THURSDAY, OCTOBER 27, 1881

SCIENTIFIC WORTHIES

XVIII.—James Clerk Maxwell

Born June 13, 1831; *Died November* 5, 1879

WE have already (vol. xxi. pp. 43 and 317) said so much on the life and work of the late Prof. Clerk Maxwell, that in presenting his portrait as one of our Scientific Worthies, little more is necessary than to refer to the leading facts of his life. Born on June 13, 1831, he was the son of John Clerk Maxwell of Middlebie, a scion of a well-known Scottish family, the Clerks of Penicuick. When James was only eight years of age, he lost his mother, after which his father led a retired life, devoting himself to the care of his estates and of his son. The latter was educated in the first instance at the Edinburgh Academy, where in 1845 he gained the Academical Club Medal for Geometry, and the Silver Medal for Mathematics in 1847. A visit to William Nicol at this period was a marked event in his life, leading him, with apparatus of his own construction, to make observations on polarised light. A pair of prisms presented to him by Nicol were treasured by him throughout life, and three weeks before his death they were deposited in one of the show-cases of the Cavendish Laboratory.

After leaving the Academy, Maxwell, to quote the words of Prof. Tait (NATURE, vol. xxi. p. 317), "spent the years 1847-50 at the University of Edinburgh, without keeping the regular course for a degree. He was allowed to work during this period, without assistance or supervision, in the Laboratories of Natural Philosophy and of Chemistry: and he thus experimentally taught himself much which other men have to learn with great difficulty from lectures or books. His reading was very extensive. The records of the University Library show that he carried home for study, during these years, such books as Fourier's *Théorie de la Chaleur*, Monge's *Géométrie Descriptive*, Newton's *Optics*, Willis' *Principles of Mechanism*, Cauchy's *Calcul Différentiel*, Taylor's *Scientific Memoirs*, and others of a very high order. These were *read through*, not merely consulted." In October, 1850, Maxwell went to Cambridge, entering at Peterhouse. Soon after his entry at Peterhouse, however, in December, 1850, he migrated to Trinity, where he found spirits of tastes similar to his own in the matter of physical research; here he soon became a leader among his fellows. In 1854 he came out Second Wrangler, and was bracketed as First Smith's Prizeman. In 1855 Maxwell became a Fellow of Trinity, and in 1856 he obtained the Professorship of Natural Philosophy in Marischal College, Aberdeen. To quote the memoir by Mr. W. Garnett in NATURE, vol. xxi.:—"In 1858 he married Katherine, a daughter of Principal Dewar of Marischal College, thus vacating his fellowship at Trinity. In 1860 he succeeded Prof. Goodeve as Professor of Natural Philosophy and Astronomy in King's College, London, but after the death of his father he retired in 1865 to his estate in Scotland, where he subsequently carried out his father's plans for completing the house and offices at Glenlair. In 1871 he was invited by the Senate of the University of Cambridge to accept the Chair of Experimental Physics which had just been created, and on October 25, 1871, he delivered his inaugural lecture as Professor of Experimental Physics in the University of Cambridge. At first the most important part of his work consisted in arranging the details of the Cavendish Laboratory which the Duke of Devonshire had offered to present to the University, and the building of which was personally superintended by Prof. Maxwell from first to last. The whole of the arrangements which render the Cavendish Laboratory so admirably adapted for Physical investigations, are due to the care and forethought of Prof. Clerk Maxwell. When the building had been completed and formally presented to the University, the Duke of Devonshire further signified his desire to provide it with a complete equipment of apparatus, and all this was procured under the personal supervision of the Professor. In 1872 he was elected Honorary Fellow of Trinity College, Cambridge."

During the winter of 1878-9, Prof. Clerk Maxwell's health began to give way, and with some transient gleams of hope he gradually sank, dying on November 5, 1879. He received many honours during his lifetime; he was a Fellow of the Royal Society, LL.D. of Edinburgh, and D.C.L. of Oxford; Honorary Member of the American Academy of Arts and Sciences, the American Philosophical Society, and the New York Academy of Sciences; Corresponding Member of the Imperial Academy of Sciences, Vienna, and Associate of the Amsterdam Royal Academy of Sciences.

In 1860 the Rumford Medal of the Royal Society was awarded to Prof. Clerk Maxwell "for his Researches on the Composition of Colours, and other Optical papers." In his address on the presentation of the medal, Major-General Sabine alluded to Prof. Maxwell's calculation showing the connection of the "mechanical strains to which elastic solids are subjected under certain conditions with the coloured curves which those solids exhibit in polarised light."

To Clerk Maxwell's private character, to the position he unobtrusively took as a Christian, to his qualities as a poet and humorist, and to the varied work he has accomplished, it is scarcely necessary again to allude here; all these points will be found clearly brought out in the articles by Prof. Tait and Mr. Garnett above referred to. Nor is it necessary to repeat here the list of his principal papers and publications, and the great and important additions which Clerk Maxwell made to the sum of scientific knowledge, or the light he shed on the principles of the departments of science which he specially cultivated. Besides the references already given we would commend the reader who desires to have a fairly complete notion of the value of the work of the remarkable man whose portrait we give to-day, to the articles by Prof. Tait on Clerk Maxwell's "Electricity and Magnetism," vol. vii. p. 478, "Matter and Motion," vol. xvi. p. 119, and the numerous papers by Maxwell himself scattered through the volumes of NATURE.

DR. SIEMENS ON TECHNICAL EDUCATION

FEW can read the address of Dr. C. W. Siemens to the Midland Institute, which appears in another place in our columns (p. 619), without admitting that of all living men Dr. Siemens has the best right to speak upon the relations between scientific education and the scientific industries. Himself a product of the educational system of Germany, and one of the foremost, if not in his own line the foremost, of scientific men in the industrial world, and in the land of his adoption, he yet uses no unmeaning terms when he tells us that the particular form of technical education afforded by that characteristic institution, the German Polytechnicum, "is certainly inapplicable to the condition of things which we find in this country."

The argument with which Dr. Siemens enforces this view is, so far as we are aware, a novel one from the educational point of view. He assumes frankly and without disguise that in any industry which is, like the railway system of Germany or our own telegraphic system, a Government monopoly, there is essentially a tendency to discourage improvements or any thing savouring of novelty or innovation. He also assumes that the system of "polytechnic" education fosters a like tendency, inasmuch as he thinks that, as administered in Germany, this system turns out students destitute of originality, and dogmatically persuaded that the particular machines or processes they have studied in the Polytechnicum are embodiments of perfection proved and established like propositions in Euclid. From these two premises the inference logically follows that although the Polytechnicum may be all very well for turning out young men fitted for Government appointments in a country where railways, mines, and factories are State establishments, such an institution is inappropriate in a country like England.

There is doubtless much force in this position, though the contrast between industrial conditions in Germany and England is hardly fairly represented by so sweeping a generalisation. If in a land of strong tendencies toward monopolism and conservatism the system of technical education has taken a similar bias, we should be disposed to argue that a complete system of technical education would, in a country where industrial enterprise is freer, tend toward a freer development.

On the other hand, Dr. Siemens sees plainly the inherent badness of the condition of things in England, where technical education has so long been neglected. He condemns *in toto* the old system of binding a lad to an apprenticeship of seven years' drudgery and mechanical routine, causing him, as such a system does, to give up thinking altogether; and is in favour of a much shorter term of pupillage.

Though he is not very explicit on the point, it is not difficult to gather the general drift of Dr. Siemens' views as to what system he would adopt in preference to the method of the German Polytechnic Colleges. Firstly, he would have science-teaching systematically incorporated in the educational curriculum of every school in the manner in which we have for years advocated, and in which Sir John Lubbock and many others have advocated it. He would also have science taught by practical work in chemical, physical, and mechanical laboratories attached to the schools. In the case of the industrial classes he would have mathematics and natural science taught to all lads before the age of fourteen, and would fix that as the *minimum age* at which they should be admissible to work in mines or factories. Were this done, he thinks a three years' apprenticeship would be amply sufficient to learn any mechanical trade; and he would lay upon the employer the responsibility of seeing that during this term the apprentice spent his evenings and his Saturdays in diligent attendance at some technical or technological class where the principles underlying the operations of his business would be taught him.

We cannot too heartily endorse this last suggestion, which is now the more appropriate when not only in the metropolis but in all our chief towns and cities such classes for pure and applied science are being held under the auspices of the Science and Art Department and of the City and Guilds' Institute.

Another point on which Dr. Siemens speaks with weight is the importance of providing an adequate supply of trained teachers. Those who know the history of the attempts to render the teaching of the science classes under the Science and Art Department of greater efficiency, will heartily unite in the satisfaction expressed by Dr. Siemens concerning the reforms now in progress by which the Royal School of Mines and its associated science classes will be reorganised and developed into a Normal School of Science. The neglect and apathy of previous Governments have been indeed deplorable; but it is to be hoped that the greatest of the acknowledged defects of the national system of science-teaching are now in a fair way to be efficiently remedied.

Dr. Siemens points out that while laboratory work in schools is necessary it is comparatively inexpensive, being elementary in character. But for the efficient training not of teachers alone, but of students who have advanced beyond first principles, the delicate and elaborate appliances of exact science are more than ever essential: and for that reason "very complete laboratories are of great importance at the universities and superior colleges, where exact science and independent research take the place of mere tuition of first principles." We trust these words will not be lost in the places where they are most needed. When we look at the large and complete equipment of the mechanical, physical, and chemical laboratories of the colleges and universities to be found in every large town in Germany, France, and Switzerland, and compare them with the utterly shabby and insignificant dens which go by these names in the science colleges of Newcastle, Bristol, and Leeds, we feel that by no means the least important point of Dr. Siemens' discourse is the paragraph we have quoted above.

The concluding remarks, in which Dr. Siemens alluded to the Electrical Exhibition in Paris as pointing the moral of the inevitable changes and improvements which are continually invading every branch of industry cannot fail to impress many whose experience will confirm the truth of the observation. The plain fact remains that in the race of industrial improvements England cannot afford to stand still. And if the Continental nations have in some respects stolen a march upon us in these last years, it is not yet too late to organise and develop a system of technical education of our own adapted to our own special industrial conditions and needs.

RECENT ORNITHOLOGICAL WORKS

The Ornithological Works of Arthur, Ninth Marquis of Tweeddale, F.R.S., etc. Reprinted from the Originals by the desire of his Widow. Edited and Revised by his Nephew, Robert G. Wardlaw Ramsay, F.L.S., etc., Captain 74th Highlanders. Together with a Biographical Sketch of the Author, by William Howard Russell, LL.D. 4to. Pp. i-lxiv., 1-760. (London: For Private Circulation, 1881.)

Ornitologia della Papuasia e delle Molucche, di Tommaso Salvadori. Parte seconda. 1 vol. 4to. 706 pp. (Torino, 1881.)

THE very handsome volume, in which the works of the late Marquis of Tweeddale have now been collected and published, forms a fitting monument of the labours of one of the best ornithologists that this country has ever produced, and its utility to working naturalists cannot be doubted. No one who knew the author of these memoirs will be surprised at the new aspect which is thrown upon his life by the publication of the biographical sketch which Dr. Russell has contributed, though to scientific men Lord Tweeddale was chiefly known as a laborious ornithologist and a thoroughly sound writer and critic; but from the volume now before us we read the highest testimony to his qualities as a soldier, and receive evidence that the same thoroughness which characterised his scientific work was also prominent throughout the whole of his military career. His first ornithological paper appears to have been published in 1844, and was a carefully-written essay; and then for the space of twenty-two years nothing bearing on his favourite study appeared from his pen. His biography, however, shows that during this lapse of time he was completely occupied with his military duties, serving throughout the Sutlej campaign, and later on taking part with the Guards in the memorable Crimean War; and even at this distance of time it is refreshing to read the clear and vigorous criticisms which his keen perception enabled him to make at that period on the conduct of military affairs in the East. Retiring from active service in 1863, he appears to have from that time devoted himself to the pursuit of his favourite science, and until his death, in 1878, he worked with unflagging zeal at the ornithology of the Indian region, amassing one of the grandest collections of birds which has as yet been seen in any country, and forming a library unsurpassed for its completeness in ornithological literature.

To his nephew, Captain Wardlaw Ramsay, who has inherited his scientific tastes, the late Marquis bequeathed his magnificent library and collection, and the pious duty has devolved upon him of editing a complete edition of his uncle's memoirs, at the request of Lady Tweeddale, who has hereby raised a monument to her husband's memory which will keep the latter green in the minds of ornithologists for many a long year to come. Many of Lord Tweeddale's most important observations were contained in letters or short papers to various journals, and there was always a possibility of their being overlooked; but by the publication of the present volume, with its complete indices and cross-references supplied by the editor, there will be no such risk in future. Lord Tweeddale's life forms a pleasing picture of what an English nobleman can do for science, if only his intelligence leads him in that direction; and many who are living can remember with pleasure the days spent beneath the hospitable roof at Chislehurst, where Lord Tweeddale was always glad to welcome any scientific visitors, for his love for science took a deeper turn than the mere following of his own particular branch of ornithology, and he always displayed an interest in every branch of intellectual study.

The perusal of his many excellent essays only deepens the regret that was felt by every one at the time of his decease, that a life only in its prime, and capable of doing so much good in every way, should have been prematurely closed.

In our notice of the first volume of Prof. Salvadori's work (NATURE, vol. xxiii. p. 240) we gave some account of the scope and origin of this great undertaking, and of the extensive materials upon which the author had based it. It is with great pleasure that we now chronicle the issue of the second volume, and record the announcement that the third, which will complete the work, is far advanced in preparation.

It will be recollected that the rich collections made by the Italian travellers D'Albertis and Beccari during their several expeditions into New Guinea and the adjoining islands, all of which came under the examination of Prof. Salvadori, were the "moving cause" of the present undertaking. Besides amassing numerous minor novelties and whole series of little-known species, these industrious explorers were the original discoverers of four new birds-of-paradise, several new pigeons and parrots of splendid plumage, and the large and fine bird-of-prey named *Harpyopsis Novæ-Guineæ*. It was an obvious, though by no means light and easy task, to weave together the numerous papers and memoirs in which the different collections had been described into a uniform series, and to supplement it by summarising what was previously known of Papuan ornithology. This is what Prof. Salvadori has undertaken, and the result will be an excellent work upon a subject with which our previous acquaintance was of a very fragmentary description.

In his first volume, published in 1880, Prof. Salvadori treated of the *Accipitres*, *Psittaci*, and *Picariæ* of the Papuan sub-region. In the second volume now before us the numerous army of *Passeres* comes under consideration, and swells its size to 706 pages. The plan of treatment pursued is exactly the same as that which we have described in the case of the first volume. Every species is fully and fairly described, its complete synonymy is given, and a detailed list of the specimens examined from the various localities over which the species is spread is added.

It appears that the Royal Academy of Sciences of Turin, which published Prof. Salvadori's first volume as one of their "Memorie," have unfortunately not found it convenient to adopt the same course as regards the second. The author is therefore compelled to appeal to his brother ornithologists to subscribe for copies of the second and third volumes of his most meritorious work, in which we are sure he will receive every sort of support. Few special works of the present day have been so well planned, or so thoroughly carried into execution.

OUR BOOK SHELF

Deschanel's Natural Philosophy. Edited by Prof. J. D. Everett. Sixth edition. (Blackie and Son, 1882.)

PROF. EVERETT'S admirable adaptation of "Deschanel's Natural Philosophy" is so well known as a text-book, that it needs no commendation from us. We heartily welcome this sixth and greatly improved edition. Amongst the new items we notice that the chapter on thermodynamics has been amplified and re-written; and other parts of the book devoted to heat have also been improved, particularly those relating to the apparent minimum density of water, and to conduction of heat. We notice also a useful note on the mathematical treatment of the periodical variations of underground temperatures. The section dealing with electricity and magnetism has also been greatly improved. The elements of electric testing by Wheatstone's bridge and resistance coils are now included. The modern dynamo-electric machines and such recent inventions as the electric pen and the induction-balance are described. Rowland's experiments on electric convection-currents, and Planté's secondary battery are also mentioned; though it appears to us that by a slight slip of the pen in the paragraph dealing with Planté's researches his "rheostatic machine," which is in reality a compound condenser of mica plates, is described as a species of commutator (like that of Müller) for his secondary batteries. There is another slip in the paragraph on the use of the galvanometer for measuring transient currents, for it is stated that the quantity discharged through the galvanometer is proportional to the swing of the needle, whereas by the well-known balistic formula of Maxwell, it is proportional to the sine of half the angle of the first swing. These are however minor points. In the section on Light and Sound little has been changed; the more recent measurements of the velocity of light, and the phonograph, being the most important additions. It is a pity that in the optical formulæ the editor does not use the same notation as in the accepted Cambridge text-books. The problems, which in former editions were lumped together at the end of the book, are in this new edition placed at the ends of the separate volumes, a change which is a great boon to teachers and students who find it most convenient to buy the separate parts. Why the date of 1882 should be put upon a work which appears in October, 1881, is one of the mysteries of publishing which lies beyond the pale of scientific criticism.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Struggle of Parts in the Organism

As the Duke of Argyll does not appear to have quite understood the meaning which I intended to convey in the paragraph of my review to which he refers, I should like to state that meaning a little more explicitly. This I should have done in the first instance had I not shared the feeling which he expresses, that "a purely scientific journal" is not an appropriate place in which to discuss the relations of science to theology, and I shall now hope to show that in my review I did not transgress the border of any such debatable ground.

My remarks were limited to the "Argument from Design as elaborated by the natural theologians of the past generation," the material of which was furnished by "the endless number and complex variety of those apparently purposive adaptations of structures to functions which are everywhere to be met with in organic nature." By this limitation I intended every one conversant with the writings of these theologians to understand that I alluded only to the Argument from Design as this was expounded by the school of Paley, Bell, and Chalmers, and which amounted to inferring that particular instances of adaptation were so many separate pieces of evidence pointing to as many "operations of special design." This is the form of teleology which I conceive Mr. Darwin's writings to have completely "subverted," for these writings have shown that in natural selection we have a general law whose operation is presumably competent to produce most of the adaptations previously ascribed to special design. This form of teleology is what I called in my review "scientific teleology," and I did so because it embodied what is, in the full sense of the term, a scientific theory; certain definite facts or results were observed, and of these results the immediate cause was inferred. Therefore this endeavour to explain the causation of special mechanisms in organic nature properly admits of being discussed in the pages of a scientific periodical; it is as purely a scientific hypothesis as is that of natural selection.

But the Duke of Argyll clearly attaches to the term "design" a much wider signification than that which I expressly and intentionally assigned to it. For he uses the term in its most unlimited sense, and says: "There are many minds, including some of the most distinguished in science, who not only fail to see any contradiction between evolution and design, but who hold that the doctrine of evolution and the facts on which it is founded have supplied richer illustrations than were ever before accessible of the operation of design in nature," &c., &c.

Here and elsewhere the Duke clearly alludes to the whole question of Theism, or of Mind as the First Cause, and not to the narrower one of this or that particular mechanism in nature as the result of immediate and special design. Now teleology in this larger sense, or the doctrine that behind all the facts open to scientific inquiry (special mechanisms, physical causes, and general laws) there is "Mind and Will" as the ultimate cause of all things—teleology in this sense is a general theory of things which it does not fall within the scope of scientific method to examine. In contradistinction to the cruder teleology of Paley, which, as I have said, may properly be called "scientific," this may be called "metaphysical"—if we use these terms as they are used by Lewes to denote respectively a theory that is verifiable (or the reverse) and a theory that is not. The school of Paley thought that the existence of a designing Mind in nature could be proved by a purely inductive method; Mr. Darwin has since shown that such is not the case; therefore this system of teleology is a scientific system, and, like many other theories of the scientific class, it has had to yield to fuller knowledge. But there remains the metaphysical theory of an ultimate design pervading all nature and blending into one harmonious cosmos what the Duke calls the "combination and co-ordination of physical causes"; and this theory, I quite agree with him, "no possible amount of discovery concerning the physical causes of natural phenomena can affect," either by way of proof or of disproof. But this has nothing to do with the special question between Darwinism and "the argument from design as elaborated by the natural theologians of the past generation"; and therefore I shall not discuss the merits of the theory in these columns. GEORGE J. ROMANES

"The Micrococcus of Tubercle"

AN article on "Disease Germs," by Dr. W. B. Carpenter, in the current number of the *Nineteenth Century*, contains the following:—"Another line of inquiry which has obviously the most important bearing upon human welfare is the propagability of the micrococcus of tubercle by the milk of cows affected with tuberculosis, a question in regard to which some very striking facts have been brought before the Medical Congress by a promising young pathologist"—naming myself; and I hope that I am sufficiently grateful to a veteran in science for his complimentary if not altogether accurate reference to my work. What I did say at the recent Medical Congress, and at much greater length in a small volume entitled "Bovine Tuberculosis in Man" (London, 1881)—Dr. Carpenter will find it, I think, among his books—was not anything about "the micrococcus of tubercle," but about a variety of somewhat technical morphological details in respect to which certain cases of tuberculosis in man resembled the tuberculosis or "pearl disease" of the bovine species. I did indeed introduce half a page at the end of my essay to show how clear was the issue between my view of tuberculosis communicated from the cow and the view which Dr. Carpenter has been expounding, and I hope you will have room for the passage:—"The doctrine of a tuberculous virus was stated by Klebs in 1868, and has been advocated by him, as well as by Cohnheim, in recent writings. In its latest form this doctrine asserts the existence of a specific minute organism to whose agency the infection is due. The minute organism is called by Klebs *Monas tuberculosum*. The method of proof which I have followed in this work makes it impossible that the infective agency of a minute organism should in any way come into my view of the communication of bovine tuberculosis to man. I have rested the whole case upon certain minute identities of form and structure in the infected body, due to the mimicry of infection. Among other points there were the leaf-like and cord-like outgrowths of the pleura and peritoneum, these being the early stages of the lentil-like or pearl-like nodules and their connecting threads; the lymphatic glands, with distinct nodular formations in their substance; the lungs, with smooth-walled closed vomicæ or with encapsuled nodules. In the new formations generally there was a particular pattern of microscopic structure, in which giant-cells and epithelial-like cells figure largely, and there was a relatively high degree of vascularity. In all these points the disease in man is a mimicry of the parent disease in the bovine animal. That mimicry is not only in single features, but it is of the whole disease. It is possible to conceive of the juices and particles of the primarily diseased body acquiring a kind of spermatic virtue which gave them the power to communicate the specific disease as a whole and in all its several manifestations to another body in which they should happen to lodge. But it is hardly possible to think of a neutral living organism being charged with the power of conveying so complex details of form and structure from one body to another" ("Bovine Tuberculosis in Man," pp. 103, 4).

25, Savile Row, W., October 24 C. CREIGHTON

A Kinematical Theorem

PROF. MINCHIN's Theorem in NATURE (vol. xxiv. p. 557) may be proved easily by considering the motion as due to the rolling of one closed curve on another back into its first position, their lengths being of course commensurable. If you measure y for the rolling curve from the straight line which forms the envelope, and x along that line, then the differential of the area between the envelope and the fixed curve is easily seen to be $ydx + \frac{1}{2}y^2dw$, where dw is the angle turned through by the rolling curve, and is equal to ds multiplied by the sum of the curvatures at the point of contact, which we shall call σ. The summation of the former part is a multiple of the area of the rolling curve, and therefore the same for all lines; that of the latter is half the moment of inertia of matter distributed over its perimeter with density σ, about the line in question. The result is therefore the well-known property of equi-momental ellipses. Similar reasoning, with the use of the property of the centre of inertia of a system, leads to the further result that when the perimeter of the envelope is of constant length, the line touches a circle, and different values of the constant correspond to concentric circles. In the same way by a property of the centre of inertia we may also prove immediately the known theorem that when the area traced out by a point is constant, the point lies on a circle, and different values of the constant correspond to concentric circles; and we may extend it to areas traced on a sphere. JOSEPH LARMOR

54, Antrim Road, Belfast

IF Prof. Minchin will refer back to the *Bulletin des Sciences Mathématiques et Astronomiques* for August, 1878, he will, I think, find in a paper by M. Darboux the theorem stated by him under the above title in NATURE, vol. xxiv. p. 557.

C. LEUDESDORF

Pembroke College, Oxford, October 21

"The Dark Day"

REFERRING to the account of the phenomenon in New England on September 6 last (NATURE, vol. xxiv. p. 540), and in Mr. Harding's letter (p. 557), let me refer your readers to a succinct account of the occurrence on May 19, 1780, which they will find in Webster's Dictionary, "Explanatory and Pronouncing Vocabulary of the Noted Names of Fiction, &c." In *Public Opinion* (June 4, 1881) there is an account of a precisely similar occurrence on the morning of Sunday, November 8, 1819, known, it is remarked, as the "Phenomenon of 1819." The account of this phenomenon is very explicit, and the details furnished correspond so closely with the event of May 19, 1780, that a doubt might be felt whether there had been two such days, or whether there had not been some mistake made in regard to the date given. I wrote to *Public Opinion*, making inquiries (see *Public Opinion* of June 11, 1881, p. 755), but no reply has hitherto appeared to my inquiries. I may observe that the year 1819 would not coincide with any one of the sunspot cycle of eleven years from 1780 to which the New York *Nation* refers. A. TREVOR CRISPIN

6, Melbury Terrace, Harewood Square, N.W., October 22

OWENS COLLEGE SCIENCE AND LITERATURE FELLOWSHIPS

THE first award of these Fellowships, of the annual value of 100*l*. each, which are intended to encourage original investigation, was made on Friday last by the Council of the Owens College. These are remarkable as being the only fellowships given in any University or College in the United Kingdom solely for the encouragement of research. They are not awarded on the results of examination, but after consideration of documentary or other evidence. Every holder of a fellowship is expected to devote his time to the prosecution of some special study, and before the close of the year to give evidence of progress by the preparation of a thesis, the delivery of a lecture, or the completion of some research. He may also be called upon to render some service to the College either by acting as occasional examiner or by giving instruction by lectures or otherwise to the students.

Of the thirty candidates four gentlemen were elected to Fellowships. Of these one is awarded to Mr. Alfred Sidgwick, B.A. of Lincoln College, Oxford, in the Department of Logic; two were awarded in the Department of Chemistry, namely, one to Dr. Bohnslav Brauner, of the University of Prague, who has already published several papers on original subjects, some from the laboratory of the Owens College; and a second to Mr. Harry Baker, Dalton Chemical Scholar of the College, who has likewise published several papers in the *Journal* of the Chemical Society. These two gentlemen will continue their researches, devoting the whole of their time to original investigation. In the Department of Biology an award has been made to Mr. H. Marshall Ward, B.A., F.L.S., of Christ College, Cambridge, at one time a demonstrator in the Owens College, who has recently distinguished himself as Government cryptogamist in Ceylon, in an investigation of the cause of the coffee disease.

THE AGE OF THE IGNEOUS ROCKS OF ICELAND

DURING a recent visit to the south-west part of Iceland, one or two points connected with the general geological structure of the island came under my observation, which I do not remember to have seen noticed before, and which seem to me to be of sufficient interest to be put on record. It is well known that the rocks of the island are of very different ages, some going back to the Miocene period, while others are quite of yesterday's date. It is also perhaps a general belief that the volcanic forces may have continued to be more or less active from the time that the older Miocene basalts and tuffs were erupted down to our own day. I doubt very much whether there is any evidence to justify this conclusion, and will presently mention some of the facts which lead to a very strong suspicion that a prolonged period of repose supervened after the accumulation of the Miocene rocks, and before the eruption of the later lavas, &c., had begun. The Miocene group consists of a vast series of basalt-rocks with interbedded layers of palagonitic tuff, &c. These rocks, so far as my observations go, exactly resemble those of the Færöe Islands. The basalt-rocks are chiefly anamesites, but some are true basalts, while others are dolerites. But in the areas traversed by me I saw none so coarse-grained or so highly porphyritic as those which occur so abundantly in Stromöe, Österöe, and other islands of the Færöes. They form lofty plateaux, deeply gashed with gorges, and abruptly truncated, so as to present bold cliffs and precipices to the low grounds at their base, as in the case of the Esja near Reykjavik. Moreover, they appear to be developed chiefly in the maritime districts. Only a glance at these basaltic masses is needed to convince one that they are the mere fragments of what must once have been a most extensive plateau. The Esja, built up chiefly of comparatively horizontal beds of basalt, tuff, &c., rises to a height of nearly 3000 feet above the low tracts at its base. Nor can there be any doubt that these beds formerly stretched far away in all directions, and that they have since been removed by the various agents of denudation from the broad undulating low grounds, over which they may still be traced, sometimes continuously for many miles, at other times in sporadic hills and rising grounds which peer above the surface of the recent lavas by which they are surrounded. In short, the Miocene basalt-rocks of Iceland present precisely the same features as the similar rock-masses of the Færöes. Like the latter they probably formed at one time a wide elevated table-land, which has since been cut down and worn away—the lofty walls of the Esja, &c., serving to give us some idea of the enormous erosion that has taken place. Now all this vast erosion had been effected before any of the later lavas, agglomerates, tuffs, &c., in the south-west part of Iceland were erupted. In the region between Hafnarfjörd and Krísuvík the lavas have poured through old valleys in the Miocene rocks and spread themselves out over the highly denuded surface of the latter in the opener low grounds. In a word, it is evident that in the south-west part of Iceland a long interval separates the accumulation of the Miocene basalt-series from the eruption of the later volcanic rocks, and I incline to think that the same break in the continuity of volcanic action will be found to hold true for the rest of the island. I believe it will be found that there is no more connection between the display of volcanic activity in Miocene times and that of the present day in Iceland, than there appears to have been between the volcanic action which manifested itself in Scotland at such widely separated periods as those of the Lower Old Red Sandstone and the Carboniferous. Had there been more or less continuous volcanic activity in Iceland from Miocene times down to the present, we might well be surprised that the later volcanic masses are not much more considerable than they are. If we think of the time required for the removal by denudation of some 3000 feet of basalt-rocks, &c., over thousands of square miles, we must be prepared to admit that the volcanic forces cannot have been continuously active. Either they have not been so, or the denuding agents have far surpassed them in energy.

There is another point which interested me. I found that the whole of the south-west region had been glaciated before the eruption of the later volcanic series. The Miocene basalts are everywhere ice-worn and abraded; *roches moutonnées* are well-marked, and in many places glacial ruts and striæ are conspicuous. Glacial gravels and coarse boulder-clay are likewise sprinkled over the surface of the low-lying tracts. Between Reykjavik and Hafnarfjörd the glaciation is distinctly from south-east to north-west, and could not have been the result of any mere local glacier. The whole wide tract has been overflowed by a general *mer de glace*. And if this be the case with that part of Iceland which now enjoys the mildest climate, we may be sure that the rest of the island must likewise have been enveloped in ice during the Glacial period. In the south-west region all the traces of glaciation are strictly confined to the Miocene areas. Nothing of the kind is visible upon any of the later volcanic rocks. These last have flowed over a glaciated surface, for the ice-worn Miocene basalts terminate abruptly at the margins of the wide sheets of black scoriaceous lava, as do also the drift-accumulations of glacial gravels and erratics, while now and again ice-worn knolls of basalt-rock may be seen rising up like islands in the midst of the later lava-fields. Everywhere the lavas and their associated agglomerates and tuffs show their original surfaces—the only changes which they have undergone being the result of subaërial weathering. In a word, all the post-Miocene eruptions of the south-west are of later date than the Glacial period. It would be interesting to ascertain whether the same is the case throughout Iceland. As there is every probability that the great break in the continuity of volcanic action, of which I have spoken, is not confined to the south-west, but may hold true of the whole island, it seems not unlikely that the conclusions I have formed as to the post-Glacial age of the later volcanic series of the south-west will also be extended to the same series in other districts. In other words, we may yet be compelled to admit that the oldest eruptions of Hecla and her sisters are not only of vastly more recent age than any of the Miocene basalt-rocks, but belong to one of the latest epochs of which geology takes cognisance. JAMES GEIKIE

THE EVOLUTION OF THE PALÆOZOIC VEGETATION

SOME statements made in Mr. Starkie Gardner's abstract (NATURE, vol. xxiv. p. 558) of the recent work of Saporta and Marion "On the Evolution of the Cryptogams" are so opposed to conclusions at which I have arrived that I can scarcely allow them to pass unchallenged, lest by doing so it may be inferred that I no longer oppose the French school of Carboniferous palæo-botanists on several vital points connected with the interpretation of the Carboniferous flora. But before doing so I may venture to suggest a doubt whether the time has yet arrived for making the attempt to trace the lines of descent of the Palæozoic flora. It is true that much has been done of late years to extend our knowledge of that flora, but perhaps at the same period our knowledge of the extent of our ignorance has, *pari passu*, been equally enlarged. We now possess accurate information respecting the structure of many well-known plants, but we have also obtained glimpses of the existence of many obscure but very important organisms which represent factors that cannot be left out of consideration in dealing with the problem of their evolution. Besides this, opinions of experts are widely divergent on some very important questions of interpretation affecting the relationship of conspicuous plants whose organisation is understood. So long as experienced palæontologists are disagreed on the relations of the Calamites to the Calamodendra, and of the Lepidodendra to the Sigillariæ, a scheme of evolution explaining the development of the Carboniferous flora can scarcely be possible. The French school of botanists still believe that what they call Calamites are Equisetaceous Cryptogams, whilst the Calamodendra are Gymnospermous Phanerogams. In like manner they believe the Lepidodendra to be Cryptogams, and as such to be devoid of all exogenous growths in the exterior of their stems, whilst they regard all the Lepidodendroid stems that possess such growths as Sigillariæ, and relegate them also to the Gymnospermic section of the vegetable kingdom. I am more than ever convinced that these views cannot be sustained, and I think that my memoirs on these subjects, especially Parts IX. and XI., contain a sufficiently abundant array of detailed facts to justify the conclusions at which I have arrived.

But even were this not the case, there are other important considerations that cannot be overlooked. As I have already hinted, we have become acquainted with a large number of curious organisms, many of which are unmistakably reproductive, but respecting the botanical affinities of which we are as yet entirely ignorant. New forms present themselves in a more rapid ratio than discoveries are made of the true character of older ones. Yet many of these objects are so remarkable that they must have constituted very important links in the chain of Palæozoic life; and until we learn more about them than we at present know, we cannot possibly assign to them their true place in that chain; whilst their omission must leave serious gaps in the succession.

But our difficulties do not end here. All the objects to which I have just referred have been discovered but recently. Ten years ago we knew nothing of their existence, and new forms are still being added to our cabinets. The old fossiliferous shales and sandstones revealed no traces of them. We only found them when the microscope came to be applied to the calciferous nodules of Oldham and Halifax. Our first supply of special types was derived from the former locality. The examination of the Halifax nodules revealed the existence of several new forms, though obtained from the same geological horizon and from localities but a few miles apart. Arran and Burntisland have, in like manner, contributed types wholly unknown in Yorkshire and Lancashire, and the French localities of Autun and St. Étienne (where also are found Carboniferous plants of which all the structure is preserved) have each their own characteristic forms.[1] We thus learn that so far as these six special localities are concerned, whilst certain common features characterise their floras, each locality has, as in living floras, genera or species peculiar to itself. Now we chiefly know the full extent of the localisation of these six Carboniferous floras from their accidental preservation in calcified or siliceous deposits, and not from the revelations of the ordinary fossiliferous shales and sandstones. But we cannot suppose that the six localities enumerated are the only ones that possessed floras peculiar to themselves. Does not common reasoning justify the suggestion that all Carboniferous plant-bearing localities would exhibit similar features, had their fossils been preserved as they are at Halifax or at St. Étienne? If so, seeing how widely Carboniferous deposits are diffused throughout the world, what myriads of minute, but phytogenetically important forms of plant-life must have existed of which we are absolutely ignorant—an ignorance that can only be diminished by the discovery of other localities as productive as the six that I have enumerated.

But even were we perfectly acquainted with the Carboniferous flora, we should not be much nearer the end. Beyond the fact, established by Dr. Dawson, that in the Devonian age a flora existed almost, if not wholly, as rich as the Carboniferous one, a flora in which Gymnosperms existed with as high an organisation as characterised the similar Carboniferous types, what do we know respecting the minuter forms of this flora, which correspond to those which I have described from the Coal-measures? But can it be doubted that such objects must have existed in abundance? Still less can it be supposed that so rich and highly organised a flora as that of the Devonian age first sprang into existence during that age. That flora must have been preceded by one rich in types of a lower terrestrial vegetation than is represented by the ferns—the Lycopods and the Dadoxylons of the Devonian beds of North America. But what do we know of this earlier flora? Almost nothing. The remains of pre-Devonian plants now known are so obscure that little reliance can be placed upon them. Eophyton is rejected from the vegetable kingdom by Nathorst, and most of the other so-called Fucoids of the Palæozoic strata are of almost equally dubious nature. Where more definite forms of what may probably be Marine Algæ do occur they come too late in time to avail in the construction of the Palæozoic pedigree. Even the Liassic *Chondraites bellensis* of the Lias cannot be depended upon with absolute certainty. It is only when we reach the Tertiary age that we find the Delesseriæ and Halymenites in shapes that leave little room for doubting their true nature. Yet our French friends trust to these dubious objects as being real Fucoids, and as such, the ancestral predecessors of the higher Cryptogams of the Devonian and Carboniferous ages. So long as this ignorance and uncertainty remain, it seems to me that we cannot construct, with any degree of probability, the genealogical tree of Palæozoic plant life.

As to the many detailed conclusions arrived at by MM. Saporta and Marion, I will only refer to two or three statements in addition to the more important ones to which I have already called attention. Thus Mr. Gardner's abstract states that "eight still existing Diatoms have been discovered in British Coal." I thought that I had thoroughly exploded that fallacy in my Memoir, Part X. MM. Saporta and Marion conclude that Asterophyllites was a floating or procumbent plant allied to the Equisetaceæ, thus following M. Renault in separating it from Sphenophyllum, which the authors believe to be a Rhizocarp allied to Salvinia. I see no ground whatever for these conclusions. They further consider that some of his Calamariæ (Equisetaceæ) were heterosporous. They arrive at this conclusion from my discovery that *Calamostachys Binneana*, which I believe to be a fruit of an Asterophyllitean plant, was a heterosporous Strobilus; but I wholly demur to the idea that either the plant or the fruit was Equisetaceous.

For the reasons above given, I doubt whether even my valued friend the Marquess Saporta, highly accomplished as I know him to be, will be able to "make clear the precise lines through which the evolution of the one from the other [*i.e.* the Phanerogams from the Cryptogams] has been accomplished." WM. C. WILLIAMSON

Owens College, Manchester, October 14

[1] I believe that this fact partly explains the unwillingness of the French palæontologists to accept our English views as to the close affinities existing between the Lepidodendra and the Sigillariæ. The peculiar Diploxyloid forms of Lepidodendron, *i.e.* those which possess the outer exogenous zone which the French botanists regard as characteristic of a Sigillarian stem, appear to be absent from the beds of Autun and St. Étienne, as they are rare in Canada and the United States. In Great Britain, on the other hand, they constitute, with several variations of specific details, our prevailing type.

THE INTERNATIONAL EXHIBITION AND CONGRESS OF ELECTRICITY AT PARIS[1]

V.

THE labours of the jury are now finished, and the distribution of medals took place on October 21 at the Conservatoire des Arts et Métiers. It is understood that they have been somewhat liberal in their distribution of honours, and have endeavoured to make things pleasant all round. Indeed the time allotted to them for investigation being postponed for a week at the beginning, and afterwards cut short by a week at the end, was quite insufficient to settle the burning question which is the best of all the electric lights.

The diploma of honour (*diplôme d'honneur*), which is the highest award of all, has been voted to Dr. Werner Siemens, Sir William Thomson, Mr. Edison, M. Gramme, Prof. Graham Bell, Prof. Hughes, Prof. Pacinotti, Prof. Bjerknes, M. Gaston Planté, M. Baudot, and M. Marcel Deprez, the last-named being the inventor of a system of distribution of electricity which has found much favour in Paris. M. Baudot is the inventor of a multiple printing-telegraph. The Exhibition has been announced to close on November 15, but there is some talk of a later date.

[1] Continued from p. 589

During the last week a body calling itself the Réunion International des Électriciens has been holding meetings in a room granted for the purpose in the Exhibition building. It is understood to be mainly composed of persons who felt slighted at not being appointed members of the Congress, and are determined to have a little congress of their own; but their movements have not attracted much public attention.

As this will be our last article, we will endeavour to supplement our previous accounts by some information on what must be regarded as the most important of all the objects in the Exhibition, namely, the machines which generate the electricity. Those which have permanent steel magnets are few in number, and the only large ones are the machines of De Meritens. These usually give alternating currents, but can be made to give direct currents by a change in the connections. The principal type contains five Gramme rings mounted on the same axis, each of them surrounded by eight horseshoe steel magnets with their feet inward. The introduction of the Gramme ring is the chief difference between this machine and the old lighthouse machine of Holmes. The great bulk of the machines in the Exhibition are dynamos, in which the whole current produced passes through the coils of the field magnets, and a large proportion of them are of the Gramme type, generally with one pair of straight massive field magnets arranged in one line above the ring, with a pair of like poles near together close to the ring, and with another similar pair below of opposite polarity to the first pair. The ring thus revolves between two very strong poles outside it, and massive iron pole pieces are usually employed, so shaped as to embrace a considerable arc of the ring. These are the machines for direct current. In the alternating current Grammes, the ring is generally broadened out into a hollow cylinder whose length is as great as its diameter. Sometimes this revolves between four external pole pieces attached to electro-magnets, and sometimes it is fixed, while four broad electro-magnets radiating from the common axis revolve within it. In some examples a separate exciter giving a direct current is mounted on the same stand and on the same axis.

The three firms of Siemens at Berlin, Paris, and London have a very large and diversified collection, partly historical, partly representing the commercial demands of the present day, and partly embodying their latest ideas for future improvement. The prevailing pattern is the well-known Siemens direct acting machine, in which an armature in the form of a cylinder, about three times as long as it is broad, rotates between two sets of pole-pieces, one above and the other below, of opposite polarity produced by the action of four straight flat and massive electro-magnets. The coil of the armature is wound, as nearly as the presence of the axle permits, in planes containing the axis, so that the wires cross one another at all angles at the two ends.

The most remarkable novelty that struck us in going over their collection was a machine in which two armatures consisting of cylindrical iron cores, each inclosed between four longitudinal segments of copper, revolve within two hollow cylinders of iron, which are the poles of a composite magnet, so that each armature is surrounded by a pole of one name, while opposite polarity is induced in the outer part of the iron core. The lines of force thus radiate from the common axis with complete symmetry, and the longitudinal coppers cut these lines at right angles in every position, so that the electromotive force in each copper remains constant as the armature revolves.

A peculiar adaptation of the ordinary Siemens armature has been made by Mr. Edison. The conducting portion of his armature consists of bars and disks. The bars form the outside of the cylinder, and the disks, with mica between for insulation, are built up into two solid masses which form the ends. The intervening portion is occupied by the core, which consists of a thousand or more very thin disks of iron separated by silk paper. The course of the current is nearly the same as in a Siemens armature, being first along a bar, then across a disk, then back along an opposite bar, then across another disk, and so on. The ends of the bars are disposed along two helical curves at the two ends of the cylinder, each helix having two convolutions. The object of having such excessively thin iron plates is to promote rapid demagnetisation and to avoid the formation of induced currents in the iron. This monster machine has only recently arrived, and is not yet ready for action. Its armature (to which, as well as to that of a smaller machine, the above description applies) is about four feet long by two in diameter. It has two straight and very long field magnets, which are actuated by a branch of the main current of the machine.

A very common pattern of machine for alternating currents, which one sees under various names, has a number of flattish cylindrical coils disposed in circular fashion like the holes of a siren, and revolving in siren fashion between pairs of fixed cylindrical field magnets of more massive appearance, the number of pairs of these fixed magnets being equal to the number of revolving armatures.

There are also some direct current machines of this construction. They can be distinguished by having a commutator of many segments on which the brushes rub to collect the currents, while the alternating machines give off their currents from two insulated rings which are not divided in any way.

Last Saturday evening there was a special gala at the Opera House in honour of the Electrical Congress, admission being by presentation ticket. In addition to the ordinary operatic performances there was a somewhat stilted poem in celebration of the achievements of electricity, which was read between two of the pieces by an eminent comedian; and the whole performance wound up with a grand chorus calling on the earth to light itself up. Preparations had been made for illuminating the house by electricity, but they were far from complete, and gas was decidedly in the ascendant. The place where the telephonic transmitters are bestowed was easily recognised, there being a wooden screen about ten inches high and six feet long on each side of the prompter's box.

We stated in a previous letter that a committee of jurors had undertaken some quantitative experiments on the machines and lamps. These are still going on, and will probably be continued till the Exhibition closes.

The chief practical result of the Congress has been the agreement to adopt the British Association system of units, and we understand that Prof. Everett's book, which is the recognised exposition of this system, will be immediately translated into French, German, and Italian.

THE IRON AND STEEL INSTITUTE

ONE of the most interesting features connected with the recent meeting of the Iron and Steel Institute was the fact that the Arsenal authorities abandoned at last the official reserve which has so long been complained of, and descended into the arena of professional discussion by reading papers on the manufacture of ordnance, projectiles, small arms, and gun-carriages, and submitting them to public criticism. We must specially congratulate Col. Maitland, the present distinguished head of Woolwich Arsenal, on having had the courage to take this step. His paper on the Metallurgy and Manufacture of Modern British Ordnance was extremely interesting. Its production also was well timed, coming at a period when the confidence of the public was considerably shaken in the management of the Royal Arsenal, by the bursting of the *Thunderer's* 38-ton gun. Col. Maitland reviews in succession the early history of Steel *versus* Iron, the successive improvements in the manufacture of gunpowder, the processes of the manufacture of the iron and steel, the building up of the gun, and the boring and rifling of the barrel. The paper concludes with a description of some of the special tools and furnaces in use at the Arsenal. As regards the question of powder, it is satisfactory to find from an official utterance that the problem of the proper action of gunpowder is at last thoroughly understood. On this point the author states, "With the large slow-burning powders now used, long heavy shell move quietly off under the impulse of a gradual evolution of gas, the pressure of which continues to increase till the projectile has moved a foot or more; then ensues a contest between the increasing volume of gas, tending to raise the pressure, and the growing space behind the advancing shot tending to relieve it. As artillery science progresses, so does the duration of this contest extend further along the bore of the gun towards the great desideratum, a low maximum pressure long sustained." To this last sentence we call particular attention, for in the attainment of this object by our powder manufacturers lies the whole possible development of the power of artillery. When the author uses the words *low* maximum pressure, we take it that the expression must be understood in a relative sense only, and that the maximum pressure should not be high as compared with the mean; what is in reality the great desideratum is as high a maximum pressure as is consistent with the strength of the gun, sustained throughout the entire length of the bore. How far this object is from being attained at present can be seen at a glance from the shape of even the most modern heavy gun, which is very thick at the breech and dwindles down to almost nothing at the muzzle, showing that the pressures at the breech are still far from being sufficiently sustained. The problem here is more one for powder-makers than artillerists. The latter can but indicate what is wanted. It seems from *à priori* grounds impossible to expect that the solid pebble powder now in use, burning as it does from the surface to the centre, can ever give off the increasing volumes of gas wanted in order to fill up the spaces behind the advancing projectile, and thus maintain the pressure. It is, we believe, no secret that the results attained with our home-made powders are inferior to those furnished by the perforated prismatic powders made in Germany and Russia.

In dealing with pure metallurgical processes Col. Maitland made a great mistake in not making himself acquainted beforehand with the name of the inventor of the process of making steel adopted at the Royal Arsenal. Nearly two pages of the paper are taken up with a description of the process invented by Dr. Siemens, which is described in detail without any reference to that distinguished engineer, so much so that any uninitiated person reading the paper would have inferred that the process was peculiar to the Royal Arsenal. It is true that in the discussion which followed Col. Maitland disclaimed any originality for the Royal Arsenal, but it seems, to say the least of it, curious that he should have occupied so much space in describing a process which was perfectly familiar to everybody in the audience, had he been aware that it was in use in every civilised steel-producing country in the world. Of course this line of conduct compelled Dr. Siemens to speak in his own defence, and the stories which he told of the conduct of the Royal Arsenal authorities towards himself ought to have been sufficient to make Col. Maitland ashamed of some of his own predecessors in office, or of their immediate superiors in Pall Mall. Not only has the Siemens open hearth process of steel manufacture been appropriated without thanks or even acknowledgment, but on a former occasion they endeavoured to imitate his regenerative furnace without his cognisance, by employing a former draughtsman in his office. The furnace failed, having cost the country some thousands of pounds, and then, and not till then, was Dr. Siemens' help called in. It is really time that the Government claim to appropriate all patents without consulting or rewarding the owners should be inquired into, for the present policy cannot even be commended on the score of economy, for in the case in point the blundering of inexperienced engineers cost the country far more than the few hundred pounds of royalty which would have been due to Dr. Siemens.

We are glad to infer from this paper that there is some hope that wrought iron will shortly be entirely superseded by steel in the manufacture of ordnance. Really the caution in this matter which has been hitherto observed at Woolwich exceeds the bounds of prudence and sense. For years past the most eminent metallurgists and users of steel in every branch of manufacture have over and over again declared publicly that steel is in every respect, including ductility and toughness, vastly superior to iron, but we still find at Woolwich Arsenal that wrought iron is used for all the coils of a gun. All that Col. Maitland can bring himself to say on this point is, "but now that the pressures" (of the powder) "are longer sustained, it becomes advantageous to thicken the inner tube of steel, and it will most likely be found beneficial to support it with steel in place of wrought iron." We welcome the conclusion, though we fail altogether to appreciate the soundness of the reasoning which has led up to it; for if it is advantageous now when pressures are weak to use the stronger and tougher material, it must have been doubly so when the internal strains generated by the powder were greater than at present. The remainder of this paper calls for no special comment. It is undoubtedly interesting as an official statement, but in style it seems to us to betray the fact that the author is dealing with information which he has only recently acquired; otherwise how does he betray himself when addressing an audience composed exclusively of technical men into dwelling with minuteness on such trivial details as, for instance, the use of soap and water as a lubricant for cutting tools, in place of oil? Surely he ought to be aware that the same practice obtains in nearly every workshop in the country.

Of the remaining papers read before the Institute, one by the Assistant-Superintendent of the Enfield Small Arms Factory was a mere chronicle of the various details of the manufacture and inspection of Martini-Henry rifles and bayonets. Another, by Mr. Butter of the Royal Arsenal, was a short account of the application of steel and iron to the manufacture of gun carriages and slides. The last paper which we shall notice was by M. Ferdinand Gautier of Paris, on the Application of Solid Steel to the Manufacture of Ordnance and Small Arms. M. Gautier had already communicated two papers to the Institute on the remarkable Steel Castings of the Terre Noire Company. The peculiarity of the castings of this Company is their freedom from blow-holes, which is attributed to the rather considerable percentage of silicate of manganese used in the manufacture.

At Bofors, in Sweden, the same process is used with perfect success in the production of steel barrels for artillery.

The following analysis is given of the material produced:—

Carbon	Silicon	Manganese	Sulphur	Phosph.
0·45 ...	0·351 ...	0·540 ...	Traces ...	0·042
0·40 ...	0·322 ...	0·612 ...	0·02 ...	0·045
0·50 ...	0·183 ...	0·360 ...	0·02 ...	0·040

The tests of this steel, both ordinary tensile tests and in guns, when fired with heavy proof charges, are stated to have given most satisfactory results.

NOTES

ON Monday a preliminary meeting was held in the Mansion House in furtherance of the scheme of the International Electrical Exhibition which it is proposed to hold at the Crystal Palace on a very large scale in the winter months. There were present, among others, Mr. William Spottiswoode, Mr. John Holms, M.P. (one of the Lords of the Treasury), Mr. Mungo M'George (Chairman of the Crystal Palace Company), Capt. Douglas Galton, C.B., Dr. Gladstone, F.R.S., Col. Gouraud, Dr. J. Hopkinson, F.R.S., Mr. C. V. Walker, F.R.S., and many more. Mr. Mungo M'George, in moving the appointment of an influential honorary council to advise with the directors of the Crystal Palace in carrying out the proposed exhibition, said that no effort should be wanting on their part to make the scheme a great scientific and commercial success. The honorary council was formed of those present, and, among others, the Lord Mayor Elect, the President of the Institute of Civil Engineers, Dr. C. W. Siemens, Prof. Adams, Sir H. Cole, Prof. Fleeming Jenkin, Mr. W. Crookes, Sir E. J. Reed, M.P., Sir Edward Watkin, M.P., Sir Herbert Sandford, and many more. Major Flood Page, the manager of the Crystal Palace, read a report, which stated that communications have been opened with the leading exhibitors at the Electrical Exhibition in Paris, and with others who have made the development of electricity their special study; and, although but a very short period has elapsed since the first steps were taken, the responses have been such as to render it certain that an effective and varied display will be made at the Crystal Palace. Most of the best-known systems of electric lighting will be represented—among others, the Siemens, Brush, British Electric, Electric Light and Power Generator Company's systems, the Joel, Pilsen, Edison, Swan, Maxim, Weston, Lontin, Rapieff, and Gerard lights; and various new lamps will be exhibited for the first time in public. The storage of electricity will, it is hoped, be illustrated by Faure's and De Meritens' secondary batteries. Telephones, which are not nearly so much used in England as elsewhere, will be strongly represented; and the various applications of electricity as a motive power will be seen in Trouvé's boats and other interesting exhibits. Many eminent scientific men have expressed great interest in the undertaking, and intend to become exhibitors. Colonel Gouraud promised all the help of his fellow-countrymen towards the success of the Exhibition, which, though following that at Paris very sharply, might be more attractive to American exhibitors, for it would be one stage nearer home, and its arrangements would be conducted in a language which the exhibitors could understand. Capt. Galton expressed a hope that military and submarine electricity would be suitably and adequately represented on the occasion. Sir James Anderson also supported the proposal, which was carried unanimously. Major Flood Page then read a *résumé* of the arrangements for the exhibition, which stated that the principal objects to be admitted were comprised in the following:—Apparatus used for the production and transmission of electricity; magnets, natural and artificial; mariners' compasses; applications of electricity—to telegraphy and the transmission of sounds, to the production of heat, to lighting and the production of light, to the service of lighthouses and signals, to apparatus giving warning, to mines, railways, and navigation, to military art, to fine arts, to galvano-plastic, electro-chemistry, and to chemical arts, to the production and transmission of motive power, to mechanical arts and horology, to medicine and surgery, to astronomy, meteorology, geodesy, to agriculture (in its application to industries), to apparatus for registering, to domestic uses, lightning conductors. Major Page earnestly hoped that Mr. Fawcett would allow the Post Office exhibit at Paris to be shown at the Crystal Palace, and that Mr. Childers, as Secretary of State for War, would give aid to experiments in electricity as applied to military purposes.

AT the first meeting of this session of the Birmingham Philosophical Society, the Rev. H. W. Crosskey (secretary) read the annual report, in which it was stated that the Council last year reported that Dr. George Gore, F.R.S., had accepted the position offered him, and that the amount of 150*l*. per annum had been allotted to him in order that he might have greater facilities for continuing in Birmingham his original researches. Dr. Gore had forwarded a report stating that since he had been intrusted with grants from the Birmingham Endowment of Research Fund, he had made, partly with the aid of those grants, the following researches in physics and chemistry, which had been communicated to the Royal Society, and published, as follows:—Thermo-electric behaviour of aqueous solutions with platinum electrodes; influence of Voltaic currents on the diffusion of liquids; experiments on electric osmose; phenomena of the capillary electroscope; electric currents caused by liquid diffusion of osmose; influence of Voltaic currents on diffusion of liquids; and phenomena of the capillary electroscope. He hoped before long to submit to the Philosophical Society an original communication. In addition to the before-mentioned researches, and as an entirely separate matter, he had been aiding the cause of original research by preparing for publication a small book on "The Scientific Basis of National Progress," and it was now being printed.

A NEW zoological station is to be established at Banyuls-sur-Mer, on the Mediterranean, at the end of the natural prolongation of the mole at the beach of Fontaulé. The building will be of considerable size, have several apartments, and be well lighted. It is expected that the laboratory will be ready for work by January. M. Lucaze-Duthiers intends to illuminate the aquarium by electricity. This station will really be an annexe to that at Roscoff, permitting the study of marine zoology to be carried on in winter, when it has often to be suspended on the colder coast of the Atlantic. The municipality of Banyuls, mostly very humble individuals living in an out-of-the-way place, have lent cordial and substantial support to the enterprise.

THE arrangements for the festival in honour of the twenty-fifth anniversary of Virchow's appointment as Professor to the University of Berlin—an anniversary which coincides with his sixtieth birthday—are now being made, we learn from the *Lancet*. An influential committee, comprising the names of Prof. Bastian, Director of the Royal Ethnological Museum, Town-Councillor Friedel, Prof. Küster, Dr. Voss, Herr Ritter, &c., have asked permission of the Town Council to grant the use of the large hall in the Rathhaus and to defray the cost of the decorations, as on the occasion of the banquet to Dr. Schliemann. The 19th of November has been fixed for this festival. The most interesting part of the proceedings will be the handing over to Prof. Virchow the title-deeds of a new institution to be devoted to the prosecution of scientific researches especially relating to anthropology, of which he will have the full control. As a politician, an anthropologist, and an antiquarian, no less than as a pathologist, Prof. Virchow has claims not on Germany alone, but on the whole of civilised humanity; and we heartily join in the desire to do him honour.

THE first general meeting of the London Sanitary Protection Association was held on Tuesday at the Society of Arts, Adelphi, Prof. Huxley, the president, in the chair. Mr. Holmes, the treasurer, stated that the Association had been in operation only for a few months, and for a certain portion of that time its action had been suspended by legal difficulties. The number of members enrolled up to the 15th of this month was 126, the total contributions, together with a loan of 100*l*.

from Prof. Jenkin, for the purpose of advertising and starting the Association, was 391*l*. 11*s*., and the total expenditure 346*l*. 3*s*. 6*d*. Prof. Huxley said that, to put it briefly, the Association was a co-operative store for the supply of good advice, and the modest success which had hitherto attended it was very likely due to the antipathy inherent in human nature to the reception of good advice. Their good advice, however, had this peculiarity—that they did not expect anybody to take it unless he liked. His interest in this Association came from the remote connection he once had with medicine and hygiene. Whatever suspicion of knowledge he ever possessed had led him to the conviction, strengthened by every day's experience of life, that when we aggregated close upon 4,000,000 of people on something less than fifty square miles, if we did not take care we should be desolated, not like old London by the plague or black death, but by those other forms of disease, as fatal in their way, which have the terrible peculiarity of being easily disseminated by the means we took to get rid of them, unless those means were perfect. Disagreeable as the old cesspool system was, it was attended with very little danger compared with that which waited upon the water sewage system if that system was imperfect, for then it was an admirably-contrived arrangement for distributing disease and death in our own houses and in the houses of people who lived adjacent. There were two ways of meeting the danger. One was by the action of Government in some shape or other; but in England no one would tolerate the intrusion of Government officials for the purpose of knocking about and looking into everything, and besides, the expense and difficulty of working such a system would put it out of the range of the practicable. The other way was to meet the danger by means of those who supplied a good report, such as that Association would do. Therefore it was for the public good that the Association should become a great one, and its work be carried out as widely as possible.

THE success which has attended Dr. Vines' English edition of Prof. Prantl's "Elementary Text-Book of Botany" has induced the publishers, Messrs. W. Swan, Sonnenschein and Co., to arrange for a companion volume on zoology, viz. an English adaptation of Prof. Claus's "Handbuch der Zoologie," which Mr. Adam Sedgwick of Trinity College, Cambridge, has undertaken to make. Hitherto this work has appeared without illustrations in Germany; but for the present edition between 500 and 600 drawings have been prepared by Prof. Claus himself. The book is announced to appear next spring. We learn also that Dr. Vines has undertaken for the same firm a "School Botany," covering the ground commonly taken up in the school course. The important treatise on the "Theory and Practice of the Microscope," by Professors Naegeli and Schwendener, which Messrs. Sonnenschein and Co. have had in the press for the past three years, has at length reached completion. It is announced for issue next month.

IT is stated that the Report of the Commission appointed in 1879 to inquire into the sanitary condition of the cemeteries in and around Paris negatives, generally, the popular belief in the noxious influences of great burial-places. The composition of the air in the cemeteries, according to M. Schutzenberger, is not distinguishable from that of arable lands.

UNDER the title of "Prehistoric Devon" (the opening address of the seventieth session of the Plymouth Institution), Mr. R. N. Worth, the president, has brought together in an interesting form many valuable data and references on the subject from all quarters.

IN No. 9 of the *Chrysanthemum*, the monthly magazine for Japan and the East, to which we have already referred, published in Yokohama (London: Trübner), there is the the first instalment of a useful vocabulary of Aino words by Mr. W. Dening.

MISS E. A. ORMEROD, authoress of the "Manual of Injurious Insects," delivered a lecture on Thursday afternoon to the students of the Royal Agricultural College, Cirencester, on the methods of investigating attacks of insects on crops, and the general treatment to be employed. The lecture was profusely illustrated by enlarged diagrams, and was enthusiastically received by the students and their friends. The lecture will be published in full.

THE death is announced, at the age of fifty-three years, of Mr. James Craig Niven, curator of the Hull Botanic Gardens.

THE Abbé Moigno's journal, *Les Mondes*, has again, we are glad to notice, passed successfully through a crisis. A fresh start has been made, the old title "Cosmos" becomes more prominent, and a bright-coloured cover has been added. Better paper, more illustrations, and re-arrangement of matter will, we trust, procure the journal increased support.

AT the meeting of the Institution of Mechanical Engineers at the Memorial Hall, Albert Square, Manchester, to-morrow, the following papers will be read and discussed:—On Bessemer steel plant, with special reference to the Erimus Works, by Mr. C. J. Copeland of Barrow-in-Furness; on compressed air upon tramways, by Mr. W. D. Scott-Moncrieff of London; on meters for registering small flows of water, by Mr. J. J. Tylor of London.

J. B. LIPPINCOTT AND CO. have in the press "The Honey-Ants of the Garden of the Gods, and the Occident Ants of the American Plains," by the Rev. Henry C. McCook, D.D.

A VIOLENT shock of earthquake, lasting three seconds, occurred at Agram at 10 p.m. on the 23rd inst.

La Nature of October 22 has a long article, with microscopical illustrations, on the drinking water of Paris.

SOME interesting facts are brought out in a paper by M. C. Nielsen of Christiania on the impression produced upon animals by the resonance of the vibration of telegraph wires. It is found that the black and green woodpeckers, for example, which hunt for insects in the bark and in the heart of decaying trees, often peck inside the circular hole made transversely through telegraph posts, generally near the top. The phenomenon is attributed to the resonance produced in the post by the vibration of the wire, which the bird mistakes as the result of the operations of worms and insects in the interior of the post. Every one knows the fondness of bears for honey. It has been noticed that in mountainous districts they seem to mistake the vibratory sound of the telegraph wires for the grateful humming of bees, and, rushing to the post, look about for the hive. Not finding it on the post, they scatter the stones at its base which help to support it, and, disappointed in their search, give the post a parting pat with their paw, thus showing their determination at least to kill any bees that might be about it. Indisputable traces of bears about prostrate posts and scattered stones prove that this really happens. With regard to wolves, again, M. Nielsen states that when a vote was asked at the time for the first great telegraph lines, a member of the Storthing said that although his district had no direct interest in the line proposed, he would give his vote in its favour, because he knew the lines would drive the wolves from the districts through which they passed. It is well known that to keep off the ravages of hungry wolves in winter the farmers in Norway set up poles connected together by a line or rope, under which the wolves would not dare to pass. "And it is a fact," M. Nielsen states, "that when, twenty or more years ago, telegraph lines were carried over the mountains and along the valleys, the wolves totally disappeared, and a specimen is now a rarity." Whether the two circumstances are causally connected, M. Nielsen does not venture to say.

WE are informed that the lists of papers, &c., appended to Mr. C. R. Markham's "Fifty Years' Work of the Geographical Society," referred to in our leading article of last week, were not compiled by Mr. Rye.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♀), from India, presented by Mr. G. R. J. Glennie; a Rhesus Monkey (*Macacus erythræus* ♀) from India, presented by Miss Richardson; a Malbrouck Monkey (*Cercopithecus cynosurus* ♂) from West Africa, presented by Mr. J. Pope; a Black-faced Kangaroo (*Macropus melanops* ♂) from Australia, presented by Miss Drax; a Black-headed Gull (*Larus ridibundus*), European, presented by Master Rew Lloyd; two Common Kestrels (*Tinnunculus alaudarius*), British, presented by Masters John and Charles Godfrey; a Snow Bunting (*Plectrophanes nivalis*), North European, presented by Mr. H. A. Macpherson; a —— Monkey (*Macacus*, sp. inc. ♂) from Hainan Island, China, deposited; a Sooty Mangabey (*Cercocebus fuliginosus* ♂) from West Africa, an Ariel Toucan (*Ramphastos ariel*) from Brazil, a Naked-footed Owlet (*Athene noctua*), European, an Ornamental Hawk Eagle (*Spizaëtus ornatus*), a Black Tortoise (*Testudo carbonaria*), an Argentine Tortoise (*Testudo argentina*) from South America, two Radiated Tortoises (*Testudo radiata*) from Madagascar, purchased; a Gaimard's Rat Kangaroo (*Hypsiprymnus gaimardi*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

COMET 1881 *f* (DENNING).—From the elements of the orbit of this comet it is evident that it was a much more conspicuous object about the time of perihelion passage in the middle of September, than when it was detected by Mr. Denning on the morning of October 4, and its not having been sooner discovered can only be attributed to the general prevalence of clouded skies in September. Mr. Denning writes us that from September 2 to 29 he could not make a single observation before sunrise, owing to cloudy weather, but that on the mornings of September 29 and October 1 he missed the comet "in some unaccountable manner." The comet having escaped in September, the systematic examination of the sky, which is now pursued by him, is thus explained.

It ought now to be possible to decide by calculation from accurate positions, whether the comet be one of short period or not. The resemblance of the orbit to that of the fourth comet of 1819 has been pointed out. That comet was undoubtedly moving in an elliptical orbit of very limited dimensions: a computation founded upon a new reduction of the observations made at the Observatory of Paris, which alone are precise enough for the purpose, has led Mr. Hind to a period of revolution of 5·155 years, which is somewhat longer than that deduced by Encke in 1820 from the same observations as they were published at the time by Bouvard. At the previous aphelion passage in 1817 the comet would pass in close proximity to the planet Jupiter, and considerable perturbations may have then occurred. In the interval between the perihelion passage of the comet of 1819 and that of Mr. Denning's comet there are twelve periods of 5·151 years, and the comet would again be greatly disturbed by Jupiter near aphelion in 1853, so that it is possible to explain to a great extent the differences between the orbits of 1819 and 1881, but that the period of revolution should not have undergone material alteration at the same time, may perhaps be considered as an argument against the identity of the comets. However, as we have intimated, the question should soon be decided by direct calculation. Less than a fortnight's observations have been shown in more cases than one to be sufficient to give pretty close approximations to the periods of comets moving in small ellipses, as in the case of De Vico's comet of 1844, for which from only eight days' observations M. Faye inferred a revolution of 5·15 years, the correct one being 5·46 years, or that of Brorsen's comet at its first appearance in 1846, when from ten days' observations Mr. Hind assigned a revolution of 5·519 years, the true one being 5·569 years.

The following positions of Mr. Denning's comet are from an ephemeris calculated by Dr. Oppenheim for Berlin midnight:—

		R.A. h. m. s.	Decl. ° ′	Log. distance from Sun.	Log. distance from Earth.
October	28	10 10 0	+14 51·6		
	30	10 13 1	14 52·2	0·0685	0·0411
November	1	10 15 52	14 53·1		
	3	10 18 35	14 54·5	0·0888	0·0503
	5	10 21 7	14 56·4		
	7	10 23 30	14 58·7	0·1084	0·0582
	9	10 25 44	15 1·4		

The intensity of light on November 9 is less than half that on the day of discovery.

HERSCHEL'S "GARNET SIDUS."—This variable star, the μ Cephei of our Catalogues, appears to require more regular observation than, to judge from published statements, it has of late received, and is an object well deserving the attention of some one of our many amateurs. No doubt satisfactory observations are attended with some difficulty from the high colour of the star, but on that account the results of a single observer may perhaps be deemed more reliable. Mr. Webb, in the new edition of his "Celestial Objects for Common Telescopes," assigns it a period of five or six years, which is assuredly a mistake. It has been included amongst the irregular variables, and its period may be usually about 430 days, instead of several years. Argelander, as an approximation to the period, gives 431·8 days, from observations between 1848 and 1863, but there are very material perturbations. He considered that the period of increase of brightness is greater than that of decrease in the proportion of 4 to 3. The position of μ Cephei for 1882 is in R.A. 21h. 39m. 53·7s., Decl. + 58° 14′ 21″.

This star, which was not observed by Flamsteed, is the first of Ptolemy's ἀμόρφωτοι, under the constellation Cepheus, which he places in 13° 40′ of Pisces with 64° north latitude. If we carry back the position of the variable star from the second Radcliffe catalogue to the reputed epoch of Ptolemy's catalogue—the first year of Antoninus, or A.D. 138—we find its longitude to be in 14° 16′ of Pisces, with north latitude 64° 7′, so that, as was first shown by Argelander (*Astron. Nach. Erganzungsheft*), the identity is beyond doubt.

GEOGRAPHICAL NOTES

THE St. Petersburg Correspondent of the *Times* writes as follows:—The question of the existence of volcanoes in Central Asia, especially on the Kuldja frontier, has always been a matter of doubt and discussion among geologists and Russian explorers. The Governor of Semiretchinsk, Gen. Kolpakofsky, had already fitted out expeditions to settle the question—once in 1878, and again in 1879; but owing to the difficulties of reaching the mountains, which the Chinese consider impassable, and also to the disorders which were then taking place in Kashgar, both expeditions were unsuccessful. This year General Kolpakofsky again set himself to the task, and now reports that he has at last discovered the perpetual fires in the Thian Shan range of mountains. He telegraphs that the mountain Bai Shan has been found twelve miles north east of the City of Kuldja, in a basin surrounded by the massive Ailak Mountains, and that the fires which have been burning there from time immemorial are not volcanic, but proceed from burning coal. On the sides of the mountain there are caves emitting smoke and sulphurous gas. The *Official Messenger*, referring to this interesting telegram, observes that the question as to the existence of volcanic formations in Central Asia, which has so long agitated the learned world, is now irrevocably decided in the negative, and bears the testimony of many Russian explorers. Mr. Schuyler also, in his "Turkistan," mentions that these perpetual fires in the mountains referred to by Chinese historians were considered by Severtzoff, who explored the region, as being caused by the ignition of the seams of coal or the carburetted hydrogen gas in the seams. The same author further mentions that Capt. Tosnofskey, another Russian explorer, was told of a place in the neighbourhood from which steam constantly rose, and that near this crevice there had existed from ancient times three pits, where persons afflicted with rheumatism or skin diseases were in the habit of bathing.

MR. DORWARD, of the China Inland Mission, has lately made a lengthened journey in the Chinese province of Hunan, of which he has sent home somewhat full particulars. He was absent from Wuchang, opposite Hankow, on the Yang-tsze-kiang, for five and a half months, and visited almost every part of this province, so notorious for its turbulent braves, whose hostility to foreigners is proverbial. Mr. Dorward has however established the fact that a European, with two native assistants, can now traverse the province in safety. Near the city of Shênchi, some 450 miles from Wuchang, he had an opportunity of observing the processes used for extracting gold-dust from the sand, which consist in roughly sifting and afterwards using quicksilver.

THE Argentine Government has just despatched two officials to survey five thousand square leagues of country in the neighbourhood of the Neuquem, one of the chief tributaries of the Rio Negro. This extensive tract of country is close to the Andes, and is said to be extremely fertile. When the survey is completed the Government will dispose of the land with a view to its early colonisation.

THE Commercial Geographical Society of Bordeaux in its last *Bulletin* publishes a useful topographical note on the itinerary followed by the Upper Niger Surveying Expedition from Kita to Bamaku.

THE Department of the Interior in Canada has issued a new map of Manitoba and the North-West Territories, showing the country surveyed, &c., and in a later edition the line of the Canadian Pacific Railway will be shown.

WE hear that the Dépôt de la Guerre at Paris has just issued the first sheet of Col. Perrier's map of Tunis, drawn from his recent topographical survey of the country, which has been awaited with much impatience by French geographers.

PÈRE DUPARQUET, the well-known missionary traveller, who returned to South-West Africa early in October, has recently commenced the publication, in *Les Missions Catholiques*, of an account of a journey made by him through Ovampo Land as far as the River Cunene. He travelled in company with Mr. Erchison, one of the principal traders of Omaruru, who also had with him a son of the late Mr. C. J. Anderson. Père Duparquet's memoir is illustrated by a sketch-map of the region, on which is shown a singular connection between the River Cunene and Lake Etosha.

IN the new number (Heft 3, Band 4) of the *Deutsche geographische Blätter*, all the existing information on Wrangel Land and Herald Island has been collected, and will be of interest at present in connection with the missing *Jeannette*. Dr. Albrecht Penck of Munich contributes an interesting article on glaciation with special reference to Eschscholtz Bay in Kotzebue Sound on the north-west coast of America; and Herr G. Kreitner gives a detailed account of the Koko Nor and the surrounding region. There are besides a variety of notes on various points of geographical interest.

To the Austrian *Monatsschrift für den Orient* for October, M. Z. Janiczek of Port Saïd contributes a letter containing a good deal of valuable information on the trade of the Red Sea. In a letter from Herr Hansel of Khartoum we find some interesting information from Dr. Emin Bey. Among other things he tells us that there are three lakes to the north of Victoria Nyanza; that Beatrice Gulf certainly does not belong to Albert Nyanza, but to a lake lying from the south; that steamers now go regularly from Dufilé to Mahagi, a station on the west coast of Lake Albert; and that the only radical cure for the Central African slave-trade is the importation of free Chinese colonists. Prof. Blumentritt contributes notes on some important vegetable products and branches of industry in the Philippine Islands.

HEFT I, for 1880-1, of the *Mittheilungen* of the Hamburg Geographical Society contains a paper of great interest on the distribution and relative value of cowrie shells by Herr John E. Hertz. These shells are used as money mainly in the region between the Niger and the coast of Africa, though they are also in use in other parts of the world. Herr Hertz gives the exchange value of these shells in the various regions where they are used, and traces their hi tory as a trading medium. A kindred paper, of much practical value and considerable interest, is on the barter-trade of Africa, by A. Wörmann. A long paper, with chart, on the paths of barometric minima in Europe and on the North Atlantic, and their influence on wind and weather in North Germany, by Dr. W. Köppen, is of considerable scientific interest. There is also a lecture by Dr. J. Classen on a visit to Olympia.

ACCORDING to the latest census the population of Japan on January 1, 1880, was 35,925,313. Of these 18,210,500 were males, and 17,714,813 females. When the numerous and destructive civil wars of the last twenty years are remembered, this relative proportion of the sexes will appear striking. Writers of the last century held very exaggerated notions of the population of Japanese towns, but the present census shows that some of them may properly rank among the most populous cities in the world. Tokio and its environs has a population of 957,121; Kioto, the old capital, of 822,098; and Osaka, 582,668. The smallest population of any district is that of the Bonin Islands, recently annexed to Japan, which contain only 156 inhabitants, composed of officials and descendants of Kanakas and deserters from English and American whaling vessels.

CAPT. JOHN MACKAY, of the ss. *Southern Cross* (Auckland), sends us, along with a note, an account by himself in the *Queenslander* of his discovery and settlement of the district of Mackay in Queensland. To the now flourishing town of Mackay we referred some time ago in connection with a special number of the *Mackay Standard*. The town bids fair to become one of the most flourishing in Queensland, though its discoverer does not seem to have met with the recognition he deserves.

SOLAR PHYSICS[1]

II.

AT the conclusion of my last lecture I stated my belief that those changes which are continually going on at the surface of the sun had their origin in currents of convection, and I illustrated the processes which are there going on by what we know to be going on on the surface of our own earth. I referred, but only historically, to a theory which was thrown out many years ago as to the origin of solar heat by Sir William Thomson, according to which it depended on the impact of meteoric bodies. I did not suppose at the time that he still retained that theory, regarding it as the most probable; in fact he gave it up many years ago, and I was glad to find, from conversation with him after the lecture, he is quite of the same opinion as I am, that these disturbances—the enormous disturbances which take place at the surface of the sun, have their origin in currents of convection. I stated my belief that the spots were produced by the downward rush of, comparatively speaking, cool portions of gas which had been in the first instance ejected during these eruptions. In speaking to Mr. Lockyer afterwards I found that he had obtained independent evidence from his spectroscopic researches that these spots consisted of down-rushes of gas, and not, as some have supposed, of up-rushes. He may have mentioned it to me before; if so I must apologise for it having passed from my memory. I will not however say anything about the evidence on which he was led to that conclusion, because he is going to lecture himself, and of course he will be the proper person to explain his own discoveries.

Now with regard to these spots I have hitherto said nothing except as to their existence. The German astronomer Schwabe assiduously observed them in the beginning of 1826, and for about a quarter of a century he went on constantly observing them and making careful drawings of them. As the result of this long-continued and careful work, he was led to the conclusion that these spots as to their frequency and magnitude appear to be subject to a periodical inequality. The period appeared to be about ten years, during which, supposing you start with the maximum of spots, they dwindle away to the minimum, then after some years again rise afresh, and by the end of ten years or thereabouts you get to the maximum. M. Wolf of Berne has discussed the subject, and referred back to older observations, and was led to the conclusion that the period was longer than ten years. He makes it eleven years, or perhaps more exactly nine periods per century.

I will now come to some phenomena observed on the earth with which the solar spots would, at first sight, appear to have no possible connection. You are all, of course, familiar with the magnetism of the earth, by the aid of which our ships are navigated through the ocean. Now it has been long known that the magnetic needle is subject to disturbance; by the magnetic needle I mean the magnet suspended so as to turn freely round a vertical axis. For a long time after the discovery of magnetism that was the only kind of instrument used for the observation, and it had been observed that these disturbances were of two kinds. There was a regular diurnal movement of the needle to the west, and then to the east, of its mean position,

[1] Lecture by Prof. Stokes, Sec.R.S., in the South Kensington Museum Theatre, continued from p. 598.

and besides that there were from time to time irregular, or apparently irregular, disturbances following no observable law. It was known, too, that the diurnal fluctuation, which has now been known considerably more than a century, was greater in summer than in winter. It had been also observed that these apparently irregular fluctuations in the direction of the magnet are observed when an aurora is seen.[1] If there is an aurora there are sure to be these fluctuations, and if there are these fluctuations the probability is, if other circumstances permit, that we shall see an aurora. The connection between the two was made out about the year 1750, so that it is by no means new. Of course we cannot expect that for every magnetic disturbance we shall have a visible aurora; for in the first place the disturbance may take place in the day-time, in which case of course no aurora can be seen; then, supposing even it takes place at night, it may be that at the time the whole sky is covered with clouds, which prevent the aurora being seen; or again, it may be a bright night with the moon shining brightly, not far from the full, and then a faint aurora would not attract much notice. In fact I have often felt in doubt when I saw a luminous streak in the sky on a moonlight night whether it was an auroral streamer or merely a mare's-tail cloud illuminated by the light of the moon. After watching some time one can generally determine which it is, because if it be an auroral streamer it is pretty sure to be unsteady; but if the observer happens to have a small spectroscope in his pocket, or even a prism and a slit, the distinction can be made out at once, on account of the peculiar spectrum of auroral light.

There appears then to be evidently some intimate connection between magnetic disturbance and the aurora. The recent progress of telegraphy has caused us to be familiarly acquainted with another electrical phenomenon, or, if you like, magneto-electrical. (I assume here that the aurora is an electrical phenomenon—that, in fact, has long been admitted—for considerably more than a century.) I allude to the earth-currents. In telegraphy we have occasion to use insulated wire, the ends of which are placed, or may be placed, in connection with the earth. Now when that is done it frequently happens that, without sending any current from the battery at all through the line, there is a more or less powerful current transmitted along the wire, which is made evident by the deflection of the galvanometer. In fact, in certain cases these currents are so strong that they interfere with the working of the lines.

At the failure of the first Atlantic cable in 1865, Sir William Thomson (whom I am happy to see before me) made some experiments with these earth-currents, as they are called, transmitted through this cable. The failure was of such a nature as would have been caused if there was a breakage in the cable something like 300 miles off, and currents were transmitted through the cable, indicating an electromotive force, as it is called, amounting to one or two Daniell's cells; on one occasion to five or six; and currents more powerful even than those are observed from time to time.

Now it is well known that at times of magnetic disturbance we have these earth-currents powerful; and as I mentioned that magnetic disturbances and auroræ come together, we have here a third phenomenon, that of earth-currents, which accompanies the two former. These three are evidently intimately connected with one another, whatever be the cause of that connection. But at present I have said nothing whatever of the relation of these three phenomena to the sun. Of course any one would say there is the remote relation, that it is to the radiation from the sun that all the great changes that take place on the surface of the earth are due: the evaporation of moisture, the heating of the air, and consequent production of winds; and in a remote sense, therefore, there would in all probability be a relation between these three phenomena and the sun. But that relation is very far from remote. I forgot at the proper time to mention one circumstance connected with these earth-currents before I came to the sun, which, if you will allow me, I will do now. I mean the magnetic disturbances.

One of the first fruits of the establishment of regular magnetic observatories was the remarkable discovery that these magnetic storms occurred simultaneously over large tracts of the earth's surface; so that even the sudden and apparently capricious variations of say the direction of the declination needle would be observed simultaneously at the same moment of absolute, not local time, at places far separated from one another, such as London and Paris, and London and Lisbon even.[1] The cause of this magnetic disturbance, whatever it may be, must be one very widely spread. In discussing the results which have been obtained at the colonial magnetic observatories, Sir Edward Sabine made a remarkable discovery, namely, that whether you take the range of ordinary diurnal fluctuations of the magnet, or whether you take the frequency and magnitude of these magnetic disturbances that I spoke of, in both cases there appeared to be a decennial period, or a period nearly decennial, and that corresponded to the period of solar spots, corresponded not merely as to the duration of the period, but also as to the time of the maximum; so that in those years when the sun showed an unusual number of spots of unusual magnitude, both the regular diurnal variation of the magnet was greater than the average, and there were more numerous and more violent magnetic storms; on the other hand, when the sun was comparatively free from spots, the magnetic elements were, comparatively speaking, in a tranquil state. In the older observations the declination was the only one of the magnetic elements which had been observed, but all three components of the magnetic force were observed in these observatories, and accordingly the phenomena could be more searchingly investigated. Further research has fully confirmed this connection, so that there can be no doubt now that there is some intimate connection, whatever be its nature, between solar spots and magnetic disturbances.

I will mention one circumstance which is a remarkable corroboration of this observation. The late Mr. Carrington for many years was engaged in a series of most careful and elaborate measurements of the positions and magnitudes of the solar spots. The way he worked was by throwing a large image of the sun by means of an equatorially-mounted telescope, with its eyepiece suitably focussed, on to a fixed screen. One day he was engaged at this work when he saw two bright spots on the screen. His first impression was that the screen which was used to shut off the light of the sun, which otherwise would have passed down outside of the object-glass of the telescope, outside the tube, had got disarranged somehow or other, and that it was merely the sun shining through the holes, and coming on the screen. He moved the telescope a little, and these spots moved with the image of the sun, proving that it was not merely the sun shining through holes in the shading screen, but that they really belonged to the sun. They remained visible some minutes, during which they moved over a very sensible portion of the sun's disk at such a rate that the actual lineal motion of them must have been—I forget the figures, but I think it was something like 100 or 150 miles per second. Moreover one of them passed over a dark spot, which is confirmatory of the old observation of Wilson, that the spots are at a lower level than the general surface of the sun.

Now it so happened that on examining the records of the magnetic needle, which were kept automatically by a photographic process at Kew, just at the moment when these spots were seen, there was an unusually great magnetic disturbance. Well then, what can be the connection between these apparently so dissimilar, apparently so disconnected phenomena, and what is the cause in the first instance of the three terrestrial phenomena I first mentioned—magnetic disturbances, auroræ, and earth currents?

Different theories have been started as to this connection. Some have supposed that the disturbance of the magnetic needle was an electro-magnetic effect due to the earth currents; others have supposed, on the contrary, that the earth currents were due to the electro-magnetic induction produced by a change in the magnetism of the earth. But what of the auroræ? It has long been recognised that the aurora is an electrical phenomenon. It has been supposed to be imitated—and there can be no reasonable doubt that the supposition is a correct one—by sending an ordinary electric discharge through a highly-exhausted tube. But whence comes the electromotive force requisite to effect that discharge? My colleagues are not in any way responsible for what I am going to advance. I am going to suggest a cause for this phenomenon which, so far as I know, has not hitherto been broached,[2] and of course you must take it for what it is worth. It has not seen the light, and therefore has not had the opportunity of being subjected to the criticism of men of science. If laboratory experiments are to be any guide to us it requires no

[1] At least of the dancing kind; faint, steady auroræ do not seem to be accompanied by sensible magnetic disturbances.

[1] A number of photographic records from various magnetic observatories have recently been compared and discussed by Prof. W. G. Adams.

[2] This refers to the theory as a whole; the individual parts of it had mostly formed limbs, so to speak, of one or other of a set of theories which, taken in their entirety, must be regarded as quite different.

inconsiderable electromotive force to send an electric discharge through even a moderate length of rarefied air, though it passes far more freely through rarefied air than through air at the ordinary pressure. I will endeavour to show you that experimentally.

[An experiment was here exhibited in which the coatings of a Leyden jar were connected with the terminals of a Holtz machine, and also, by two branches, with each other, each branch involving an interruption by air. One branch led through a universal discharger, the brass knobs of which were separated half or three-quarters of an inch, the other through a long tube filled with rarefied air—a so-called aurora tube. The second branch being at first broken, the knobs were adjusted to a distance not too great to allow the spark of the jar to pass without fail. The connection with the terminals of the aurora tube being now restored, the discharge, which was at liberty to pass by either branch, chose the aurora tube.]

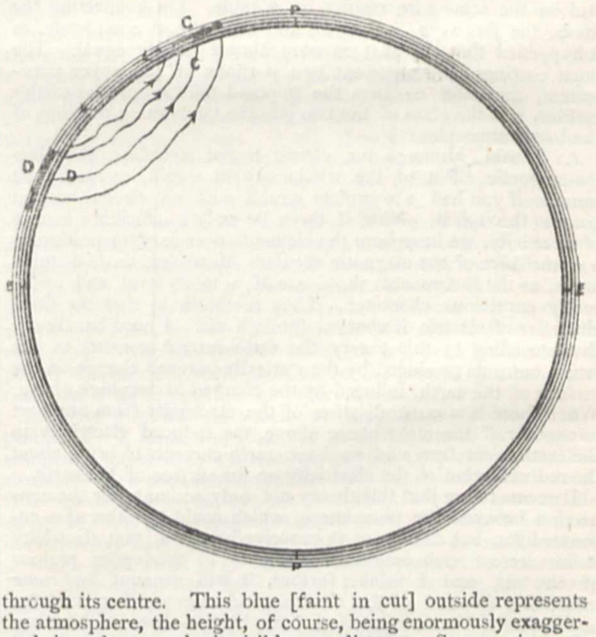
It appears then that the resistance to the passage of the electric discharge is greater across about three-quarters of an inch of air at ordinary pressure than across the whole length of the tube, which I suppose is somewhere about five feet, so that, although there is considerable resistance to the passage of the electric discharge through rarefied air, it is very much less than through air at ordinary pressure; but although it is very much less, it is very far indeed from being inconsiderable. Mr. De La Rue has a splendid battery of about 11,000 cells of chloride of silver. It required about 2000 of these to send electric discharges through tubes perhaps two or three-quarters the length of that, but not quite so broad, exhausted to such a degree as to oppose least resistance to the passage. We see then that, if one may judge by laboratory experiments, it requires a very considerable electromotive force to send an electric discharge through even a moderate distance in rarefied air.

Now attempts have been made to measure the height of the aurora, and very large figures have been brought out. It is said to be fifty or sixty, or even eighty miles high; I think some have made it even higher than that. It is a difficult matter of course to measure with much certainty, because you want a base to measure from; and the two stations must be distant a few miles, in order that you may get a sufficient angle of parallax. Then with observers situated a few miles apart it is a difficult matter, with such a variable and indefinite phenomenon as aurora, to fix on what they should observe. Possibly in the future, when such observers may be put in connection by telephone and be able to speak to one another and tell each other what sort of aurora they see, and settle by conversation at that distance what particular part they shall observe, we shall get more certain results. However, there can be no doubt that, although there may be some uncertainty as to the precise height of the aurora, it is very high indeed.

Now, even in spite of this great height, the auroral streamer subtends a very considerable angle at the eye of the observer. If this be a discharge, the length of that discharge must be very considerable, probably many miles. Where shall we get the electromotive force sufficient to send a discharge through so great an interval of air, rarefied though it be, and that not too highly? I say "and that not too highly," because experiments with exhausted tubes have shown that the resistance to the passage of the spark through the tube goes on diminishing as you make the exhaustion higher, until you reach a certain point, after which it goes on increasing again, and this exhaustion, at which the resistance to the passage of the discharge is least, is by no means very considerable as exhaustions go nowadays. Tubes have been so exhausted that rather than strike across a millimeter within the tube from terminal to terminal, the discharge would pass some inches outside in air. Well, then, it would appear from that that we do not gain so very much as regards facility of passage for an electric discharge by going up to a tremendous height in the air. Where then can we get an electromotive force sufficient to send an electric discharge through such a length? Sir William Thomson, in the case of the Atlantic cable which failed the first time, as I said before, obtained earth-currents indicating an electromotive force of a few Daniell cells; but a few Daniell cells, or a few scores of Daniell cells, or a few hundreds of Daniell cells would be quite insufficient for sending a discharge through such a space as I have spoken of, if laboratory experiments are to be any guide. There is, however, one instance of electric phenomena where we have tremendous tensions to deal with—I mean atmospheric electricity. In the case of the atmosphere we may have the electric spark striking all the distance from a cloud to the earth, perhaps half a mile or a mile. I need not say that the electric spark I refer to is a flash of lightning. Here I found some difficulty in getting the discharge to strike through air of ordinary density, across more than about three-quarters of an inch, but in lightning it strikes all that distance that I mentioned. Atmospheric electricity of tension sufficient to strike across a mile of air at ordinary density (or at least slightly reduced as you go up) might have an opportunity of striking across many miles of rarefied air, and if the experiment which I have showed you just now with that tube is to be any guide, then it would be competent to do so. In atmospheric electricity it is conceivable that we may have a sufficient tension to cause the electric discharge to strike across that great distance which the length of an auroral streamer must be.

It has long since been remarked that displays of auroræ seem in some way or other in high latitudes to take the place of thunderstorms in low latitudes. Well, then, I will endeavour to explain what I imagine takes place. I do not enter into any speculation as to the cause of atmospheric electricity. We know as a fact from its manifestation that it exists, and that is sufficient for my purpose. Suppose now that the air, especially the higher portions of the air, over a large tract of country, say to the north of us, were more or less highly electrified—positively or negatively, as the case may be—we will suppose positively—if the electric tension were sufficient, although, considering that the air is a non-conductor, we might not have a flash of lightning, which gathers into itself in one moment the electricity from an entire cloud and sends it down into the earth (we might not have tension enough to produce such a discharge, the resistance to the passage of electricity from one portion of the air to another, which at any rate would be comparatively dry compared with what we have in warm latitudes, would prevent it by itself alone), we might nevertheless have a discharge taking place in the higher regions of the atmosphere where the air is rarefied, and accordingly opposes less resistance to the discharge.

Now let me refer to this figure. This great circle, P E *p e*, I suppose to represent a section of the earth by a plane passing



through its centre. This blue [faint in cut] outside represents the atmosphere, the height, of course, being enormously exaggerated, in order to make it visible at a distance. Suppose in some way or other a portion of this upper atmosphere, as C, got considerably charged positively or negatively, say positively; it would act by induction on the earth below. The opposite electricity, negative in that case, would be accumulated underneath, as at *c*, and this portion of the earth would form, as it were, a portion of a Leyden jar, the lower atmosphere being the di-electric or glass of the jar, the upper atmosphere being partly, you may say, the di-electric and partly also the charged coating. It would be represented more precisely by an imaginary coating outside composed not of tinfoil, but of some badly-conducting substance. The positive electricity about C would be bound down in part by the negative electricity about C, which it induces. In another portion of the atmosphere—it may be at some considerable distance from the former—you may have the atmosphere charged in an opposite way, and of course if this were negative there would be induced positive electricity below, or it might be that the whole of the atmosphere from C to D is charged positively, but at D the negative charge is much feebler than at C. The end-result would be the same; but for facility of explanation I will suppose that the upper portion in one place is actually charged with electricity of the opposite kind to what the charge is at the other. If the tension were sufficient, then there might be a striking across of the electricity of this name in the atmosphere from C to D, and in the earth in the reverse direction. Compared with the atmosphere, the earth would be an exceedingly good conductor, so that the electromotive force concerned in sending the currents from one part of the earth to the other would be, comparatively speaking, trifling, and therefore the electromotive force represented perhaps by a few scores of the elements of a Daniell's battery. Well, then, in atmospheric electricity we appear to have the tension requisite to send the discharge through a considerable space of rarefied air. Now if a discharge took place, and if it were night, and the sky were clear, it would, at least where sufficiently concentrated, be visible to us just in the same way as the discharge passing through the exhausted tube is visible, by the light it produces. It would produce in fact an aurora. The air is not a comparatively good conductor, like a thunder-cloud, from which a great quantity of electricity strikes in one moment, but is, after all, a bad conductor, so that the electricity can only pass in a spitting sort of way. We may conceive here that we have a sort of double current, yet not forming a complete circuit; nevertheless a discharge would go on nearly of the same nature as if the circuit were complete, and the effect of such a discharge on the magnetic needle would be nearly the same as that of a circuit which was complete. I will endeavour to produce a discharge in a circuit which is doubly incomplete.

[An experiment was here shown in which two Leyden jars were charged, one positively, and the other negatively, and were laid on the same wire resting on a table. On connecting the knobs the jars were discharged, and that almost completely, as it happened that the charges were almost exactly equal. The inner coatings here represent two portions of the upper atmosphere, the outer coatings the opposed portions of the earth's surface, and the glass of the two jars the intervening portions of the lower atmosphere.]

As I said, although the circuit is not complete, the electro-magnetic effect of the whole system would be nearly the same as if you had a complete circuit with an electric current passing through it. Now if there be only a sufficient quantity of electricity, we have here the elements necessary for producing a disturbance of the magnetic needle. Moreover, those disturbances, as the instruments show, are of a most fitful and apparently capricious character. They resemble in that the fitful character of electric discharges through air. I need hardly say that according to this theory the earth-current consists in the return currents produced by the statically-induced change on the surface of the earth, induced by the charged atmosphere above. When there is a neutralisation of the electricity from one part to another of the atmosphere above, the induced electricity in the earth is set free, and we have earth-currents to bring about the redistribution of the electricity on the surface of the earth.

It seems to me that this theory not only accounts for the connection between the phenomena, which could be otherwise accounted for, but enables us to conceive how it is that electricity strikes across such enormous distances in the upper regions of the air, and I think, further, it will account for some interesting features of the electric discharge which constitutes no doubt itself the aurora. I have here a sheet of blotting- or filtering-paper, and I will suppose this to represent an electrified tract of air lying over, it may be, an extensive tract of country, say somewhere to the north of us. Suppose that this air is charged positively, it will induce negative electricity on the earth below. This metallic coating on this sheet of glass [over which the blotting-paper was held horizontally at a little distance] may be supposed to represent the surface of the earth on which this negative electricity is induced. The two may be quietly in equilibrium. Suppose, however, that from some cause or other the tension becomes sufficient to enable the electricity from some point in this stratum of air to strike across higher up—because the streamers are found to be parallel to the direction of the dipping-needle, and parallel accordingly to the lines of magnetic force—higher up in the first instance; from thence I do not know where the discharges go, but I should suppose that in our country they generally go somewhere to the south of us. Now if a tract of air were pretty uniformly electrified, it would induce electricity of the opposite name underneath it, pretty uniformly distributed except about the edges, where the electrified air which was the inducing body would tend rather to overlap the electrified portion of the earth below, and where accordingly, if the charge were the same throughout, there would be the greatest tendency for the electricity to strike off and pass into the upper regions of the atmosphere, and thence probably to the south. Well, suppose now that a discharge begins anywhere, say somewhere along this edge of the paper, which I will suppose to be the northern edge. The paper which I hold in my hand is really touch-paper (such as boys use for amusement), and I will light the edge of it. Now this smouldering away of the touch-paper I conceive to represent the mode in which the rarefied air becomes successively discharged. Suppose that a discharge takes place somewhere about the edge of this sheet of electrified air covering a large tract of country, then if once a hole (so to speak) were formed, the tendency would be for the discharge to continue along that edge, because, as I said, as soon as the electricity at the edge was discharged the electricity of opposite name which had been induced on the surface of the earth below would be set free, the earth-current would be set up; and then again, what now is the edge of the electrified tract of air would be left exposed, no longer protected in the same manner as before by the induction of the electricity of opposite name beneath; the electricity would fly off from it in turn, and so on, so that there would be formed a sort of curtain composed of auroral rays, and gradually advancing, in our country usually in the direction from north to south; because we live in a sort of neutral region not too far south to see the aurora from time to time, and not far enough north to be exempt from thunder-storms. This auroral discharge, which takes the place of thunder-storms in lower latitudes in some way or other, usually occurs to the north of us, and accordingly the aurora is called the Northern Lights; but when there is a fine display it sometimes reaches down to us and goes south of us. So I say the discharge would usually begin from a place north of us, and would creep along the edge of the electrified stratum of air, forming a sort of luminous curtain, and passing from north to south, just as the smouldering edge of the touch-paper passes along the paper gradually. When we are just under the edge at which the discharge takes place we have, as I conceive, an auroral arch passing, it may be, through the zenith, generally stretching also east and west, and generally moving with a slow motion from north to south.

Now supposing that that is the explanation of the three phenomena—magnetic disturbances, earth-currents, and auroræ—can we in any way connect their occurrence with changes going on at the surface of the sun? I think we can. We know that a tube containing rarefied air, supposing the density of the air in it is given, opposes less resistance to the electric discharge through it when it is warm than when it is cold. The conducting power of a wire for electricity decreases if you heat the wire, but it is the reverse with air. The passage of electricity through rarefied gases is very different in its nature from the passage of electricity through a wire or through an electrolyte. Mr. De La Rue has shown in the course the researches made by means of his splendid battery, that in these highly exhausted tubes the electric discharge, be it ever so steady to all appearance, obeys laws connecting it rather with a series of disruptive discharges, with a rapid succession of sparks, than with a discharge passing through a wire. Now connected with that difference, or at least accompanying it, there is that opposite action of heat which, as I say, in the case of gases renders the passage of electricity more easy instead of less easy. We may imagine that if from any cause the sun gives out greater radiation than usual, the upper regions of the atmosphere may thereby become heated to a certain extent[1] and oppose less resistance to the passage of the electric

[1] The rays of the visible spectrum, and even the invisible rays for some considerable distance beyond the extreme violet, pass freely through clear air, which could not therefore be sensibly heated by them. But there is reason to think that the atmosphere, or some of its constituents, are more or less opaque to rays of very high refrangibility; and it is just for copious emission of these that sources of radiation of an excessively high temperature are so remarkable. The substance, which is opaque to the rays of excessive refrangibility, and consequently enables them to heat upper regions of the atmosphere, is probably not nitrogen or oxygen, but some gas or gases present in very small quantity.

discharge through it than they did before. In this way we may conceive that in a great outbreak like that observed by Mr. Carrington, where the hot interior of the sun is turned up, as it were, and radiates towards the earth, the facility for the passage of the electric discharge is increased, and it may be very rapidly increased. So that according to this theory the foundation of these three phenomena lies in atmospheric electricity, which forms as it were the magazine, and the solar radiation, as it were, supplies the match, and allows it to be discharged. Of course, over and above that, when solar radiation is active, all the phenomena which depend on solar radiation may be expected to be active too; and therefore beyond its influence in firing the match, to speak metaphorically, this solar radiation, when more active than usual, and lasting, will also produce a more rapid development of all those processes at the surface of the earth which depend on solar radiation, among others, no doubt, the generation of atmospheric electricity, although we are not at present able to explain with certainty the manner in which it is produced. So that in two ways, by applying the match to the train already laid and by gradually manufacturing the powder, the increased solar radiation may cause an increase in those electric discharges and earth-currents as the result of the redistribution of the induced electricity at the surface of the earth, and thereby a disturbance of the magnetic elements. I do not know of any other theory than that of atmospheric electricity which furnishes anything like sufficient electromotive force to account for these auroral discharges, if they are really electric discharges analogous to those which take place in exhausted tubes. As I said, it has been supposed by some that the magnetic disturbances are due to earth-currents; according to the theory which I have advanced, they are due rather to a vast assemblage of currents, partly atmospheric and partly terrestrial. An objection has sometimes been taken to the supposition that the magnetic disturbances are due to earth-currents arising from the consideration of the electro-magnetic effect which the earth-current actually observed would have upon the needle. But this, I think, is obviated when you remember that an earth-current actually observed is merely what results from the examination of a very small portion of this vast electric system, stretching it may be over hundreds of miles of country. At Greenwich, for instance, there are now wires by which earth-currents are regularly observed. The coincidence between photographic traces left by the earth-currents and those left by the magnetic storms is most remarkable. Every peak of the one, you may say, answers to a peak of the other. It has been noticed, however, that there appears to be a slight difference in the time of the occurrence. It would appear as if the disturbances preceded the earth-currents. Well, that may very well be, because, according to the theory which I have advanced, the effect on the magnet is the resultant effect of a vast series of currents, partly terrestrial and partly atmospheric, stretching over a very large region of country, whereas the earth-currents observed are merely obtained by tapping the earth at a couple of places at no great distance, so that the two do not by any means necessarily correspond exactly.

I forgot to mention at the proper time a diagram which Capt. Abney has kindly prepared for me. This is a copy of the diagram made by Mr. Ellis of the Royal Observatory, giving the result of his discussion of the Greenwich observations on two out of the three magnetic elements, namely, the declination and horizontal force, as compared with sun-spot frequency. [Mr. Ellis's diagram in Part ii. of the *Philosophical Transactions* for 1880 was then referred to.]

You see that an examination of the phenomena going on at the solar surface itself leads us to the conclusion that there are vast currents up and down, by means of which the comparatively speaking cool upper portions are continually replaced by hotter matter from beneath. Mr. Lockyer, in the lectures he is about to give, I have no doubt will have a great deal of very interesting evidence derived from spectroscopic study of the phenomena to lay before you, bearing out that same conclusion We have seen that the supposition that there is extra radiation when the interior portions of the sun are ejected and come to the surface, falls in very well with the known relationship between the occurrence of sun-spots and the three terrestrial phenomena I have mentioned—magnetic disturbances, auroræ, and earth-currents. I say between the sun-spots, although it is not, strictly speaking, the sun-spots themselves, but the tremendous disturbances which are their precursors, and of which they form the most easily-observed manifestation.

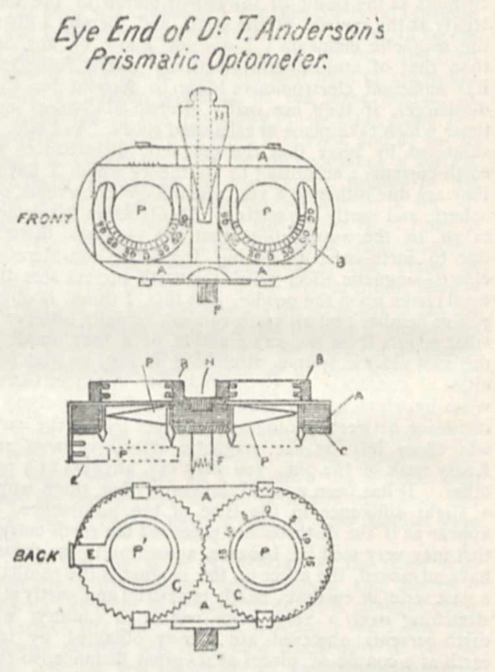
Now if there is reason to believe that, when the sun is in a state of activity in this manner, there is increased radiation from it, it may well be that the meteorology of the earth is affected by the changes which take place at the surface of the sun; but the meteorology of the earth forms an exceedingly complicated problem. We have, so to speak, to deal here with a very complicated integral of a differential equation. I am speaking somewhat metaphorically, but my words will be understood by the mathematicians who happen to be present. We cannot very directly connect that integral with the disturbing forces. One thing, however, we may say: supposing that there is a system of any kind subject to periodic disturbing forces—and we have seen reason to believe that these great eruptions which take place on the surface of the sun are, perhaps somewhat roughly, periodic—if, I say, we have a periodic system of disturbing forces, then the system which is acted upon by these forces will show a periodic disturbance which may be more or less concealed by apparently capricious disturbances, but which yet may be expected to come out in the long run; and it has been supposed by those who have studied meteorological phenomena that there are indications of a decennial, or nearly decennial period in some of the meteorological elements, for instance, the mean temperature of the air and the fall of rain. Again, in some observatories thermometers have been sunk to a considerable depth in the earth, and observations of such thermometers were carried out for a great number of years by the Astronomer-Royal of Scotland, Prof. Piazzi Smyth, and they are regularly carried out now at Greenwich. Connected with the annual variation of temperature between summer and winter there are, so to speak, waves of heat and cold slowly propagated down from the surface of the earth to the interior, rapidly decreasing in amplitude as they descend, and by going a suitably moderate depth you get these fluctuations, indicating the annual fluctuation of the atmospheric temperature, and free in a great measure from the fluctuations which take place at much shorter periods. When you go a little way down the results given by these thermometers seem to indicate something of a decennial or nearly decennial period. Conflicting statements, however, have been made by different observers as to the time of maximum of the meteorological elements which were supposed to have such a period, and some have argued from the results that when the sun was in a highly spotted condition we had a higher temperature than usual, and some the reverse. Now this is an important matter to attend to. Suppose we had such a system acted on by periodic disturbing forces; it will show at least in the mean a corresponding periodic fluctuation, corresponding however only as regards the length of the period. The epoch of maximum of the element observed, whatever it may be, has no necessary relation to the epoch of maximum of the disturbing forces, excepting that they are separated by a constant interval, and the epoch of maximum of the element observed may be different at one locality from what it is at another. So that it is only the period and not the epoch of maximum which you can expect to arrive at possibly by an observation of such elements as I have spoken of. It is very difficult indeed to say, even if a ten-yearly period be observed, what ought to be the year of greatest solar radiation if we have given the observed results.

Is there any way in which we may hope to attack that problem? I think there is. It is by no means hopeless to attempt to measure by a direct process the solar radiation. Instruments have been devised for the purpose, called actinometers. One was devised by the late Sir John Herschel, and goes by his name, and it is a very beautiful instrument; but unfortunately it is excessively fragile, and if the instrument has got rough travel or rough work at all to go through, it is pretty sure to be broken. Other instruments have been devised for the purpose, and among them I may mention one by Prof. Balfour Stewart. He has lately devised a new actinometer, and one of his construction has recently been sent out to India, and is at present under trial. In these cases heat is observed by a thermometer. Another has been devised by Prof. Roscoe, depending on the chemical action of radiation. I think none of these have yet had a thoroughly complete trial, because in such a climate as ours a fair trial can hardly be made, since there are so many disturbing elements in the lower atmosphere. An exceedingly slight cirrus-haze makes an enormous difference in the amount of heat radiated from the sun as received by us without being deflected from its course. If there be the slightest haze a good deal of the heat rays are deflected from their course, perhaps not much deflected, so that if we take in the direction of the sun itself and the neighbouring directions from the sun for some considerable distance all round it, the totality of radiation from that portion of the heavens may not be so much inferior to what it is when there is none of that slight cirrus haze there. But still we have haze enough in the lower regions, and besides that we have water in an invisible state of vapour, and Dr. Tyndall has shown that that absorbs with great avidity a portion of the heat rays. Those, however, are mainly rays of very low refrangibility. Still the absorption of these may very sensibly affect the totality of radiation received from the sun. How then shall we, if possible, get rid of these sources of disturbance? The best plan seems to be to take observations at a considerable altitude, where if possible you may get many thousand feet above the level of the sea and get rid of the lower, dustier, hazier portion of the atmosphere, and get rid also of by far the greater portion of the aqueous vapour, which by itself alone would absorb a portion of the heat. That is what the Committee on Solar Physics have attempted to do. We contemplate having actinometric observations made in the north of India. Of course, if observations are to be continued, it is not sufficient to go to some high mountain. You must go to some habitable place where the observer can live and be in some sort of comfort. Now in the Himalayas you may get up to many thousand feet and yet be still within reach of human habitations; or what is better still, if you cross the range and go over into Thibet, you have there a high table-land many thousand feet above the level of the sea, with a sky usually cloudless, and where observations of this kind may, it is hoped, be made with success for a considerable period together, and the result may, we hope, in time throw light on the question whether or no there is in reality a change in the amount of radiation received from the sun, and whether the amount of that change is sufficient to make any material difference in the meteorological conditions of our globe.

I have spoken of meteorological elements in which various observers suspected that they saw some indications at least of a decennial, or nearly decennial, period. Speculations have been made as to whether there is not a decennial period, or something of the kind, traceable even in the occurrence of Indian famines. If so, there may be some very close relationship between the solar spots and these famines. At first sight one would be disposed to say, "What possible connection can sun-spots and famines have with one another? You might as well speak of the connection between comets and wars!" But when we go deeper below the surface, and study carefully the phenomena presented to our view, we see that a possible connection between such apparently remote things as sun-spots and famines may not be chimerical; and there is no saying what practical application may in the end result from a study of solar phenomena undertaken in the first instance for a purely scientific object.

A PRISMATIC OPTOMETER[1]

It is well known that in the normal eye, with its accommodation relaxed, parallel rays of light, that is, those from distant objects, are brought to a focus on the retina. Rays from near objects are divergent, and if they enter such an eye they are not brought to a focus on the retina, but would be at some point behind it. In order that they may be so brought to a focus and form a distinct image on the retina, an effort of accommodation is necessary. This is performed by a small muscle called the ciliary muscle, inside the eyeball, the ultimate effect of whose contraction is an alteration in the shape and perhaps the condition of the lens, which causes the rays to be more strongly refracted, and brings them to a focus on the retina. The effect is in fact the same as if a convex lens were added to the optical system of the eye. As age advances, the muscle and lens become stiffer, and work with difficulty. They are relieved of part of their work by putting a convex glass in front of the eye. Hypermetropia is a condition in which the axis of the eyeball is too short, compared with the refracting power of the lens. In it an effort of accommodation is necessary to see even distant objects clearly, and a still stronger effort to see near objects. A person suffering from it requires convex glasses. When both eyes are used together, the optic axes of both are directed to the object, so that in looking at a distant object they are directed parallel, and in looking at a near one they converge. These movements are effected by the external muscles of the eyeball, which are supplied by branches of the same nerve as the ciliary muscle. As a fact these movements of the ciliary muscle and of the external muscles of the eyeball are associated, or habitually performed in conjunction; that is, the brain has become accustomed to send an impulse to the one set of muscles proportionate to that sent by the other. Any disturbance of this association can only be accomplished by a distinct effort which, if severe or long continued, is apt to be painful. Suppose a man has become presbyopic, *i.e.* his accommodation has gradually become stiff, and its range reduced. In order to accommodate for rays from an object at the ordinary reading distance of ten or twelve inches, he has now to exert an effort equal perhaps to what he would have employed when young on one four inches off, but the change has been gradual, and the convergence of the eyes for twelve inches has become associated with this amount of effort. If he now use convex glasses of suitable power, the want of refracting power is supplied, the effort of accommodation is reduced to its natural amount, but the amount of convergence which has become associated with this small effort is now insufficient, and the eyes, instead of converging to twelve inches, converge on a point several feet distant, so that double vision would be produced, unless by a distinct effort the eyes were converged more, and

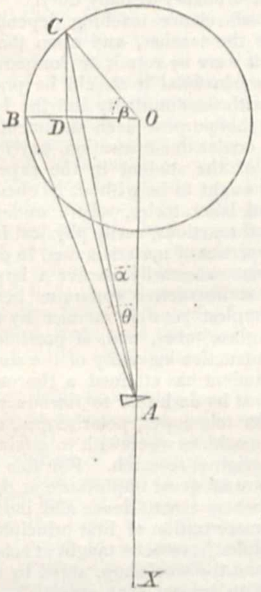


A, main frame carried by F, graduated rod; C, rotating frame carrying P P, prisms; E, frame carrying P', third prism; H, wedge to separate B B frames for lenses.

this effort is often painful, and is expressed by the term that the spectacles "draw" the eyes. After a time new associations are formed, and the spectacles can be used comfortably; but this does not happen in all cases, and for these it is necessary to grind the lenses on glasses of prismatic section. The action of the prism is so to bend the pencils of rays coming to the eyes that they appear to diverge from a point corresponding to the new focal distance of the eyes provided with the spectacles. Sometimes the amount of prismatic effect required is calculated, but the calculation, being based on general considerations, does not always suit individual persons; at other times prismatic glasses from a trial case, are combined with the calculated spherical, or spherical and cylindrical glasses, until one is found with which vision is comfortable. In many cases it is not necessary to use glasses specially ground on prisms, but sufficient to move the centre of the glasses nearer together. The glass being thicker in the centre, looking through the part near the edge produces an amount of prismatic effect which is often sufficient. If concave glasses are used, as in cases of short sight, then they must be further apart than the distance of the eyes, in in order to produce this effect. The object of the instrument exhibited is to find experimentally the amount of prismatic power, and the distance of the centre of the lenses which is

[1] "On a Prismatic Optometer," by Tempest Anderson, M.D., B.Sc., read at the York meeting of the British Association.

required in any individual case. Two circular frames each $2\frac{1}{2}$ inches in diameter, and with teeth cut in their edges, are mounted, so that the teeth gear into each other, and they can rotate freely, but in opposite directions. In the centre of each frame is mounted a prism of 18°; one of the frames is graduated, and when the graduation is at 0° the axes of the prisms are parallel, so that parallel pencils of rays falling on both are deviated both in the same direction, and still parallel. Thus when the pair of prisms are arranged horizontally in front of a pair of eyes, an object looked at appears displaced up or down, but there is no lateral deviation on either. If the frames be rotated 90° in one direction, the prisms both have their bases inwards, or, if in the other direction, both outwards, so that two pencils of rays are deviated to the full power of the prisms. In the intermediate positions part of the prismatic effect is resolved in a direction at right angles to the line joining the centres of the frames, and can be neglected as only producing parallel displacement of the image, and part is resolved in the direction of this line so as to produce apparent separation or approximation of the images. This amount is read off from the graduation, which is constructed on the following principle:—Suppose a ray of light X A O perpendicular to the plane of the paper meets the paper at O. Suppose a prism be introduced at A



having an angle of deflection θ, the ray of light now falls on the paper at B. If the prism be rotated through angle β, the ray now falls on the paper at C. Join O B, O C, and resolve O C into vertical and horizontal co-ordinates C D, O D. C D being neglected as described, we wish to find O D the horizontal component of the deflection.

$$\text{Since } OB = OC$$

$$\therefore \frac{OD}{OB} = \frac{OD}{OC}$$

$$\therefore \frac{\frac{OD}{OA}}{\frac{OB}{OA}} = \frac{OD}{OC}$$

$$\frac{\tan \alpha}{\tan \theta} = \cos \beta$$

$$\text{Log} \cos \beta = \text{Log} \tan \alpha - \log \tan \theta.$$

Two other frames are placed in front of the prisms. They contain grooves to hold lenses or combinations of lenses, and are graduated so that cylindrical lenses can be set at any desired angle. The frames can be separated or brought nearer with greater accuracy by a wedge, and the distance of the centres of the glasses is marked on the bearing. The whole is carried at the end of a graduated bar which carries a sliding support for an object. This bar is graduated in inches for use in calculation and also in focal lengths of a set of dioptric lenses. A third prism is attached, so that it can be placed between one of the frames and the object. When it is in position, the rays going through it to the eye appear to come from an object higher than when it is absent. Double vision is produced, and the eyes left free to find their most comfortable position free from any effort to make the two images coalesce. To use the instrument, the spherical and cylindrical elements of the spectacle required are first found either by some of the ordinary methods or by the ophthalmometer described in the Annual Volume for 1880, and the required lenses from the trial case put in the appropriate frames. The third prism is interposed, and an object, such as a vertical line, looked at at reading distance. If the images seen by the two eyes are exactly one above the other, the prismatic adjustment is presumably correct, the third prism is removed, and trial is made whether reading can be carried on for some time without fatigue. If the images are slightly displaced externally, trial is made whether shifting the centres of the lenses nearer or further off suffices to bring them into position. If so, the distance is noted and sent as a direction to the optician. If the displacement be more than can be corrected by this means, the prisms are rotated till the desired effect is produced, and the amount of prismatic deviation to be given to the proposed spectacles read off. The third prism is removed, and reading practised as above.

SCIENCE AND INDUSTRY[1]

CONSIDERING the high position in literature and science of my predecessors in this chair, I feel that I have been bold indeed in accepting the distinguished office of President of the Midland Institute during the current year. I shall not attempt to rival my predecessors in those literary or philosophic flights which befitted their powers, but shall confine myself to certain suggestive remarks flowing from personal experience of men and matter, which may prove of some interest to an audience consisting in the main of persons who, like myself, are intent upon combining science with practical aims, but who, unlike myself, have the best part of their career still before them.

In venturing to express my views regarding the great question of the day, that of Technical Education, I shall run considerable risk of disappointing some of its most ardent advocates, who may have looked upon me, a foreigner by birth, as a staunch supporter, if not as the living embodiment, of that particular form of education that the Polytechnicum of Germany and other Continental countries imparts to the aspiring engineer and manufacturer, but which, in my opinion, leaves much to be desired, and is certainly inapplicable to the condition of things which we find in this country.

The subject of education, and of science education in particular, is one the practical and national importance of which it would be difficult to over-estimate. It is well known that the Continental nations have in some respects stolen a march upon us in providing for the education of the young engineer, the architect, the manufacturer, and the craftsman. Colleges of high and low degree abound where both science and practical processes are taught, whereas the teaching of the latter has been looked on hitherto amongst us as professional or trade knowledge to be acquired during lengthy periods of pupillage or apprenticeship.

The more ardent advocates of the Continental method of technical education go so far as to think that the irksome system of apprenticeship should give way entirely to technical teaching within the college walls, whereby it is assumed much time could be saved and a better knowledge be imparted to the aspiring engineer or manufacturer. Having had some experience of young men brought up at these technical schools, I am bound to say that I have not been favourably impressed with the results produced by that system. The practical knowledge acquired at those establishments is wanting in what may be called the commercial element, that is of due regard to cost of production, of which the teacher himself must be comparatively ignorant, as otherwise we should find him employed at the factory or engineering office, instead of in the schoolroom.

The young polytechnic student is apt to look on the machine or process which he has studied, not as one of many solutions of a practical problem influenced by ever-varying external circumstances, but as something representing an absolute condition of things almost as completely proved and established as a first

[1] Abstract of Address at the opening of the Birmingham Midland Institute, by Dr. C. W. Siemens, F.R.S., president of the Institute.

principle in nature, or a proposition of Euclid; he is very proud of this positive knowledge, and impatient of any suggestion aiming at the accomplishment of the same object by means not sanctioned by his authoritative text-book. He is apt to be a dogmatist, a splendid man for coming out first-class in a competitive examination, and likely enough to make a good official in a Government administration, but most unlikely to venture of himself on such new embodiments of first principles of nature as are essential to the accomplishment of improved results, and as have animated our Watts, our Cromptons, our Corts, and our Bessemers in enriching the world with new processes.

On the Continent, where the Governments themselves are largely engaged in trade and enterprise, where railways, mines, and factories are State establishments, it was necessary to create a large staff of men educated to the point of being able to assume at once a position of some authority in the ranks of rigid organisation, and such men are provided by the polytechnic schools. Our Indian Government being similarly situated, had to resort to similar means, and to establish Cooper's Hill Engineering College.

In this country, where happily the great commercial interests, with one exception, are still in private hands, educational establishments on the Continental model would be, I consider, inappropriate. The object a young man has in view is not the attainment of a snug position in a Government establishment, but to be fitted by his education for the great battle of life, in which he will be judged, not by the answers he can give to certain set questions in his competitive examination, but rather by the faculty he may have acquired of realising useful results under even adverse circumstances and conditions.

The time was, not long ago, when the opinion prevailed in this country that useful knowledge could only be attained in the workshop; that a lad, after having mastered the three R's at a primary school, had to be bound to a manufacturer or craftsman for a period of seven years, where his time was occupied in routine work or in mechanical repetitions of one and the same operation, causing him to give up thinking altogether, and to become what was dignified by the appellation of practical man—a man of notions, with a supreme contempt of theory or science. The reign of this practical man *par excellence* is happily drawing to a close; for those who wish to treasure up his memory, I would recommend a lucid description of him by my friend Sir Frederick Bramwell in his presidential address to the Mechanical Section of the British Association in 1872 (which may be found in the *Transactions* of that year). Since then Sir Frederick Bramwell has done much to hasten the burial of the character he describes, in making himself the principal promoter of that splendid endowment, the London City Guilds Institute, which, under wise direction, cannot fail to exercise a very important influence on the educational development of the country.

Having now spoken, somewhat disparagingly, I fear, of both the old English system and of the more recent Continental system of technical education, I shall be asked, no doubt, what in my opinion should be the plan adopted in preparing the mechanical engineer, the manufacturer, and the artisan of the future for their respective careers. The answer to such a question is one involved in much difficulty, scarcely admiting of universal solution. There are, however, certain principles of general application which, I submit, should never be lost sight of. Moral education being provided for, the main object in teaching the young should be to strengthen the power of memory, and after that the reasoning faculty. The first is most appropriately accomplished by the conventional three R's, and by the teaching of geography, history, and languages, both ancient and modern; and the second by mathematics, logic, and the natural sciences. Sir John Lubbock, in addressing you some years ago from this chair, forcibly called attention to the necessity of combining both literary and scientific education in our grammar schools, suggesting that at least ten hours a week should be given up to the teaching of science.

Such a system of education has since been established at Eton, where (as reported in NATURE, vol. xxiv. p. 287) all pupils attend science classes, and are said to be very fond of what they are pleased to call the "stinks" (in allusion to the chemical laboratory); whereas at other grammar schools a "modern department" has been added to the establishment, where science is taught to those only who elect not to go in for a classical career, whilst the classical scholars remain untaught in science as before. I am of opinion that the Eton system is the better of the two, for I cannot regard an education to be complete that does not combine literary with scientific training; the one gives the polish and the other the fibre and practical direction to the understanding. A Birmingham manufacturer by no means despises polish to make his goods tempting in the market, but he would hardly like to offer them composed entirely of lacquer and polish without that solid fibre in the interior that is necessary to fit them for practical usage; such internal fibre may in our case be likened to the knowledge of useful information such as modern languages and natural science, without which the classical polish must be devoid of the power to produce results, which after all is the standard to be aimed at.

The man of classics, the Bishop, the Legislator, and the Judge of the future, educated at Eton, will be none the worse for standing upon an educational foundation comprising "stinks" in its composition, whereas the man of practical pursuits will be all the better for his early literary culture.

But it may be urged that the time available for study is too short to admit of both, and that one or other must therefore be chosen. I should venture to doubt the sufficiency of this objection, being of opinion that the study of the one kind of knowledge qualifies the mind the better for the other, in the same way as in after life recreative exercise of mind and body is resorted to in order to relieve the drudgery of daily duty.

The usefulness of science teaching depends of course to a great extent upon the teacher, and upon the system adopted. Science taught as it were by rote is of comparatively little value in after life; to be beneficial it should be practical, impressing the mind vividly with the simplicity and the beauty of the laws of nature, and for this purpose each statement of a law should be followed up by ocular demonstration, nay by active co-operation on the part of the student in the experiment. For this purpose no school ought to be without its chemical, its physical, and its mechanical laboratories, where students could test for themselves chemical reactions, verify physical laws, and ascertain the mechanical properties of materials used in construction. Nor do these laboratories necessarily involve a large expenditure for apparatus, the most instructive apparatus being that which is built up in the simplest possible manner by means of pulleys, cords, wires, and glass tubes, and, if possible, by calling into requisition the constructive ingenuity of the student himself.

Only after the student has attained a thorough knowledge of first principles will it be desirable to introduce him to elaborate instruments such as telescopes, polariscopes, electrometers, and delicate weighing-machines wherewith to attain numerical results and to commence original research. For this reason very complete laboratories are of great importance at the universities and superior colleges, where exact science and independent research take the place of mere tuition of first principles.

After first principles have been taught at school, the university on the one hand, and the workshop, aided by study on the other hand, are requisite to impart that special knowledge necessary for the profession or business to be followed in after-life. In this respect the German University—that glorious institution for the development of independent thought—offers advantages much more commendable for imitation than the technical school, and it is a significant fact that while the thirty universities of Germany continue to increase both as regards number of students and high state of efficiency, the purely technical colleges, almost without exception, have during the last ten years been steadily receding; whereas the provincial "Gewerbe Schule" has, under the progressive Minister, Von Falk, been modified so as to approximate its curriculum to that of the "Gymnasium" or grammar-school.

In some technical schools mechanical workshops are provided, in which students may work at the lathe, the vice, and the planing-machine, and where they are allowed to construct small steam-engines or other pieces of machinery. I doubt very much whether these toy steam-engines are such as would satisfy a mechanical engineer in real practice, and think that both the money of the institution and the time of the student could be much better employed if, instead of imitating practical engineering, he were made to experiment with testing-machines in order to obtain a thorough insight into the mechanical nature of materials, their absolute strength, their elastic limits, and the effects produced upon them by the processes of annealing, tempering, and welding. University College, London, has taken a lead in this respect under the able direction of Prof. Kennedy, and its example will, I hope, be followed by other colleges.

As regards middle class education, it must be borne in mind that, at the age of sixteen, the lad is expected to enter upon practical life, and it has been held that under these circumstances at any rate it is best to confine the teaching to as many subjects only as can be followed up to a point of efficiency and have reference to future application. It is thus that the distinction between the German Gymnasium or Grammar School and the Real Schule or Technical School has arisen, a distinction which, though sanctioned to some extent in this country also by the institution of the "modern side," I should much like to see abolished.

But I shall be told that it is impossible to teach everything properly within the time, and shall be reminded of the proverb that says, "A little knowledge is a dangerous thing." I, for one, do not believe in this proverb, which I consider erroneous, and mischievous in its application. Referring to myself as an example, I am sorry to state that I had not the advantage of being taught Greek at school beyond the mere letters of the alphabet—my early education having indeed been irregular and cut short much too soon—which surely is the minimum of knowledge that could possibly be possessed of that language. Yet even this amount of knowledge of Greek has stood me in good stead, because it has enabled me at any rate to use those letters in mathematical formulæ, and on a push to puzzle out some of those Greek names which are given to scientific instruments. In this case, at least, exceedingly little knowledge has proved no danger, but a considerable advantage to me, and it would not be difficult to multiply examples to the same effect. A little knowledge of a modern language will be best appreciated by an English person who, speaking no language but his own, has occasion to go abroad. Arriving at his destination he finds that he is unable to make the railway porter understand what conveyance he intends to take, and where he intends to go; his perplexity will be still greater when, on entering a restaurant, say at Paris, he is presented with a bill of fare extending over several pages, from which to select his dinner. In despair he points at random to some of the enumeration of dishes, and finds to his discomfiture that the one is presented to him in the form of a *pâté* of snails, another as a preparation of legs of frogs, and the third as water ice with which to appease an appetite quite equal to roast beef, potatoes, and cheese.

In physical science a little knowledge may be a matter of the greatest importance to an artisan when he is called upon to set a machine to work, and is stopped by some such accidental cause as the accumulation of air below a valve, or unequal expansion due to a local source of heat. The knowledge of a few fundamental laws of physical science will at once enable him to divine the cause of difficulty, which has only to be recognised in order to be removed. I should therefore be disposed to reverse the proverb, and to say that "a little knowledge is an excellent thing," only it must be understood that this little is fundamental knowledge; that it is not the knowledge of the conceited pretender who has committed to memory a few scraps of information of a particular subject; who quotes a Greek author without having learned as much of the language as I have; who speaks of planetary perturbations without having a knowledge of the fundamental law of gravitation; or who pretends to know all about steam-engines without having the least knowledge of the laws of heat, of elasticity, or of dynamics involved in their action.

On the whole I am inclined to agree with Lord Brougham, who, himself a great lawyer and a lover of science, gave origin to the pithy expression, "Try to know something about everything, and everything about something." It would be hard, indeed, to realise the latter portion of his saying, but it would be difficult to know even a good deal about something without knowing at least something about a great many other things.

The question of education becomes even more difficult when we approach the condition of the artisan who needs to send his boy into the mine or factory at the tender age of twelve years. I am of opinion that fourteen years should be the minimum age at which lads should be admitted into works, in order that they may have had not less than four years of judicious training at elementary or Board schools, where in addition to the purely elementary subjects, at least so much of general history, easy mathematics, and natural science should be inculcated as to implant, if possible, the desire to acquire more of those subjects in after life. School education, whether followed up to one point or another, can after all do no more than lay a foundation and implant, if possible, a desire in the mind of the student to follow up the subjects taught in maturer years with the experience of life present to give a practical direction to his studies.

In order to aid him in these endeavours, such bodies as the Midland Institute must prove to be of great service, with its science classes and lectures open to all who thirst after knowledge and who want to understand more particularly the scientific principles involved in their occupations. Technical education such as this is indeed indispensable if this country is to maintain the supremacy won for it by men of exceptional genius, enterprise, and perseverance, but which without it can hardly be expected to withstand in the long run the competition of foreign nations, with cheaper labour and a higher standard of general education in their favour. The English system of technical education has this advantage over the system established elsewhere, that it is not governmental but essentially spontaneous and self-supporting, and will therefore shape itself into the mould best suited to the free and vigorous development of trade itself.

The system of pupillage or apprenticeship will still be necessary, but instead of involving the sacrifice of seven of the most important years of a young man's life, half that time, or say three years, will be found amply sufficient to give to the lad imbued with first principles the practical knowledge necessary for his trade. The employer would be amply compensated for the shorter time of gratuitous service by a corresponding improvement in its quality. He should be expected to see to it that during the term of his authority the pupil attended Saturday and evening classes, where, in addition to general subjects, the principles underlying the operations of his business of spinning, dyeing, paper-making, or metal-working are taught by competent persons.

It is important that the teacher himself should not be a mere specialist, but a man capable of generalising and of calling to his aid other branches of science and general knowledge, that he should be, in short, a well-educated person. It is difficult, I believe, as yet to find a sufficient number of teachers equal to such a standard, and in order to supply this deficiency normal schools will have to be established upon a much larger scale than has hitherto been the case. It is satisfactory to learn that South Kensington is coming to the rescue in converting its science teaching into a normal school for the education of science teachers; only it is to be hoped that literary subjects will be added to their curriculum.

The importance of a higher education of the working classes will be appreciated by all who have watched the rapid strides with which one branch of industry after another undergoes fundamental change, by which the mere craft-skill acquired yesterday becomes obsolete to-day, when a new process, involving entirely new modes of operation, takes the place of a previous one. Nor is there any promise of stability in the process of to-day, which may be again superseded to-morrow by something more nearly approaching ultimate perfection.

To those who still have some confidence in the stability of things as they exist in arts and manufactures, I would strongly recommend a trip to Paris, where they will still be in time to visit the International Exhibition of Electricity. That form of energy known as the electric current was nothing more than the philosopher's delight forty years ago. Its first practical application may be traced to this good town of Birmingham, where Mr. George Elkington, utilising the discoveries of Davy, Faraday, and Jacobi, had established a practical process of electroplating in 1842.

It affords me great satisfaction to be able to state that I had something to do with that first practical application of electricity; for in March of the following year, 1843, I presented myself before Mr. Elkington with an improvement on his processes, which he adopted, and in so doing gave me my first start in practical life. Considering the moral lesson involved, it may interest you, perhaps, if I divert for a few minutes from my subject in order to relate a personal incident connected with this my first appearance amongst you.

When the electrotype process first became known, it excited a very general interest, and although I was only a young student of Göttingen under twenty years of age, who had just entered upon his practical career with a mechanical engineer, I joined my brother Werner Siemens, then a young lieutenant of artillery in the Prussian service, in his endeavours to accomplish electro-gilding, the first impulse in this direction having been given by Prof. C. Himly, then of Göttingen. After attaining some promising results, a spirit of enterprise came over me so strong that I tore myself away from the narrow circumstances surrounding me, and landed at the East End of London with only a few pounds in my pocket and without friends, but with an ardent confidence of ultimate success within my breast.

I expected to find some office in which inventions were examined into, and rewarded if found meritorious, but no one could direct me to such a place. In walking along Finsbury Pavement I saw written up in large letters "So and so" (I forget the name), "Undertaker," and the thought struck me that this must be the place I was in quest of; at any rate, I thought that a person advertising himself as an "undertaker" would not refuse to look into my invention with a view of obtaining for me the sought-for recognition or reward. On entering the place I soon convinced myself, however, that I came decidedly too soon for the kind of enterprise here contemplated, and finding myself confronted with the proprietor of the establishment, I covered my retreat by what he must have thought a very lame excuse. By dint of perseverance I found my way to the patent office of Messrs. Poole and Carpmael, who received me kindly and provided me with a letter of introduction to Mr. Elkington. Armed with this letter, I proceeded to Birmingham to plead my cause before your townsman.

In thinking back to that time, I wonder at the patience with which Mr. Elkington listened to what I had to say, being very young, and scarcely able to find English words to convey my meaning. After showing me what he was doing already in the way of electro-plating, Mr. Elkington sent me back to London in order to read some patents of his own, asking me to return if, after perusal, I still thought I could teach him anything. To my great disappointment I found that the chemical solutions I had been using were actually mentioned in one of his patents, although in a manner that would hardly have sufficed to enable a third person to obtain practical results.

On my return to Birmingham I frankly stated what I had found, and with this frankness I evidently gained the favour of another townsman of yours, Mr. Josiah Mason, who had just joined Mr. Elkington in business, and whose name as Sir Josiah Mason will ever be remembered for his munificent endowment of education. It was agreed that I should not be judged by the novelty of my invention, but by the results which I promised, namely, of being able to deposit with a smooth surface 3 dwt. of silver upon a dish-cover, the crystalline structure of the deposit having theretofore been a source of difficulty. In this I succeeded, and I was able to return to my native country and my mechanical engineering a comparative Crœsus.

But I was not to remain there, for in the following year I again landed in the Thames with another invention, worked out also with my brother, the Chronometric Governor, which, though less successful, commercially speaking, than the first, obtained for me the advantage of bringing me into contact with the engineering world, and of fixing me permanently in this country. This invention was in course of time applied by Sir George Airy, the then Astronomer-Royal, for regulating the motion of his great transit and touch recording instrument at the Royal Observatory, where it still continues to be employed.

Another early subject of mine, the anastatic printing process, found favour with Faraday, "the great and the good," who made it the subject of a Friday evening lecture at the Royal Institution. These two circumstances combined obtained for me an entry into scientific circles, and helped to sustain me in difficulty until, by dint of a certain determination to win, I was able to advance step by step up to this place of honour situated within a gunshot of the scene of my earliest success in life, but separated from it by the time of a generation. But notwithstanding the lapse of time, my heart still beats quick each time I come back to the scene of this, the determining incident of my life.

At the time I am speaking of, the electric telegraph was occupying the minds of the philosophers of different countries, but it was not until the year 1846 that the first practical line of telegraph was established between Paddington and Slough, where it soon gained notoriety in preventing the escape from justice of a great criminal. It is unnecessary for me to insist upon the enormous results that have been achieved by this great modern innovation, which goes even beyond the poetic vision of Shakespeare himself, who in the extravagance of his "Midsummer Night's Dream" makes Puck "encircle the earth in forty minutes," a rate of communication which would nowadays hardly satisfy the City merchants, who expect Calcutta and New York to respond to their calls much more promptly than that.

The telegraph has found its simplest but most remarkable development in the telephone, which, although shadowed forth by Ries in 1862, was only reduced to anything like a practical shape by Graham Bell in 1876, and subsequently extended by Edison, Hughes, and others.

This latter invention appeared at first particularly unpromising of practical results. The currents set up through the vibrations of a metallic diaphragm facing the poles of a small magnet are so feeble, and the rate of succession of currents necessary to produce sound (represented by 440 vibrations per second to produce the note fundamental *la*) was so very much beyond anything met with in telegraphy, that it was difficult to conceive how such a succession of distinct currents with the infinite variety of strength and quality necessary to reproduce speech could be transmitted through a line wire many miles in length, and could reproduce mechanically the same sounds at the receiving end. Yet the telephone has become a practical reality, and its ultimate powers are illustrated in a very remarkable manner at the Paris Exhibition.

There, in a certain room, you may listen of an evening one minute to the performance going on at the Great Opera House, the next minute to an air sung at the Opéra Comique, and again the next minute to the well-known voices of the principal actors of the Théâtre Français. The novelty of this particular arrangement consists in having each receiving telephone connected separately to a transmitting telephone, fixed in front of the footlights towards the two sides of the stage, whereby an acoustic effect is produced that may almost be called stereoscopic; you actually hear when the actor turns his or her head from one side to the other, and are able to separate most distinctly the several voices, as well as the orchestral instruments when concerted music is being produced. Nor are the sounds in any way distorted or disagreeable, or too low to be enjoyable, but loud and full, producing an agreeable impression even on the musical ear. The person with his ears to the two receiving telephones imagines himself in a mysterious dreamland of sound, but remove the instruments only half an inch from the ear, and all has departed; no sweet sounds of music are heard, but in their stead the speaking voice of the person anxious to take your place at the auditory. I leave to your imagination to picture the innumerable applications which this new power of man in directing the forces of nature may ultimately lead to.

The most striking feature upon entering the Paris Exhibition in the evening is the blaze of electric light that makes the interior of that large building even brighter than by daylight; nor is the effect of this illumination marred by the flickering, fizzing, and colour changing of the earlier attempts in this direction. The character of the lights comprises a range from the central arc of 10,000 candle-power, to the incandescent lamp of only fifteen candles, equalling the light only of an ordinary gas-burner, and the grouping and shading of some of these lights are such as to produce effects extremely agreeable to the eye. Who would venture to say, after this display, and after the practical applications that have been made of the electric light in the City of London, at several of our docks and harbours, at works, halls, and theatres, that it is not a practical illuminant destined to work as great a change as gas-lighting did before it, thirty years ago, when it was inaugurated at the Soho Works not many miles away from this hall?

But although I predict a great future for electric light as being the most brilliant, the cheapest, and the least objectionable from a sanitary point of view of all illuminants, I do not agree with those who consider that the days of gas must therefore be at an end.

In addressing the British Association of Gas Managers in this town a few months ago, I called attention to certain means by which gas of much higher illuminating power might be obtained from the ordinary retorts, if only, at the same time, the gas companies or corporations could be induced to supply at a reduced rate heating gas, of which we so much stand in need; and how, by certain improvements in the burners themselves, the illuminating power of a given quantity of gas might be still further augmented. Gas companies have for many years enjoyed the sweets of their monopoly position, which position is generally speaking not productive of desire for change. The electric light has furnished for them the incentive to advance, and the effect of that incentive has told already, I am glad to observe, in a very striking manner upon the street illumination of this immediate neighbourhood.

The time is not far distant, I believe, when gaseous fuel will almost entirely take the place of solid fuel for heating, for obtaining motive power, and for the domestic grate; and if gas companies and corporations rightly understand their mission, they will take timely steps to supply, separately, heating gas at a greatly reduced cost, the demand for which would soon be tenfold the gas consumption of the present day. The economy and the comfort which would accrue to the inhabitants of large towns by such a change would be great indeed, and it would, amongst other things, effect a radical cure of that great bugbear of our winter existence, a smoky atmosphere.

The third great practical illustration furnished by the Paris Exhibition has reference to the transmission of power from one place to another by means of the electric conductor. When, only five years ago, in addressing the Iron and Steel Institute, I ventured upon the assertion that the time was not distant when the great natural sources of power, such as waterfalls, would be transferred to considerable distances by means of stout electric conductors, to be there utilised for providing towns with light and motive power, I elicited an incredulous smile even from some of those most conversant with the laws of electricity. Electricity had been looked upon by them as a swift agent to flash our thoughts from country to country, but the means of producing that form of energy by the expenditure of power on the dynamo-electric machine, although known, was not yet properly appreciated. Such can hardly now be considered the case. I could point to at least three instances in this country where power is practically transmitted to a distance by means of electricity, to be utilised for pumping water, for lighting, and for working machinery, and the Paris Exhibition furnishes additional illustration of the facility with which that transmission may be effected.

The electric railway leading from the Place de la Concorde into the Exhibition, and only half a kilometre in length, does its work regularly and well, running a trip every five minutes, and conveying generally as many passengers as can be packed both inside and outside of a tram-car of ordinary dimensions. This system of propulsion will soon be in operation on a new line of railway six miles long, with which I am connected, in the north of Ireland, to be extended, if successful, to a further equal distance. This will give us twelve miles of electric railway worked without expenditure of fuel, for the motive power will be obtained from a neighbouring waterfall, which at present runs to waste. Mr. W. A. Traill, the Resident Engineer of the line, has already commenced operations, and I hope that by next spring, visitors to the sister island may reach one of its most interesting sights, the Giant's Causeway, propelled by invisible but yet potential agency.

The experience gained by my brother in the working of the first electric railway, two miles in length, established by him at Lichtenfelde, near Berlin, leaves no reasonable doubt regarding the economy and certainty of this mode of propulsion, although it is not anticipated that it will supersede locomotive power upon our main trunk railways. It will have plenty of scope in relieving the toiling horses on our tramways, in use on elevated railways in populous districts, and in such cases as the Metropolitan Railway, where the emission of the products of combustion causes not only the propulsion but the suffocation of passengers.

Another application of electricity, also at any rate indicated at the Paris Exhibition, is that to agriculture and horticulture, upon which I have been practically engaged during the last two winters on my farm near Tunbridge Wells. This is neither the time nor place for me to enlarge upon this application, which should be mentioned, however, because I believe that it will ultimately exercise a considerable influence upon an important interest, besides providing a means of adding to the pleasures of country pursuits. Electroculture by itself would be expensive, but not so if combined, as it is at Sherwood, with the utilisation of electric energy for accomplishing other objects—such as chaff- and root-cutting at one place, wood-cutting at another, and pumping of water at a third, while the waste heat of the steam at the generating station is utilised to heat the water circulating through the greenhouses, &c. In this way labour and expense are saved in many ways, and the men employed on the farm find no difficulty in working the electrical horses, no longer experimentally, but as a regularly established thing.

A somewhat special application of electricity, also shown at the Paris Exhibition, is its employment as a heating agent. For temperatures not exceeding that of a welding furnace, solid or gaseous fuel produces the desired effect at a cheaper rate than it is likely to be accomplished by electricity. When electricity is used, heat energy has in the first place to be transferred from the burning fuel to the boiler of the steam-engine. The mechanical energy of the engine works the dynamo-electric machine, whence electric energy is transmitted through the conductor to the point where it is to be utilised as heat. At each intermediate stage a loss will have to be incurred, and it is therefore absolutely certain that the amount of heat finally produced in the electric arc must fall very much short of that generated by the fuel under the boiler. But the electric arc has this advantage over other sources of heat, that no waste heat need pass away from it in the shape of heated products of combustion. This loss of heat in the furnace by combustion increases with the temperature at which the work has to be accomplished, and reaches its maximum in a furnace for melting steel or platinum. Beyond this the point is soon reached where combustion ceases entirely, where, to use the scientific phrase, the point of dissociation of carbonic acid is reached; and it is for purposes where such degrees of heat are required that the electric arc can be advantageously employed, and will enable us to accomplish chemical effects which have hitherto been beyond the reach of science.

My chief object in dwelling, perhaps unduly, upon these practical questions is to present to your minds in a concrete form the hopelessness of looking upon any of the practical processes of the present day as permanent, to be acquired in youth and to be the staple occupation of a lifetime.

The respectable millwright of former years had already to enlarge his scope of knowledge and become a steam-engine builder; having made himself master of the construction of simple forms of high-pressure engines, he has had to go to school again, to study the laws of condensation and of the expansive action of steam, in order to produce an engine using only a fractional amount of the fuel which his customers were willing to expend in former years for a given effect; he now has to study the laws of electricity and understand the construction of dynamo-electric machines, in order to be able to transmit and distribute his steam power more readily than could be accomplished by means of wheels and belts. But even his condensing steam-engine with variable expansion, of which he is so justly proud to-day, will no longer be acceptable to his client to-morrow, when it will be made clear to him, by the light of thermo-dynamics, that even the best of steam-engines utilises barely a seventh part of the heat-energy residing in fuel, and that the attainment of perhaps three-fourths of that ultimate limit will be required of him.

Analogous changes threaten to invade almost every existing branch of industry, and it is necessary for every one of you to be prepared for such changes.

The practical man of former days will have to yield his place to the unbiased worker who with open mind is prepared for every forward step as it arises. For this purpose it is necessary that he should possess, beyond the mere practical knowledge of his trade, a clear appreciation of the principles of action underlying each operation, and such general acquaintance with the laws of chemistry and physical science as will make it easy for him to adapt himself to the new order of things.

In order to be so prepared, it is by no means necessary that you should have had the advantage of an elaborate school education. No man or woman should consider him or herself out of school until approaching the final reckoning, and it is through advantages such as are offered by the Midland Institute, that the means are afforded you of continuing the educational process near your homes, and without much expense or difficulty of any kind.

Let no one of you suppose that his early training or natural ability is unequal to the task of making a career in life. Goethe, that man of wonderful insight into the working of the human mind, says:—

"Was man sich in der Jugend wünscht,
Hat man im Alter in Fülle."

Or, translated,

"What you desire in youth,
Mature age will give you in abundance."

At first sight this expression seems to involve almost an absurdity, and it is necessary to interpret the "desire" of youth to mean not simply a vague sentiment or wish to be looked up to in after life, or to drive about in easy carriages, but a determination to leave no stone unturned, and let no opportunity go past that may advance you towards the well-defined object of your ambition. With a firm resolution almost every difficulty in your way will recede before you; disappointments you will have, and they are most desirable, because they are the real teachers in practical life, only you must not allow yourself to be discouraged, but rather to be strengthened by them, in your determination to succeed.

A fond mother has sometimes come to me with a doleful story that her son, "an excellent young man," had tried several things in life and had always failed, through some untoward circumstance, but that she felt sure he would succeed if I would only give him a trial in my own particular pursuits. On some occasions I have perhaps yielded to such representations, but found that the "excellent young man," though commencing with a certain vigour, soon tired of the new occupation when he approached its difficulties. He could not realise the fact that the secret of success lies not in the avoidance of, but in the victory over difficulties, that each disappointment teaches an important lesson, and that by taking these lessons to heart without swerving from his purpose he would soon find himself possessed of a power exceeding his most sanguine expectations.

Success in life depends in fact much more upon diligence and steadiness of purpose than upon the more brilliant qualities possessed by an individual; but in order to give force and direction to the sterling qualities within him, it is most important that means should be brought within his reach of enriching his stock of useful information. The Birmingham and Midland Institute, counting its 2688 students of various degrees and of both sexes, has accomplished this important object in a manner never before dreamt of; but not content with this splendid result, the Council has made provision for a further extension of its beneficial action through the erection of this magnificent lecture hall, which it is my proud privilege to inaugurate this evening, for the use of our members.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—One interesting outcome of recent changes is the promulgation by the Governing Body of Caius College of the following scheme, to take the place of the regulations providing for the annual delivery of the Thruston speech on the progress of medicine from the time of Dr. Caius, by a medical graduate, who received the sum of 18*l.* :—The money—about 54*l.*—shall be given triennially to that member of the College who has published in the course of the preceding three years the best original investigation in physiology (including physiological chemistry), pathology, or practical medicine; the person to whom the prize is awarded being required to give an account of his investigation in the form of a lecture in the College. If within the specified period no investigation of sufficient merit shall have been made, the money shall be carried forward to augment future prizes; the first prize will be awarded in 1884.

SOCIETIES AND ACADEMIES

LONDON

Entomological Society, October 5.—H. T. Stainton, F.R.S., president, in the chair. — Exhibitions: Mr. R. McLachlan, a specimen of *Gastrophysa raphani*, Fabr., bred from a parthenogenetic ovum.—Mr. T. Wood, an abnormal specimen of *Notiophilus biguttatus*, Fabr.—Mr. R. Meldola, on behalf of Mr. W. J. Argent, some interesting varieties of British *Lepidoptera*.—Mr. H. B. Pim, a specimen of *Harpalus discoideus*, Fabr.—Mr. E. A. Fitch, *Lasius mixtus*, Nyl., an ant new to Britain.—Mr. A. S. Olliff, a specimen of *Papilio Americus*, Koll., with abnormal neuration.—Communications: the Secretary read a letter respecting the ravages of *Lopaphus cocophages*, Newp., destructive to cocoa-nut trees in Fiji; and some further communications from the Colonial Office relative to locusts in Cyprus, &c.—Papers read: Mr. D. Sharp, Descriptions of some new *Coleoptera* from the Hawaiian Islands.—Mr. C. O. Waterhouse, on some new South American *Coleoptera* of the family *Rutelidæ*.—Prof. Westwood, description of the immature state of a Ceylonese insect apparently belonging to an undescribed genus.—Mr. P. Cameron, notes on *Hymenoptera*, with descriptions of new species.

PARIS

Academy of Sciences, October 10.—M. Wurtz in the chair.—The following papers were read:—On the first volume of the "Nouvelles Annales de l'Observatoire de Bruxelles," by M. Faye. It contains a new uranometry, and a repertory of constants of astronomy. M. Houzeau has represented the Milky Way on a large scale by means of curves of equal luminous intensity. He distinguishes thirty-three luminous masses, carefully determining their position. Our solar world is situated almost exactly in the plane of the great celestial circle these nearly form, and is probably near its centre. The "Catalogue des Constantes" comprises seventy-six determinations of the solar parallax, extending over twenty-one centuries. The increasing precision of astronomical measurements is well brought out.—M. Daubrée presented a large specimen of a holosideric meteorite from Cohahuila, Mexico. It contains chrome-iron, a mineral not before met with in a metallic meteorite. Prof. Laurence Smith also found in it another chromiferous mineral, *Daubrélite*.—On the employment of tar as a preservative against phylloxera, by M. Avignon. A mixture is made of tar and fine sand, and triturated to render it homogeneous. Wood-ash is added; the mixture is put in a hole round the stem in spring and covered with earth. It effectually repels the insect.—A letter of M. Govi relating to a *brochure* by Prince Boncompagni on the unpublished will of Nicolò Tartaglia, noted the fact that the true surname of this celebrated mathematician of Brescia was Fontana. He was called Tartaglia (which means a *stammerer*, and which appears as his name, even in the will) because of difficult articulation arising from a bad wound in his jaw and palate received when he was a boy, during the sack of Brescia in 1512.—Comet discovered by Mr. Denning on October 4, 1881; observation at Marseilles Observatory, by M. Coggia.—On the part of M. Arnaud, a sample of a new alkaloid from quinquina (of Santander, Columbia) was presented; M. Arnaud calls it *cinchonamine*. It differs from cinchonine by an excess of two atoms of hydrogen, and presents the composition of hydrocinchonine, with which it is probably isomeric.—On the sounds produced in a telephonic circuit during thunderstorms, by M. de Lalagade. He recalls effects similar to those got by M. Thury, which he described in 1878. To amplify the sounds he afterwards added two small microphones to the plate of the receiving telephone; the least sounds can thus be heard 1 m. or more from the second telephone in a quiet room.—Galvanometer with angular deflections proportional to the intensities, by M. Gaiffe. The multiplier frame in the instrument presented (a horizontal galvanometer) was of elliptic form. The deflections are regular under two angles of about 35°, representing 35 milliwebers, on either side of zero, and then diminish slowly, allowing of division of the scale by units to the fiftieth milliweber. With a different curve of the multiplier frame the deflections may be rendered proportional up to about the seventy-fifth degree.—On the innervation of the heart and the action of poisons in lamellibranchiate mollusca, by M. Yung. *Inter alia*, the heart is chiefly innervated by fibres from the posterior or the branchial ganglions, which fibres have an accelerative *rôle*. Rise of temperature accelerates the heart's movements up to 40° C. *Curare*, in strong dose, makes the animal's movements very slow. *Strychnine*, whatever the dose, only causes temporary convulsions, never tetanus; in direct contact with the heart it lessens the number of beats, and causes stoppage in fifteen to thirty minutes. *Nicotine* accelerates the heart-beats, enlarges the heart, and in strong dose causes death. *Veratrine* acts similarly, &c.

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POLITECHNIKI BIBLIOTEKA GŁÓWNA WROCŁAWSKIEJ