marsupials, chiefly because in it the canines are very small and the anterior incisors are largely developed, as in the Rat-kangaroos and other phytophagous Marsupials, while in the true carnivores, whether implacental or placental, the canines are very large and the anterior incisors very small. Anatomists differ in their opinion as to the overwhelming force of this argument, and many refer, on the one hand, to the molar teeth and other organs of *Thylacoleo* as differing considerably from those of any true herbivore; and on the other, to the flesh-eating Shrews and Hedgehogs, in which the development of the anterior incisors does take place at the expense of the lateral incisors and the canines.

Mr. Hull has two papers of great merit on cognate subjects. In the first he shows that the south-easterly attenuation of the Carboniferous *sedimentary* strata of the North of England, which he showed to occur in a former paper, is made the more evident by his recent investigations further north than he had previously surveyed, as in that direction those deposits continue to expand at the expense of the *calcareous* portion of the series (Mountain limestone), which he had previously shown to attain a prodigious development in the south-east.

In the second paper, "On the Relative Ages of the leading Physical Features and Lines of Elevation of the Carboniferous District of Lancashire and Yorkshire," he shows that the main lines of disturbance may be assigned to three distinct periods, namely, First and earliest, the Pendle system, having an E.N.E. direction, and marking the close of the Carboniferous period. Secondly, the Pennine system, having a direction nearly north and south, and belonging to the close of the Permian period. And thirdly, the most recent of all, the lines of fracture running N.N.W., which were formed at the close of the Jurassic period. The periods of denudation in this district he refers to seven distinct epochs, beginning with the commencement of the Permian period and ending with that which ensued at the close of the Glacial epoch.

8. METALLURGY AND MINING.

In 'The Mineral Statistics of the United Kingdom,' just issued from the Mining Record Office, we find the following returns of our Mineral produce for 1867:—

	Tons.	Cwt.	Value. £	s.	d.
Tin ore, from 117 mines	13,649	0 ..	694,734	0	0
Copper ore, from 164 mines ..	158,544	0 ..	699,693	19	0
Lead ore, from 330 mines ..	93,450	6 ..	1,158,272	0	0
Zinc ore	13,488	17 ..	41,240	11	11

	Tons.	Cwt.	Value. £	s.	d.
Iron-pyrites	116,889	7	67,454	5	10
Gold quartz	3,241	4			
Arsenic	1,255	5	2,112	10	6
Ochres and gossans	5,480	0	5,807	10	0
Nickel	1	17	14	12	5
Wolfram	10	10	62	0	0
Manganese	807	18	1,615	16	0
IRON ORE	9,965,293	0	2,936,322	11	4
COAL	104,501,249	0	26,125,312	0	0
Barytes	7,500	0	4,875	0	0
Clays	1,125,924	0	375,900	0	0
Salt	993,880	0	223,010	14	0
Coprolites	37,000	0	45,500	0	0

The only point calling for attention appears to be the continued increase in the production of coal, in the face of the depression which has been continued for some time in every description of manufacture. Metalliferous mining does not rally from the low state to which it has fallen. By a desperate effort the production of ores is maintained with tolerable steadiness, but the mines which are working to a profit are exceedingly few.

The metals produced from the ores raised from the mines of Great Britain and Ireland were as follows:—

		Value.
Tin	8,700 tons	£799,203
Copper	10,233 „	831,761
Lead	68,437 „	1,337,509
Zinc	3,750 „	79,693
Gold	1,520 ounces	5,320
Iron	4,773,771 tons	11,934,427
Silver	804,024 ounces	215,400

Of Foreign copper ores we imported 73,957 tons, and of regulus 28,825 tons; these, smelted at Swansea and Liverpool, produced 19,567 tons of copper.

In connection with these statistics of our Mineral produce, we find in the 'Moniteur des Intérêts Matériels' the following estimate of the production of copper in the world at large in 1866:—

	Tons.		Tons.
Chili and Peru	34,357	Turkey	2,000
United States	14,485	Belgium	1,825
England	11,153	Spain	975
Russia	5,600	Italy, Coast of Africa, and Mediterranean	850
Australia	4,250		
Austria	3,775	Saxony	370
Prussia	3,500	Hesse and Nassau	355
Sweden and Norway	2,850	Hanover	200
China and Japan	2,700	Portugal	125
France	2,500	Sundry places	500

Within a short period it appears probable that there will be a revival of Mining in Africa. Reports are received giving a most favourable account of some of the copper-producing districts of South Africa. There is no doubt that an extensive coal-field exists in Natal, and an experienced English geologist is to be sent to the colony to report on it. The gold-fields on the Limpopo river are exciting much attention.

Mr. Bauerman and Dr. Le Neve Foster, who went to Egypt to explore the mountain-range of Sinai and some part of the coasts of the Red Sea, for the Viceroy of Egypt, have returned to England. Their report will contain much valuable information. The latter gentleman has started for Venezuela—he heads an expedition to explore the new gold-fields of the Orinoco.

We have before us a return of the production of coal in 1867 from the Sarrebruck coal-basin:—

3,171,125 metrical tons (of 2,204 lbs. 10 ounces) of coal were raised, which was a slight advance upon the production of 1866. Of this quantity France took 971,695 tons, Prussia 453,685, the Zollverein 641,754 tons, and Switzerland 108,659 tons.

The coal-production of the Calais coal-field is stated to have been nearly 2,000,000 tons last year, this quantity having been obtained from seventeen collieries. Of these five only are of any importance: Lens produced 400,000 tons, and Counieres, Nœux, Grenay, and Dourgis about 100,000 tons each annually. The price of this coal at the pits is maintained at from 15*s.* to 17*s.* the ton. It is mainly used to supply seventy-six sugar-mills, twenty-two distilleries, and eighteen flax and silk mills.

Within the bounds of the great commercial union of Germany,—the Zollverein,—there are at the present time no less than 198 mines producing the precious metals. The gold and silver ore weighed during the year amounted to 641,000 cwt. In Saxony alone there were 176 mines, producing 598,546 cwt. of silver ore. The mines of Prussia gave 30,090 cwt. of ore, those of Bavaria 2,850 cwt., and those of Anhault 17,515 cwt. The auriferous ores extracted were valued at 21,268*l.* The argentiferous ores were far more abundant; they were smelted at thirteen furnaces, and yielded 157,084 lbs. of silver.

Coal in Russia.—It is to be regretted that journals professing to chronicle the progress of science, should allow themselves to be made the medium for conveying to the public, as established facts, the speculations of adventurers. We find in 'Les Mondes' a paragraph to this effect—"Contrary to the previsions of that celebrated geologist Murchison, the country is rich in deposits of coal." It then gives a list of places where, it is implied, coal exists in abundance. Now every one of the places named have been long known to contain coal, and in some of the districts there is a wide spread of coal-measures; but the coal is insignificant in quantity, and many of the carboniferous measures are destitute of true coal. This statement, so hastily copied by 'Les Mondes,' has its origin in the circumstance that the little coal-field of Donetz has been brought forward as one of promise; and General Helmersen has proved the extension of the coal-field on the western flanks of the Ural considerably to the south. A company has been formed, and two colliery viewers from our Midland Counties have been engaged to visit the district and to report upon the prospects. In a subsequent number of 'Les Mondes' a letter from Sir Roderick Murchison directs attention to his work on the 'Geology of Russia,' in which the coal-fields of Russia are fully described, and their value very satisfactorily stated. This is followed by the poor excuse that "l'article erroné" was taken from an English journal. The editor of a scientific periodical should be taught that he ought not to rely on newspaper announcements which have not some mark of authenticity.

The Siemens-Martin's process for the manufacture of steel is exciting much attention at the present time. During the last few years experiments have been made by Martin to supplant crucible steel with reverberatory furnace-steel, and the final success appears to be due to the use of Siemens' furnace and a due adjustment of the proportions of the materials employed. At the works of M. Verdie experiments on a large scale have been for some time going on, with every appearance of success, and similar results are now being obtained at the New Steel Works of Messrs. Samuelson and Co., near the Newport Iron Works, Middlesborough.

The Martin process consists essentially of the fusion together on an open hearth of cast and wrought-iron with rich oxides of iron, in proper proportions and under proper conditions, especially that of temperature, the heat required being about 4,000° Fahr., which could only be obtained by the use of Siemens' furnace.

The apparatus consists of one Siemens' regenerator furnace, one reverberatory furnace, and one heating furnace. The materials employed are Swedish iron, Spiegeleisen, wrought-iron,—specially-prepared Cleveland puddled bars,—in which the phosphorus has been eliminated as far as possible. The material used by M. Verdie is raw iron made from Algerian ores, and iron and steel shavings of the same origin. Ingots of very soft steel are more especially being manufactured at present, but any temper and hardness are said to be completely under command.

The Iron Ores used in the Blast Furnaces of France are principally those of the Boulonnais, in the Pas-de-Calais, and of the Avesnes (Nord). The first-named ores, containing 27 per cent. of iron, are carried by railway to the furnaces of the Pas-de-Calais, and they cost, delivered at Denain, 14*s.* 6*d.* per ton. The second, found near Malplaquet, Fourmies, and Maubeuge, give from 34 to 35 per cent. of iron, and are delivered at Fourmies at 6*s.* 8*d.* per ton. The oolitic ores of the Moselle and those of Champagne are said to yield 38 per cent. of iron, while those of Tournai give but

25 per cent.; these ores cost from 8*s*. to 10*s*. per ton delivered at Denain. Spanish iron-ores sent from Bilboa, yielding 50 per cent. of iron, and costing 1*l*. 4*s*. per ton, are used. Algerian iron-ores, said to give 65 per cent. of iron, are sent to France from Mokta-el-Hadid, and costs 1*l*. 8*s*. 10*d*. a-ton delivered at Dunkerque.

Wolfram steel some years since attracted some attention, and M. Jacob, the patentee of a process for effecting the combination, produced some beautiful examples of cutlery made from steel produced by his process. At Messrs. Cockerell and Co.'s Works in Belgium they are now using 2½ tons of wolfram per month in this manufacture.

Several French engineers have reported more favourably on the strength of iron produced by alloying ordinary pig-iron with tungsten. It is evident that some good experiments, made on a large scale, and under varied circumstances, are required to settle this question.

9. MINERALOGY.

In our Chronicles of last quarter we called attention to a recently-discovered form of silica, described by Vom Rath under the name of *Tridymite.* It now remains to describe the characters of the new mineral, and to point out the interest attaching to its discovery. Hitherto it has been the fashion to recognize two distinct forms of silica: the one, represented by common quartz, having a specific gravity of about 2·6, and crystallizing in the hexagonal system; the other, represented by opal, having a specific gravity of 2·2 or 2·3, and being non-crystalline or amorphous. A relation was thus established between density and form; and on this relation many deductions were based. We now find, however, that a low density does not necessarily connote an amorphous condition; for Vom Rath discovers a species of silica which has a specific gravity of only 2·2 or 2·3, and yet assumes well-defined crystalline forms. These forms, although belonging to the rhombohedral system, are in no wise related to those of ordinary quartz; and hence silica turns out to be dimorphous. Our new mineral occurs in small six-sided tabular crystals, which are usually grouped together in (to use a solecism) twins of threes, or, as the Germans more aptly express it, in *Drillingen.* It is this peculiarity of a three-twinned growth that has suggested the name "Tridymite." Associated with specular iron-ore and acicular hornblende, these crystals bestud the cavities of a volcanic porphyry from the Cerro San Cristobal, near Pachuca, in Mexico. That they are not pseudomorphs of amorphous silica after some hexagonal species, is clearly proved by the property which they possess of double refraction.*

* 'Poggendorff's Annalen,' No. 3, p. 507; 'Geol. Mag.,' No. 48, p. 281.

In a letter addressed to Professor Leonhard,* Dr. Sandberger notes the discovery of Tridymite in the cavities of a trachyte from Mont Dore les Bains, where it is accompanied by rock crystal. The two dimorphic forms of crystallized silica are thus presented in association.

Everyone must have experienced the difficulty of retaining in mind for any length of time the formulæ of minerals which present a complex constitution, notably those of the compound silicates. To assist in overcoming this difficulty the Rev. B. W. Gibsone suggests the employment of a mnemonic system.† Using consonants to represent the digits, he forms memorial words associated in a fanciful manner with the minerals to which they relate, and then throws the whole into rhyme in order to fix it the better in memory. Some of these rhymes form such frightful jargon that we could not disgrace our pages by transcribing them; but to give our readers a notion of this kind of *memoria technica* we may pick out one or two of the best couplets. Here is one:

"Heat Topaz and its tint will *fade*;
Of *murder* Scapolite's afraid."

Here is another:

"*Never* smoke Meerschaum, or the croup
Will *hurt* Picrosmine's *heart.*"

In these examples the memorial words are italicized. Thus, in the first line, the word *fade*, when translated into figures, gives for Topaz the value of the numerical constants in a standard formula. With the exception of students who are cramming to satisfy over-reaching examiners, there are probably few who would be willing to rely upon a system so essentially artificial.

For the third time during the present century the province of Casale, in Piedmont, has been the scene of a shower of meteoric stones. On the 29th of last February, at about 10 a.m., explosions were heard over a considerable area, and small clouds were observed at a moderate height rapidly moving from N.W. to S.E. These phenomena were followed by a fall of stones, witnessed by several labourers, and at one place a peasant's hat was actually struck by a meteoric fragment. Although several stones were seen to fall, only a few pieces were afterwards found. As usual, the stones were coated with a hard black varnish-like crust, and on fracture they presented a lighter colour and a fine texture somewhat resembling that of trachyte. The fall occurred between the villages of Villeneuve and Motta de' Conti. The stones from the latter place were too small for quantitative examination, but those

* 'Neues Jahrbuch f. Mineralogie,' u.s.w. 1868, Heft IV., p. 406.
† Aide-mémoire for siliceous formulæ. 'Chem. News,' Aug. 21, 1868.

from the former have been carefully analyzed by Dr. Bertolio. Their composition does not differ essentially from that of the meteorites which previously fell in this district on the 17th July, 1840, and on the 2nd February, 1860.*

A mass of meteoric iron has been found near Nöbdenitz, in Saxony, and is believed by Dr. Geinitz to be of meteoric origin. In some of its characters it much resembles a metallurgical product, but on analysis no carbon was found, whilst nickel was detected in considerable quantity. It differs, moreover, from terrestrial iron in many of its physical properties. Throughout the mass particles of native copper are disseminated, and from this is produced the green carbonate of copper which is associated with the oxide of iron on the exterior of the meteorite. The following is Dr. Fleck's analysis of the Nöbdenitz iron:†—

Iron	88·125
Copper	9·013
Nickel	1·340
Tin	1·321
Cobalt and Chromium	Traces.
	99·799

Attention has also been directed to a somewhat similar mass of iron found about a year ago at Weissenborn, near Zwickau, in Saxony; but it would seem that its meteoric characters are not fully established.

The gorgeous play of iridescent colours exhibited by certain polished specimens of Labradorite must have attracted the eye of even the least scientific observer. To ascertain the cause of this colour and iridescence, Herr Vogelsang has lately subjected some specimens to microscopic examination. Many sections showed a great number of minute disseminated crystals, which he calls "Microliths." These differ considerably in form and colour, and it would be difficult in all cases to say what they really are. Some, however, appear to be diallage, and others magnetic iron ore. The golden reflections exhibited by some labradorites are supposed to result from the total reflection of light incident upon these microliths; whilst the blue colour characteristic of other specimens is apparently due, not to the embedded crystals, since it is equally displayed in their absence, but to a phenomenon of polarization resulting from the refraction of light from one lamella to another.‡

Dr. Scharff has lately studied the characters of that unsatisfactory species, *Sericite*.§ It occurs abundantly in the schists of

* Bullettino Meteorologico dell' Osservatorio del R. Collego Carlo Alberti in Moncalieri. 31 March, 30 April, 30 June, 1868.

† 'Neues Jahrbuch.' 1868. Heft IV., p. 461.

‡ 'Archives Néerlandaises,' 1868, III., p. 32.

§ 'Neues Jahrbuch,' Heft III., p. 309.

certain parts of the Taunus range in Western Germany, but it seems doubtful whether it should take rank as a distinct mineral. The author recognizes two varieties—the one fibrous, with a satiny lustre; and the other lamellar, with a metallic lustre: the latter is of younger formation than the former.

A new species discovered in the copper veins of Nantoko, in Chile, by Herr Herrmann, has received the name of *Nantokite.** In its pure condition it is a perfectly anhydrous chloride of copper, but by exposure to the action of atmospheric influences it becomes converted into atacamite.

Another new species is to be termed *Helvatane*, from its occurrence in the Alps of Switzerland. It is apparently a felspathic mineral, found in the mica-schist of the Tödi Mountains.†

Two closely-allied minerals have long been known under the names of *Leadhillite* and *Susannite*. They occur together in the old mines of Lead Hills in Lanarkshire, and they possess precisely the same chemical composition,—both being sulphato-carbonates of lead. Leadhillite crystallizes, however, in the rhombic system, whilst Susannite affects hexagonal forms. Dr. Kenngott has lately examined these crystals with care, and believes that the apparently hexagonal forms of Susannite are purely deceptive, arising from the twining together of crystals of Leadhillite, just as the rhombic crystals of Witherite become twinned in pseudo-hexagonal forms.‡

10. PHYSICS.

LIGHT.—Professor H. Morton, of the University of Penna, has devised a very ingenious arrangement for obtaining monochromatic light of considerable intensity. The difficulty which there has hitherto been in producing monochromatic light in great quantity prevents us from demonstrating satisfactorily many points of interest in connection with the composition of light and the theory of vision. Coloured glasses placed in the path of powerful beams of white light are doubly unsatisfactory; they reduce the amount of light enormously, and with few exceptions (*e.g.* red glass coloured with gold) yield a beam of mixed colour. The old experiment, the spirit-lamp with salted wick, is admirable as far as it goes, but yields a very faint light at best. Something far superior to this is furnished by the arrangement of a ring of cotton wick wound on a wire, and supported immediately over and around a large Bunsen burner, the wick being soaked with an aqueous solution of some

* 'Berg-und hüttenmänn. Zeitung,' XXVII., No. 1, p. 3.
† 'Neues Jahrbuch,' Heft III., p. 348.
‡ Ibid., p. 319.

flame-colouring salt. This plan in effect is suggested in Sir David Brewster's natural magic; but as the Bunsen burner was not then known, a less simple arrangement is described to perform the same office. The drawbacks to this arrangement are: the trouble of adjusting the cotton wicks, the delay in changing to produce a new colour, and the brief duration and, to a certain extent, irregular amount of the effect. After lighting, the burners increase their effect to a certain point, and then soon rapidly diminish in the intensity of their light. When a large number of burners are to be used these difficulties become serious, and Professor Morton has therefore devised the following arrangement, which has proved, on trial, thoroughly efficient:—The burners to be used, varying in number from 5 to 30, in different experiments, are enclosed below in a box with a single large entrance, opposite to which is placed an atomiser, operated either by steam or compressed air. A spray of the colouring solution is thus mixed with the air supplying the burners, and their flames are thus tinged with the greatest ease, certainty, and intensity of effect, the whole action being entirely under control, and capable of being maintained indefinitely, while the change from one colour to another is effected by simply transferring the tube of the atomiser from one solution to another.

For experiments demanding diffused light this apparatus is most satisfactory. The author says that five large Bunsen burners, thus arranged, light up the lecture room of the Franklin Institute, which seats about 350 persons.

In certain experiments, however, it is necessary to have monochromatic light of great intensity and concentration. This can be furnished in the case of yellow light, to a certain extent, by substituting in the gas microscope or polariscope a soda-glass rod for the ordinary lime cylinder, and so adjusting its position that the rays from the heated glass should be cut off from the lenses, and only the light of the yellow flame should reach them. We can thus show, upon a screen 5 feet in diameter, the greatly increased number of rings developed by a section of Iceland spar in monochromatic light. With the spectroscope we can also project the sodium line on the screen so as to be well seen by an audience of 500 persons. By afterwards producing the absorption band due to the vapour of the substance, with the aid of a small Bunsen burner and iron spoon with sodium, and again showing the absorption-bands of nitric peroxide and of cochineal, the characteristic phenomena of spectrum analysis may be sufficiently illustrated, without the trouble and expense of the electric light.

A novel arrangement of stereoscope and slide has been brought out by Messrs. Warner and Murray, in which the inventors have taken advantage of an important feature in optics hitherto overlooked by all makers of the stereoscope, *viz.* that while the size of two pictures which can be united stereoscopically is limited in the *horizontal* direction by the fact that their centres must be as nearly as possible opposite the pupils of the eyes; in the *vertical* direction it is only limited by the angle of natural vision, which practically admits of the use of a picture nearly double as high as it can be wide. The aim of the inventors has been so to modify the mode of taking, and the instrument for viewing the stereograms, as to take advantage of this fact. Pictures adapted for the panoramic stereoscope have been taken by Mr. Harding Warner, of Ross, the well-known photographer. When taken from great heights and viewed in this instrument, the patentees state that the pictures represent objects in a better relative proportion to each other than when inspected in the old form of stereoscope. The instruments are manufactured in a variety of forms and of elegant designs, to meet the requirements of the pictures; and the latter are printed by the argento-carbon process, so as to ensure permanency.

M. Civiale has brought before the Société de Photographie some observations upon the employment of sulpho-cyanides in toning and fixing. He stated that in the summer of 1867 he fixed about 700 positive proofs by means of potassium and ammonium sulphocyanides. A print, one half of which had been protected from the light, the other unprotected, and which had been exposed for three months, showed only an uniform tint. This, however, only shows that this plan of fixing destroys the sensitiveness to light of the silver compound on the surface of the paper. It speaks nothing for or against the liability of the pictures to fade when exposed to darkness and damp.

Electricity.—Wiedemann and Franz have proved experimentally that the values obtained for the conducting power of metals and alloys, for heat and electricity, are identically the same. The truth of this statement was strikingly illustrated by Dr. Matthiessen in a lecture which he gave at one of the Friday Evening Meetings of the Royal Institution. Bars of gold and silver and some gold-silver alloys were fixed so that one end of all of them was in a hot-water box and the other end in the bulb of a small air-thermometer; the depression in the columns of the liquid in the tubes of the air-thermometers then indicated the relative conducting powers (approximately) of the several bars; and if through the tops of the columns of liquid a line be drawn, such line would form a curve similar to that referred to as obtained for the electric conducting power. That this is true was thus shown:—By the side of this apparatus was placed another of this construction. Into the bulbs of several air-thermometers were fixed wires of the same size and length, and of the same materials as were used in the heat-conducting experiment. One end of each wire was soldered to one thick copper wire, and the other end to another similar wire. These two wires were connected to the poles of a battery. The current would then divide itself, and a portion would pass through every wire proportional to the conducting power of that wire. This current heated the wire and caused the liquid in the tubes connected with the air-thermometers to descend, and the line drawn through the top of the columns was nearly similar to the curve already mentioned, which was formed by the bulbs in which the heat-conducting bars are fixed.

11. ZOOLOGY—ANIMAL MORPHOLOGY AND PHYSIOLOGY.

Morphology.

The Hair of different Races of Men.—M. Pruner-Bey has lately published two series of observations on the microscopic appearances of human hair in the different races. In five plates, he exhibits the forms of transverse sections of the hair in various people, and in many cases at different ages. Several of the more interesting races are represented by a considerable number of individuals, so that the characters of their hair have been established with great precision. Other isolated specimens belong to less known races, but M. Pruner-Bey has thought it advisable to include them for future comparison. He says a few words, especially in the first memoir, with reference to the characters of the hair which are visible to the naked eye. With respect to *colour*, he has established the fact that it is not always *black* in the negress. Besides a red colour, which is very exceptional, he has met with hair of an ashy tint in some cases. Among two hundred specimens of hair from natives of India, only one occurred of a straw colour, and even this might have been of foreign origin. The hair of every race south of the Himalayas is jet black; but in proportion as we ascend into the more elevated regions, a brown colour occurs more and more frequently. The differential characters of the hair of various races are found chiefly in the forms presented by transverse sections; such sections, moreover, afford an opportunity of determining not only the *form*, but also the *size* of the hair, a character which M. Pruner-Bey considers of the greatest importance. Amongst the races whose hair our author has examined are Arabs and Jews, Greeks, Brahmins, and Lithuanians, Fins, Esthonians, Samoyedes, Sicilians, Nigritoes, Australians, Malays, Polynesians, Americans, Chinese, Japanese, and an Ape. The Arian races show a regular oval outline in the transverse section of the hair, whilst the Semitic have a more or less angular outline.

Formation of Coral Reefs.—Dr. Carl Semper, who has resided some years in the Philippines and is a most accomplished naturalist, has brought forward some objections to Darwin's theory that atolls and barrier reefs imply the gradual sinking of a continent or island, whilst coast reefs necessitate an elevation of its shores. Darwin himself, with his true honesty, mentioned some difficulties to the theory, and Dr. Semper now quotes some observations of islands near the Philippines which certainly do not accord with Darwin's theory. He describes a horizontal surface of colossal dimensions, which could not possibly be formed during a depression which a few miles farther north had produced a channel of 70 fathoms in depth. He rather regards the physical influences, especially the internal sea-currents caused by the rain, and the exterior direct and diverted ones, as the cause which have produced in the north of this district atolls, and in the south the coast reefs, simultaneously with an *elevation*. Whilst in the south the deep-going eroding action of the wave-blow or the wash of the sea, has gradually planed away the dense and solid coralline limestone to a nearly horizontal surface, which lies at about the depth to which the sea-wash is capable of acting; in the north, the becks coming down from the mountains conjointly with the wash and currents of the sea, have acted much more strongly upon the soft readily decomposable basalt of the west, than was the case with the limestone of the south, and thus has arisen the apparently incompatible conditions of their respective coral growths.

A natural Hybrid-Barnacle.—Dr. Fritz Müller, of Desterro, in South America, one of the most able of Mr. Darwin's champions, recently directed his attention to the Barnacles occurring on that coast. He found a species of Sea-acorn (*Balanus*) which either attaches itself to, or becomes overgrown by various forms of sponge, and it was observed that the third pair of legs or cirri were equipped with numerous teeth, whence he terms it *B. armatus.* He describes a very remarkable grouping of different species of *Balani* on a rock, according to depth. The sensitiveness of these animals to luminous impressions is not, he says, dependent on the eyes discovered by Leidy. He took a large *Balanus tintinnabulum* living, out of its shell and separated it from the operculum, with which the eyes remained in connection. It lay in a saucer of water, with its cirri half unrolled. As often as the shadow of the hand fell upon it, it rolled up the cirri with a sudden movement. In *B. tintinnabulum* the eyes are very distinct; in *B. armatus* they have not yet been found. The most interesting observation of Dr. Müller's is, however, the existence of a natural hybrid between *B. armatus* and *B. assimilis* which he most minutely describes, and for the existence of which he satisfactorily accounts by the isolation of the respective parents. If, he says, we regard the species of a genus as descendants of a common primitive form, and at the same time, in accordance with the well-known experience of gardeners, regard their various peculiarities as so much better fixed, or so much less variable, the earlier they were acquired, the longer they have been inherited unchanged, it becomes intelligible that, above all, the characters proper to the primitive form persist; and consequently in the crossing of two species, these are more readily transferred to the hybrid than later-acquired peculiarities of the father or mother. From this point of view, Dr. Müller thinks we shall be able to explain many peculiarities of hybrids and, *vice versâ*, perhaps in many cases to trace from the form of the hybrids to the primitive form of the genus; the latter of course only with the greatest care, for the mere fact that the hybrids produced by males of one species with females of another, do not agree with those produced by males of the second species with females of the first, furnishes a proof that other circumstances aid in determining the form of the hybrids.

The Ancestry of Insects.—Dr. Anton Dohrn, of Jena, has lately described a new fossil insect, which he calls *Eugereon Bœckingi*, and which leads him to make some observations on the development of Insects by Natural selection. This Eugereon has characters intermediate between those of the Hemiptera and Neuroptera, and must, says Dr. Dohrn, be regarded as genetically related to the two orders. He does not think, however, that it was the common ancestor of these two groups, for the Neuroptera are found along side of it, but he believes that at a period not much earlier an insect form existed completely intermediate between the Neuroptera and Hemiptera, from which these two orders were differentiated and from which *Eugereon* also was descended, not having become so much modified. Dr. Dohrn then tells us of Haeckel's views (also a Jena professor) whose book we spoke of as most significant when it first appeared. Haeckel says that Insects, Spiders, Centipedes, and Crustacea must have had a common ancestor. The ancestral form of the Crustacea is known, appearing in their development as the Zoëæ. The ancient adult Zoëæ or Zoepoda, as Haeckel calls them, flourished early in the Silurian period according to that author, and it was probably about the Devonian epoch that certain Zoepods were naturally selected for a terrestrial life, developed tracheæ and became *Protracheata*, or progenitors of all the great Tracheiferous group of the articulate-limbed animals; whilst those which remained in the water are the ancestors of the Branchiferous forms called crabs, lobsters, and shrimps. Whether any Protracheatæ still exist is, says Haeckel, doubtful: perhaps the Solifugæ, a strange group of aberrant spiders, and also those insects which have no wings (not through disuse as in many cases, but by their progenitors never developing them) represent amongst to-day's fauna, the Protracheata of the past. Surely it is a pity that the Ray Society did not adopt the suggestion of Professor Newton, at Norwich, to translate so interesting and suggestive a work as that of Haeckel. Rash his speculations may be, but they are of high interest, of much use, and are, at least, noble efforts to grasp truth.

The Glass-Rope Sponge.—The turmoil caused by this beautiful organism among systematic zoologists has taken a new direction. Professor Lovén has described a sponge which he calls *Hyalonema boreale*—placing it thus in the same genus as the Glass-rope; and from the examination of this Boreal species he concludes that everyone else has studied the Japanese sponge upside down. The long glassy fibres are, he says, merely the remains of a long pedicle which was attached to a rock, and on which the mass of the sponge was supported. Dr. Gray protests against this inference. Lovén's species is not a *Hyalonema* at all, but merely a new and interesting pedicellate form, to which there are many similar species. The Rev. A. M. Norman has pointed out several of these, and has shown how their spiculæ differ *inter se*, and from those of Lovén's *Hyalonema boreale*, which is also very different in this respect from the true Japanese *Hyalonema*, or from the reputed Lusitanian species obtained off Portugal.

A Viviparous Echinoderm.—Dr. Ed. Grube describes an Echinoid from the Chinese Seas under the name of *Anochanus*, which actually produces young Echini, like itself, having spines, feet, and even pedicellariæ. These young, though having a general resemblance to the parent, are not quite the same in detail, and must undergo modification with growth. This discovery is of remarkable interest, for it adds one more to the many diverse methods of reproduction known among Echinoderms, and completes the parallel which they present to the Worms. We now know, in both groups, of animals laying eggs which produce embryos developing directly into the adult form; of others which present strange larval conditions which either become completely altered, so as to form the adults, or bud off from their interiors a small mass of living tissue which becomes the adult, leaving the larva to perish. We know, in both groups, of hermaphrodites and of diæcious species, and now we have added a viviparous form of Echinoderm, such as was previously observed in some Nemertian worms. We have yet to discover among the Echinoderms the various modifications of asexual reproduction, by pseudova, fission, or true parthenogenesis; the first two of which methods (especially fission) are so well known among worms.

Parasites of the Sea-cucumbers.—A large division of the Holothuridæ abound in parasites, and oddly enough all these parasites belong to groups in which parasitism is quite a rare exception. In the first place there are fishes which belong to the genus *Fierasfer*, these pass in through the water-tree, or lung, of the animal, they are true parasites, feeding within the Holothuria; then there are several small Crustacea; and thirdly, the Mollusc *Entoconcha*, described by Johann Müller, from Synapta. Dr. Carl Semper describes these in his work on the Echinoderms of the Philippine Islands, and also mentions a new *Entoconcha* which lives in a true sea-cucumber; he also describes parasitic species of *Eulima*; and most interesting of all, a little Lamellibranch which lives on the skin of Synapta, and crawls with a large membranous foot, whilst its shell is so much invested by the mantle as to be completely internal. An addition to the parasites of the Holothuroid Echinoderms was made last year by Mr. Ray Lankester, who discovered a very remarkable Rotifer in great abundance amongst the genitalia of the *Synapta Sarniensis* and *inhærens*, at Guernsey.

Physiology.

New Bodies discovered by the Spectroscope.—We would direct special attention to the very remarkable report of Dr. Thudichum, issued by the Medical Officer of the Privy Council in his last (tenth) Blue Book. Dr. Thudichum sketches in a masterly manner the history of past chemical researches into the functions and products of the human organism. He then describes some of his own researches, apparently carried out within the year, and which have yielded most extraordinary results. New bodies determined by their optical properties are described in this report at the rate of about three a page. This is rather rapid work, and does not leave a very satisfactory impression on the mind. Some most interesting fluorescent products from the chemical decomposition of blood, of albumen, and of urine are described, of which we are most anxious to hear or see more. The spectroscope used by Dr. Thudichum appears to have been an excellent one; but his method of examining only one thickness of a coloured body, has, we fear, led to some misapprehensions as to new bodies. Some of the spectra drawn as new are highly interesting and no doubt indicate new bodies, as, *e. g.*, cruentine and its products; but others are old and well known to all physiologists, though Dr. Thudichum "reports" them as though previously undiscovered. This is a bad sign, and coupled with the hasty appearance of the work does much to diminish the value of what seems otherwise likely to prove a very notable and grand addition to the knowledge of animal chemistry.

Quarterly List of Publications received for Review.

1. The Medical Profession and its Educational and Licensing Bodies. By E. D. Mapother, M.D., Professor of Anatomy and Physiology, Royal College of Surgeons of Ireland. 230 pp. Fcap. 8vo. *Fannin & Co.*

2. Medical Education and Medical Interests. By Isaac Ashe, A.B., M.B. 170 pp. Fcap 8vo. *Fannin & Co.*

3. On Aniline and its Derivatives: a Treatise on the Manufacture of Aniline and Aniline Colours. By M. Reimann, P.D., L.A.M. Edited by William Crookes, F.R.S. 180 pp. 8vo. *Longmans & Co.*

4. Reliquiæ Aquitanicæ. By Edouard Lartêt and Henry Christy. Parts VI. and VII.

5. Guide to the Goldfields of Nova Scotia. By A. Heatherington. 170 pp. Fcap. 8vo. *Trübner & Co.*

PAMPHLETS, PERIODICALS, AND PROCEEDINGS OF SOCIETIES.

Die Darwinsche Theorie und das Migrationsgesetz der Organismen. Von Moritz Wagner, München. *Williams & Norgate.*

Memoirs and Publications of the Geological Survey of India.

Contributions to the History of Development in Animals. I. On Fœtal Circulation. By William Macdonald, M.D., F.R.S.E., Professor of Civil and Natural History, Zoology, and Comparative Anatomy, St. Andrew's.

Report of the First Exhibition of the Aëronautical Society of Great Britain.

Dr. Walter's Doctrines of Life. 28 pp. 8vo.

On the Temperature of the Sea and its Influence on the Climate and Agriculture of the British Isles. By Nicholas Whitley, F.M.S.

Some of the Educational Aspects of State Medicine. By H. W. Rumsey, M.D., &c.

Correspondence on the Subject of Atmospheric Electricity.

On Geological Time. By James Croll.

On Harvesting Corn in Wet Weather. By W. A. Gibbs.
Bell & Daldy.

Hints on House Drainage. By Alfred Carpenter, M.D.

Proceedings of the Essex Institute, Salem, Moss.

Journal and Proceedings of the Academy of Natural Sciences, Philadelphia.

The London Student.

The American Naturalist.

Mineral Statistics of Victoria for 1867.

Journal of the Transactions of the Victoria Institute, or Philosophical Society of Great Britain. Vol. II., No. 7.

The Geological Magazine.

The American Naturalist.

The Westminster Review.

The Public Health.

Proceedings of the Royal Society.

" " Royal Institution.

" " Royal Astronomical Society.

" " Geological Society.

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London: Printed by W. CLOWES & SONS, Stamford Street and Charing Cross.

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