THURSDAY, JANUARY 2, 1873

THE GOVERNMENT AND THE ARCTIC EXPEDITION

THE Arctic Expedition is undoubtedly the question of the day; or, seeing that the wheels of the gods have brought us to the commencement of another annual round, it may be really called the question of the year—that is, of the coming one. We may as well confess at once that we consider it quite worth all the attention it is likely to receive, either at the hands of Her Majesty's Ministers or from the public at large.

It is understood that the Government are at the present moment considering their decision, and it is because this is so that we venture to return to the subject, as there is an idea that the matter has not been put before the Government in the strong manner that it might have been; and the idea is true to a certain extent. But the blame, if any blame there be, attaches more to our scientific system, or rather our want of all system, than to any individuals. No doubt the Royal Society should have had a little more, and the Geographical Society a little less to say at the deputation that waited upon the Government, because we believe that the time has come when both Ministers and people will demand the widest possible basis of research for such an expedition; and that the widest possible basis was not put forward has since been clearly shown by Prof. Balfour Stewart, who has written to the *Times* on the subject. His letter is so important that we give it almost *in extenso*. He writes:—

"We have pursued terrestrial meteorology and magnetism now for some time, but until lately we have been rewarded with little apparent success. We are at last, however, beginning to understand the great importance of these studies, and to see the true path in which they ought to be pursued.

"Proofs of an intimate and mysterious connection between the sun and the earth are rapidly accumulating from various quarters, and the latest instance is one which is surely well worth the attention of all practical men.

"I allude to the discovery by Mr. Charles Meldrum, of Mauritius, that the years when most spots are observed on the sun's surface are also those of most cyclones in the Indian Ocean. Furthermore, a similar connection between the state of the sun's surface and the magnetism of the earth was noticed twenty years ago by Sir Edward Sabine, the late president of the Royal Society.

"Now, surely we ought to inquire into the nature of this mysterious connection, and, if necessary, we ought to spend both means and trouble in the pursuit of such an inquiry?

"What, then, ought to be done? The line of action is surely that recently suggested by Mr. Norman Lockyer. We ought, in the first instance, to scrutinise the sun's surface with all the appliances we can command, with the view of recording the meteorological changes which are there occurring; and in the next instance we ought to do the same with regard to our own earth. To do the first it will be necessary to establish a proper physical observatory; and to do the second *it is essential that we should become better acquainted with the less frequented regions of our globe, which are in many respects the most important. We must especially greatly extend our knowledge of the northern regions, and not of those alone but of the less frequented oceanic regions also.*

"Now, these are objects which can only be accomplished by means at the disposal of Government; for it will be in vain to expect whalers to supply us with the knowledge we desire of these northern regions, and it will be equally in vain to expect merchantmen to cruise about in the less frequented oceanic latitudes in order to increase our acquaintance with their meteorology.

"We have before us the splendid possibility of predicting the nature of seasons; but surely we cannot expect that Nature, who is usually so reticent, will disclose her secrets to a nation or a race who will not take reasonable trouble to complete their knowledge of the physics of the earth?"

Now there is no man of science who will gainsay these remarks coming from so distinguished an authority; and it is quite obvious that if the promoters of the expedition had taken a little more trouble and given a little more publicity to their action, the deputation might have been able to enforce its main arguments by this and other additional "reasons" given by other eminent men of science. Before it is too late, then, and another year is lost, it is to be hoped that the views so ably expressed by Dr. Stewart and held by all who have studied the subject in which he is such an acknowledged master, will be placed before the Government in the most forcible manner possible. The sun cycle to which he refers and which we now know governs cyclones and rainfall in certain parts of the earth, may it not also have something to say to the very passage to the Pole itself? May not the rainy mild seasons, which in the northern temperate zone, have more than once, to say the least, followed the sun-spot maximum, influence the dense masses of polar ice and make navigation more easy? If no one can answer this question, we have in this point alone a sufficient "reason" for undertaking the expedition; while the study of the whole phenomena including the spectrum of the aurora would furnish another, if the mere number of questions were to have weight; and it is curious to notice, that while we remain so ignorant of the nature of whole ranges of polar phenomena in the case of our own planet, the solar polar phenomena have recently been investigated by Prof. Respighi, with marvellous success, by means of the new method.

Sooner or later the polar phenomena of the earth must be studied, and their variations laid down in curves. Modern science demands this, and every year now lost it may take ten to recover. The question is, is England to have a hand in this matter? It is not a question between A's or B's pet theory of getting to the Pole. Will the Government refuse the expedition, now that Admiral Richards, the distinguished Hydrographer of the Admiralty, an officer in whose hands we may with safety leave the claims of cosmical science, has volunteered to command it? In the centuries to come, it will be told how England, in 1870 and 1871, sent out expeditions to observe eclipses of the sun, how in 1872 she sent out the *Challenger*, how in 1874 she sent out expeditions to observe the Transit of Venus. Why, then, should 1873 not be thus distinguished? We firmly believe that the Government have obtained a firmer hold upon the best side of Englishmen by their aid to these scientific expeditions than by all their merely political measures; and surely a universal approval, separated as far as possible from a party feeling, is the best thing Government can strive to obtain.

We believe a statement that the Government has refused the expedition will be received with universal disappointment by every class of Englishmen, to whom the memories which dwell round the name of Captain Cook and a whole navy of Arctic explorers in the past are very dear and a source of pardonable pride.

THE PROGRESS OF NATURAL SCIENCE DURING THE LAST TWENTY-FIVE YEARS

II.

DURING the last quarter of a century, the history of the formation of our earth has assumed a new aspect. When the *Cosmos* appeared, the opinion prevailed that our earth, once a globe of liquid fire, became covered with a crust of congealed scoriæ, on which, by-and-by, the first animal and plant life made its appearance; after an almost infinite length of time, during which the Silurian, Devonian, Carboniferous, and Permian strata were deposited, a terrible catastrophe, affecting simultaneously the whole earth, so completely destroyed the first palæozoic life, that not a single species survived the universal devastation. Upon the lifeless expanse, it was supposed, appeared then, forming the Secondary Fauna and Flora, entirely unconnected with and different from the extinguished one, until after frequent repetitions of the same process at longer or shorter intervals, man made his appearance, and along with him all existing plants and animals: with him begins the Historical Period, whose duration has not exceeded 6,000 years. The causes of these world-wide revolutions Geology sought in the violent reaction of the molten interior against the once extremely slender crust.

In opposition to these views, the opinion peculiarly associated with the name of Lyell has made way, that no violent revolutions, returning at intervals, destroyed the external structure of the earth and all the life it sustained, but that all changes even in the earliest times affected only the earth's surface, and that these could only be the results of the same powers of nature which are actively at work on the earth at the present time; and that moreover, the gradual, but ever active powers of water, of air, and of chemical change, have perhaps had a greater share in accomplishing these transformations, than the fierce heat of subterranean masses of lava. The explorers of the buried remains of plants and animals show it to be impossible that all life in those geological formations could have been destroyed simultaneously, for many species are common at several stages; in particular many existing animals and plants reach far back into the primitive world. Man himself could be shown to have been contemporary with many extinct species of plants and animals, and therefore his age on the earth must be extended back to an indefinite period. Man was witness to that inundation which buried the plains of the old and the new world under the waves of the sea of ice. Even in the immediately preceding period, when the subtropical elephant, rhinoceros, and hippopotamus disported themselves in the lignite woods of Middle Europe, have traces of mankind been found. Only in the most recent times has a foundation been laid for the pre-historic records of mankind, by means of which we may be able to obtain a knowledge of the state of civilisation, weapons, implements, and dwellings of that primitive race.

No book of recent times, Dr. Cohn thinks, has influenced to such an extent the aspects of modern natural science, as Charles Darwin's work "On the Origin of Species," the first edition of which appeared in 1859. For even to so late a period, was the immutability of species believed in; so long was it accepted as indubitable that all the characteristics which belong to any species of plants and animals were transmitted unaltered through all generations, and were under no circumstances changeable; so long did the appearance of new fauna and flora remain one of the impenetrable mysteries of science. He who would not believe that new species of animals and plants, from the yeast-fungus to the mammalia, had been crystallised parentless out of transformed materials was shut up to the belief that in primeval time an omnipotent act of creation, or, as it may be otherwise expressed, a power of nature at present utterly unknown, interfered with the regular progress of the world's development; yea, according to the researches of D'Orbigny and Elie de Beaumont, twenty-seven different acts of creation must have followed each other previous to the appearance of man—but after that, no more. It was Darwin who lifted natural science out of this dilemma, by advancing the doctrine that the animals and plants of the late geological eras no more appeared all at once upon the scene, than those of the preceding epochs simultaneously and suddenly disappeared; on the contrary, these are the direct descendants of former species, which gradually in the course of an exceedingly long period, through adaptation to altered conditions of life, through the struggle for existence, through natural and sexual selection have been changed into the new species. Professor Cohn does not doubt but that Darwin and his school may have over-estimated the reach of the explanations given by him to account for the transmutation of species, and especially the importance of natural and sexual selection, but the fundamental fact has been established, and will remain so for all future time. This fact is that the collective life of the earth, from the beginning even until now, and from the fungus-cell up to man, represent a single series which has never once been broken, whose members through direct propagation have proceeded out of each other, and in the course of a vast period have been developed into manifold and, on the whole, perfect forms.

The sciences which are concerned with life have during late years been cultivated on all sides; even in earlier years Cuvier and Jussieu had done as much for zoology and botany as the state of discovery in their time permitted, but since 1858 the boundaries of both kingdoms have been widely extended by the labours of Carpenter, Huxley, and Pourtalès.

After referring to the researches of Goethe in the last century, and those of Bauer and of Johannes Müller in the present, in reference to the physiology of plants and animals, Prof. Cohn says it was only in our own time, and first in 1843 in Schleiden's "Grundzügen der Wissenschaftlichen Botanik," that the new principle was followed out; the principle, namely, that all vegetable phenomena and all the various forms of plants proceed from the life and the development of their cells. After Schwann discovered that animal bodies also were built up from an analogous cell, mainly by Virchow was then developed from this principle the modern cellular physiology and pathology which traces the condition both of healthy and diseased men and animals back to the life-function of their cells. But, as the lecturer says, to attempt to follow out the advances made by science in these directions during the last twenty-five years would require a large volume, and cannot be done in the space of a lecture or an article.

Even the cell itself has been changed. Until Schleiden's time it was a little bleb filled with fluid; we now regard it as a soft glutinous body constructed out of the albuminous protoplasm first distinguished by Mohl in 1845, and which is covered with a cellular integument, as the oyster is with its cell. After waxing eloquent over the cell as an entity, an "ego" by itself, and its relations to the outer world, Prof. Cohn says that science now teaches us that there is only one life and one cell, the cell of plants and of animals being essentially the same. The most highly-developed animal differs from the simplest plant only in the number and greater development of the matter composing the cells, but above all, to the more complete elaboration (*Arbeitstheilung*), and the stricter subordination of the separate cells to the collective life of the organism. Between the two extremes of the living world, the yeast-fungus and man, there is the same difference as there is between a group of individual men who do not know how to organise their strength, and a strictly disciplined, well-ordered army suitably formed and well armed, and which, by the strict subordination of the many wills to the central authority, is always equal to the highest achievements.

It is true that these scientific researches into biology have left as yet the most important questions unsolved. It is not yet possible to regard all life-processes as simple modifications of the other forces of nature and to ascertain their mechanical equivalents; we cannot yet convert absolute heat or light into life; and although chemistry is daily doing more and more to bridge over the gaping chasm which once separated the organic and inorganic systems, it has not yet succeeded in finding out the precise matter which exclusively supports the life-process, on which alone the cells subsist. Thus, then, the beginning of life is still wrapped in obscurity.

After referring in this connection to the transmission of epidemics amongst plants, animals, and man, and to the microscopical labours of Leeuwenhoek, Ehrenberg, Gagniard-Latour, Schwann, and Kützing, Prof. Cohn goes on to say that the investigators of the present time, to whom Pasteur has given a powerful impulse, have been the first to establish beyond doubt that without *Bacteria* no putrefaction, and without yeast-fungi no fermentation takes place; that this decomposition is accomplished only through the sustenance and living activity of those microscopic cells.

Many a mystery of life will doubtless be unfolded to us if our opticians during the next twenty-five years should manage to raise the power of the microscope in the same proportion as in the previous quarter of a century, in which it has been at least quadrupled. The best microscope of Schiek and Plössl in 1846 did not magnify more than 500 diameters; the "immersion-lens xv." of Hartnack over 2,000 diameters. Still Dr. Cohn does not venture to hope that during the next twenty-five years all the questions of science which are at present being agitated will be solved. As one veil after another is lifted, we find ourselves behind a still thicker one, which conceals from our longing eyes the mysterious goddess of whom we are in search.

Dr. Cohn, in concluding his eloquent address, attempts to point out the characteristics which distinguish the present from the past generation. In the former epoch students confined their researches to single and carefully marked off divisions of nature, without any regard to the neighbouring and closely allied regions, which must necessarily lead to the one-sided view that these divisions belong to Nature herself. In the present generation, on the other hand, the several physical sciences have entered into the closest organic union. Physics and chemistry along with mathematical astronomy and geology, have been blended into a new science—the history of the development of worlds; palæontology, systematic botany, and zoology have been joined into a united science of organisms; the physiology of plants and of animals have become coalesced in universal biology; the boundary between the organic and inorganic aspects of nature is being ever more and more obliterated, and out of the several natural sciences a single uniform, universal natural science is being constructed.

But the deeper natural science penetrates from outward phenomena to universal laws, the more she lays aside her former fear to test the latest fundamental questions of being and becoming (*Sein und Werden*), of space and time of matter and force, of life and spirit, by the scale of the inductive method, and the more confidently she lifts her views concerning the universe out of the cloudy atmosphere of hypothesis into the clear ether of theory grounded on fact, so much the more will the gap be narrowed which since Kant has separated science from philosophy. Schiller's advice to philosophers and men of science—

> "Feindschaft sei zwischen euch; noch ist das Bündniss zu frühe;
> Nur wenn in Kampf ihr euch trennt, dann wird die Wahrheit enthült,"

has been followed for more than half a century, to the gain of the natural sciences, but often to the injury of philosophy, which would knock away the firm ground from under our feet. But since Herbart and Schopenhauer, and especially through Hartmann's labours, have the two chief drifts of the work of the human mind been approaching; and if natural science has a mission to mould the future of our race, she must court the purifying influence of philosophical criticism: and this mission, in Dr. Cohn's estimation, the science of the future cannot reject. Its importance rests not merely in the much interesting and useful information which can be made available to trade and industry, for daily economy and universal civilisation; she must build a sure foundation for our collective view of the universe, for our knowledge of ultimate and highest things. It must be no longer the case that even our most educated classes, in consequence of insufficient education, have neither interest nor intelligence for the pursuit and acquisition of scientific knowledge. Moreover, science will be no more able to shun battle with other systems of the universe which have been hallowed by the traditions of a thousand years, than were Socrates and Aristotle, Copernicus and Galileo. Victory will lie on the side of truth.

But if anxious souls should fear that with the advance of a scientific knowledge of the universe among the people, would come a breaking up of political and social order, let them be assured by the teaching of history. When we perceive the flash of an electric spark we certainly do not take it for a bolt darted by the revengeful Jupiter: and as the vault of Heaven is resolved into air and light, so also must the Olympus be shattered which was built thereon. But the ideas of the true, the beautiful, and the good remain unshaken; they have been all the more firmly established, for they have been deduced from the order of the universe and from the mind of man himself. And that the pursuit of natural science does not lead to materialism, and in no way injures the ideal mind, is vouched for by the case of Alexander von Humboldt himself, who, even in extreme old age, kept up his love for research and power of work as well as his lively susceptibility for and energetic share in all the noble pursuits of mankind.

Dr. Cohn concludes his lecture, so brimful of true eloquence founded on sober fact, with a high compliment to the many worthy qualities of the President of the Silesian Society, Dr. Goeppert. Such a man as he is said to be, the lecturer truly says, may hope, like Goethe, Humboldt, and other previous philosophers, to maintain to the utmost limit of existence, life, heart, and spirit full of the freshness of youth, and, moreover, in later generations be honoured as a true guardian of the highest good of grateful mankind.

VALENTIN'S CHEMISTRY

Introduction to Inorganic Chemistry. By W. G. Valentin, F.C.S. (London: J. and A. Churchill.)

WE must congratulate the author on the appearance of this volume. It is in reality a second and much improved edition of the first part of "Valentin's Introduction to Qualitative Analysis," and it is very encouraging that a second edition is so soon wanted. This book is one of a class which for the sake of English science we could wish were more numerous. It teaches chemistry entirely by practical work, and at the same time gives the student a clear knowledge of the general principles of the science. The very first words, indeed, afford a good idea of the system pursued throughout the work. Experiment 1.—"Fill a glass cylinder or a test-tube with water, and invert it over a basin containing water, &c." This experiment is the collection of hydrogen evolved from the action of sodium on water. This quotation may be taken as almost typical of the book. The methods of preparation and the properties of the various elements and simple compounds are studied by means of very carefully described and well-chosen experiments, and from his experiments the student is taught to draw deductions and generalisations. In this way the fundamental laws of chemistry are deduced from experimental facts, and a sound foundation of chemical knowledge is obtained. This method scarcely requires any recommendation; the fact that the author has adopted it after a long experience of practical teaching in one of our largest laboratories is one proof amongst many that the practical system of teaching is the only one which yields good and satisfactory results. This method of experimental teaching is now coming more and more into general use, and perhaps to a greater extent in chemistry than in any other science.

In the work before us there are 169 experiments carefully described, most of which are suitable for the student himself to perform; there are a few, however, the successful performance of which is almost beyond the capabilities of young beginners. The selection of experiments is left to individual teachers, and must depend to some extent also on the resources of the laboratory. It is a question whether some few of them are not more suitable for the lecture table, or to be performed under the immediate superintendence of the teacher. It would, perhaps, have been an improvement if the author had distinguished those experiments which he thinks are necessary for the student to perform. This would certainly assist a student working privately, and would to some extent be a sort of moral obligation on some teachers who might be inclined to run through the book superficially. Most of the experiments may be successfully performed if the directions in the book are adhered to, which are for the most part fully and clearly expressed. At the end of each chapter there is a short *résumé*, printed in italics, of the principal facts which have been demonstrated, and these form a very valuable part of the book. At the end of many chapters there is also placed a number of questions and exercises on the substance matter of the book, dealing, however, more particularly with those points which are found to be stumbling-blocks to students. It is recommended that the answers to these should be written out and examined by the teacher, which, though it would involve a considerable amount of labour, would render the laboratory teaching much more thorough and efficient. Many of the questions are by no means easy, and a student who can conscientiously answer them will have acquired a very fair knowledge of elementary inorganic chemistry.

The notation used is the same as that employed by Dr. Frankland in his "Lecture Notes." This, perhaps, may be a drawback to the use of the book by some teachers, although it appears that of late years this system has gained much ground. It consists essentially in the use of a series of compound radicals formed on the type of hydroxyl or peroxide of hydrogen, and in the employment of thicker type to represent certain elements which act as the grouping elements of each compound. Thus sulphuric acid is represented as consisting of the radical $\mathbf{S}O_2$ combined with two semi-molecules of hydroxyl, thus $\mathbf{S}O_2\ (HO)_2$, or, written according to the abbreviated formula, $\mathbf{S}O_2\ Ho_2$, when Ho represents a semi-molecule of hydroxyl; a sulphate, as, for instance, sodic sulphate, would be represented as $\mathbf{S}O_2\ (NaO)_2$, or $\mathbf{S}O_2\ Nao_2$, in which the monad radical Nao (sodoxyl) has replaced hydroxyl, basic sulphate would be $\mathbf{S}O_2\ (BaO_2)''$, or $\mathbf{S}O_2\ Bao''$, in which Bao'' is a compound dyad radical, consisting of one atom of barium and two of oxygen, and replaces the two semi-molecules of hydroxyl. The author uses the second of these formulæ throughout the work, although, perhaps it would appear slightly less complicated if the first of these two kinds of formulæ had been used. This system of formulating bodies with the use of this class of radicals has been employed for many years in the field of organic chemistry, so much so, that it is impossible to study this branch without being familiar with the system. We cannot see any reason why inorganic chemistry should not be treated in a similar manner, and we believe that this system will gradually and surely spread. Graphic illustration is also employed, and is very useful in explaining the constitutional symbolic formulæ employed in the book. There seems no doubt that the fear that students would materialise, as it might be called, these graphic representations was unfounded. The great argument advanced against the use of graphic illustration has been that students would imagine that it was intended to convey the positions of the atoms in space, and their linking or binding to each other ; but in practice this has not been found to be the case. As soon, however, as the pupils have become thoroughly familiar and conversant with the use of symbolic constitutional formulæ, there is less necessity for the use of graphic formulæ, except, perhaps, in the case of complex isomeric organic bodies.

The theory of the atomicity of chemical elements is also used throughout the book, and the author states that he has found it to be remarkably conducive to the quick and thorough understanding of chemical changes. This theory is without doubt of great use in assisting the mind to generalise and grasp the numerous reactions of the elementary bodies, and by thus introducing this theory we are enabled to systematise to some extent the study of chemistry, and therefore to materially aid the memory.

The illustrations are numerous and well executed, and in almost all instances give a very good idea of the kind of apparatus, which should be employed in the various experiments. In conclusion we think that if a student were to work conscientiously through this book he will secure a fair knowledge of elementary inorganic chemistry, which will serve as a suitable groundwork for him on which to found an extensive knowledge of this subject. We therefore cordially recommend this work to the notice of all teachers of practical chemistry.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Periodicity of Rainfall

THE remark of Mr. G. J. Symons in NATURE, December 26, that it seems to him "more likely that the effect of cyclone is simply to alter the locality of deposition" of rain, suggests a doubt whether the relation between rain and wind is sufficiently considered. The amount of evaporation must always be the chief element in the question of rainfall, and the total evaporation of any period must be much affected by the amount of wind. Evaporation may go on rapidly in still air, but it is almost necessarily increased if the air is moving. Storms over the sea not only bring moving air over a wet surface, but they also very largely increase the area of that surface by creating waves and foam. The evaporation during a cyclone may be presumed to be enormous. Wind in fact is almost always drying, even when rain is falling.

May we not on this account see a theoretical probability in favour of Mr. Lockyer's belief that the cycle of sun-spots coincides with that of rainfall?

If the solar spots indicate inequalities of temperature, the sun's heat when they are numerous will be radiated in bundles of rays of unequal power. These we may suppose, being directly incident on different portions of the earth, will cause special barometric differences here. The result will be special winds, and therefore special evaporation ; followed by unusual rainfall. The locality of this extra rainfall will of course depend on other causes, partly on the direction of the special winds, and if it should be thrown on polar regions or any other part of the earth where it escapes observation, there will be an apparent failure in the cycle. This also seems not inconsistent with experience as far as it goes ALBERT J. MOTT

Athenæum, Liverpool, Dec. 31, 1872

Eleven-Year Rainfall Period

THE Royal Exchange storm of Nov., 1838, happened twenty-two years before Prof. C. P. Smyth's Hyperborean one of Oct., 1860—twelve years ago. I have heard of a great one at Dantzic in 1816-17 (also twenty-two years before 1838). In a small book—"Chronological Tablets," published 1801, article on "Storms," great ones, in 1794, Oct. 6 ; 1784, Dec. 5 ; 1773, March ; 1751, Dec. ; 1740, Nov. 1 ; 1703, Nov. 26 (the Great Storm, *vide* "City Remembrancer," also *Nautical Magazine*, Jan., 1843, my extracts), this is not in the eleven-year series ; 1658, Sept. (death day of Oliver Cromwell, fifty-five years before great 1703 storm), &c.

Now as the sun and moon are probably prime agents in these periodic hurricanes, we get $11 \times 365\frac{1}{4} = 4017{\cdot}5$ days, being 156 periods of 25d. 18h. ; 147 periods of 27d. 7h. 7m. ; and 136 periods of 29d. 12h. 43m., nearly.

$$\text{Hyp. log. } \pi = 1{\cdot}1447300 = \frac{7.11.223}{15} = \frac{17171}{15} \text{ very nearly.}$$

Offord Road, N., Dec. 16 S. M. DRACH

Pollen-eaters

FROM a note in NATURE, Dec. 19, it appears that it has hitherto been a mooted question among entomologists whether any species of Diptera are pollen-eaters. I have often watched certain slender-bodied flies, belonging to or allied to the family of Noverers (*Syrphidæ*), in the act of feeding on the pollen of various flowers, which they effected by a quick jerking and grinding movement of the mandibulæ. I once witnessed the exhibition of a much more surprising taste by one of these insects, which, together with a small yellow ant, I watched for a considerable time feasting on a gout of resinous matter that had exuded from a wound in the bark of a spruce fir-tree.

Mention of ants reminds me of Mr. Meldola's statement (NATURE, vol. vi. p. 279) that Dr. Bree has pronounced their aphis-milking instinct a myth. While an undergraduate at Cambridge, I have more than once been a pleased spectator of this mythical performance ; but Dr. Bree's incredulity may be explained by the fact that all ants have not this instinct. At least, though for many years constantly on the look-out for it, only one instance of it has come under my notice on this side of the Channel. On one occasion when I introduced an ant among a number of aphides, her first act was to seize one of them in her jaws ; but after carrying it for a short distance over the backs of its fellows, she released it, and made what haste she could out of the company of creatures whose polite attentions she seemed by no means to appreciate.

Kilderry, Co. Donegal W. E. HART

Fresh Water on the Coast of Tobago

WITH reference to my letter of the 11th ult. (NATURE, vol. vii. p. 124.) I forward the following further information with regard to the appearance of fresh water on the coast of Tobago, promised from the same correspondent.

"The appearance of foreign water on our southern coast in the months of August, September, and October, is by no means a rare thing. This water is always of a dark colour, emitting after a time a most offensive odour, and leaving on the beach a line of a frothy substance of a peculiar odour and yellowish green colour.

"The influx to which I called your attention surpassed anything of the kind ever seen here. I am not aware that anyone has tested this water, or preserved any portion of it. Mr. ——— had some brought to his bath for salt water, and thinking that his servant had played him false, he repaired to the bay, (Scarborough) and found the water there fresh instead of salt.

"There is much difference of opinion here as to the source of this water. Capt. ——— supports the views of those who hold that it comes from the Oronoko. To do this, that great river must force its flood 180 miles against the equatorial stream and trade wind, while the rivers to windward, *e.g.* the Demerara, Essequibo, &c., discharge their water into that stream, which impinges on our southern and eastern shores, leaving unmistakeable evidence of its power.

"May not the Amazon have something to do with this phenomenon? It is said to send its waters 'pure and unmixed' into the ocean 300 miles. I have had no information as to excessive rains on the continent." RAWSON W. RAWSON

Government House, Barbados, Dec. 2, 1872

International Book Conveyance

THE benefits conferred upon science by the Smithsonian Institution are known to all your readers. The object of this note is to ask if it is impossible to find in the old world wealth and energy enough to copy one small branch of Prof. Henry's excellent work. I refer to the Smithsonian system of book exchanges, and I wish to know how much longer it is to continue easier and infinitely cheaper to exchange publications with one's correspondents in the other hemisphere than it is between London and Paris. Let me give an actual case. I recently sent two identical parcels of books, one to Utrecht and one to Washington. The former cost 5*s*. 6*d*., the latter cost nothing. In order that no one may run away with the idea that it would cost any very large sum to carry out this suggestion, I may remark that the Smithsonian system which is on a large scale, with agencies at Leipsic, Stockholm, Christiania, Copenhagen, Amsterdam, Paris, Milan, London, and Melbourne, besides its American ones, only costs 1,000*l*. per annum. We have only to copy on a diminished scale and to utilise existing agencies.

G. J. SYMONS

[See our note this week referring to an institution established at Haarlem.—ED.]

Dr. Cohn's Address

THERE is a passage in Dr. Cohn's address as reported in the Christmas number of NATURE (p. 137), which greatly needs correction :—

"Since, in the year 1842, an unknown physician in a Swabian country town, Dr. Mayer, of Heilbronn, pointed out that a hammer 424 kilogrammes in weight, which falls from the height of a metre on an anvil, raises the heat of the latter by one degree centigrade . . . "

Leaving historical accuracy out of the question, this is a gross misstatement of the physical fact. The correct statement is that the whole heat generated by the blow (which will be partly taken up by the hammer and partly by the anvil) will be as much as would heat *a kilogram of water* one degree centigrade.

Malone Road, Belfast, Dec. 28 J. D. EVERETT

[Dr. Cohn's words are :—"Seit im Jahre 1842, ein unbekannter Arzt in einer schwäbischen Landschaft, Dr. Mayer von Heilbronn, nachgewiesen hatte, dass ein 424 Kilogramm schwerer Hammer, welcher einen Meter tief auf einen Ambos fällt, den letzteren um einen Centigrad erwärmt," &c. ED.]

Salmonidæ of Great Britain

SOME months ago I inquired through the columns of the *Field* newspaper if any sportsman, fisherman, or naturalist would oblige me by replying to the following queries respecting the rarer *Salmonidæ* of Great Britain. Firstly, whether *Salmo ferox* (the great lake trout) had ever been taken in any lake in Wales, and, secondly, whether any of the Gwiniad tribe (*Coregoni*), such as the Gwiniad of Bala, the Vendace of Loch Maben, and the Powan of Ireland ; or any of the Chars (*Salmo salvelinus*) have ever been taken in any lake which is not *a glacial lake*—that is to say, a lake which either lies in the tracks of an ancient glacier, or that is dammed up, or otherwise surrounded by moraine matter? The only reply with respect to the first query was from Sir Philip Egerton, to the purpose that he took a specimen of *Salmo ferox* in Bala Lake in 1871, thus establishing the fact that this fish still lingers in North Wales. To the second question I have received no reply. Is it possible that I may be more fortunate among the many naturalists and geologists who take NATURE?

Pendock, Tewkesbury W. S. SYMONDS

Geographical Distribution of Dipterocarpeæ

MR. BENTHAM, in his address to the Linnean Society, delivered May 4, 1872, remarks in a note, "Dr. Hooker has, for instance, remarked that no *Dipterocarpeæ* have been found east of Borneo ;" but that in the present state of our knowledge it is premature to endeavour to establish well-marked limits between the flora of the western and eastern portions of the Indian Archipelago.

Padre Blanco (no great authority, however), describes several species of *Dipterocarpus* found in the Philippine Islands, and I myself sent to Mr. Robert Brown seeds of two species, one of which in shape and size resembled the figure given by Lindley in his "Vegetable Kingdom," in his illustration of the genus. The seeds of *Dipterocarpus* are so peculiar, that a mistake is not easily made in determining most of the species. From some of those found in these islands, valuable resins are collected. The wood of the trees, which are very large, is also of some economic value.*

Manila, Oct. 8 W. W. WOOD

Honest Cyclopædias

A FEW weeks ago Mr. A. R. Wallace asked in your columns if there existed such a thing as a cyclopædia which did not mislead or blind the inquirer by harassing and often useless cross references. As no one has yet answered Mr. Wallace's question, will you permit me to direct his attention to that admirable work, almost equivalent in its fullness to a cyclopædia and far superior to any cyclopædia I know in its recent and careful compilation, namely "Brande's Dictionary of Science," edited by the Rev. G. W. Cox. Rodwell's Dictionary is excellent, but is not so comprehensive as the last edition of Brande.

W. F. B.

"The Boring in Sussex"

ON the 9th inst. I was fortunate enough to find what I believe to be the *first fossil* from the Sub-Wealden boring at Netherfield, three or four shells of the genus *Cyclas*, in dark blue shale from a depth of 100 ft. There was also a small piece of what Dr. Bowerbank thinks is a *Paludina*.

As there are Wealden fossils, it is supposed that the borer has not yet got through the lower Wealden beds.

St. Leonard's, Dec. 17 J. E. H. PEYTON

Reflected Sunshine

THE recollection of a letter from Prof. Tyndall's pen, which appeared in NATURE some months ago, induces me to contribute an account of a curious sun effect recently seen from the summit of the Kudure Mukh, a hill nearly 6,200 ft. high.

The Ghauts here rise in bold scarps from the plains, large tracts of the latter being at this season under water, in preparation for the last rice crop.

Whilst resting one evening on the edge of the cliffs, I noticed as the sun declined that his reflection was approaching a series of sheets of water some six or eight miles off. Each of these pools cast upwards through the blue haze that overhung the plains a brilliant beam of light, the oblique rays from the water crossing those from the sun, and forming with them a chessboard pattern of light and shadow that was singularly beautiful.

As the sun dipped lower and his reflection fell full on the still expanse of water, the scene became almost magical. There shone a second sun at one's feet, its wealth of beams, undiminished in splendour, springing from the very bosom of the earth.

It required, indeed, but little stretch of imagination to fancy that a real sun was glaring up through some ghastly chasm in our globe. This phenomenon must be of frequent occurrence in many parts of the world, and wherever the distance between the observer and the reflecting surface is sufficient to greatly reduce the size of known objects, with which the eye naturally compares the apparent diameter of the reflected sun, the spectacle must always be a startling one.

Since my return from the district a friend who was camped at the Mukh prior to my visit there has told me that he also noticed the effect described above, and used to climb the hill every evening of his stay for the purpose of seeing it.

Mangalore, Nov. 21 E. W. PRINGLE

Electricity and Earthquakes

IT has been suggested that earthquakes may be caused by electrical discharges in the interior of the earth, and this may account for some remarkable effects of the great shocks which were so destructive to Manila in 1863.

It was observed that the effects of this earthquake were distributed in a peculiar manner over the comparatively small space occupied by the city and suburbs. On the banks of the river and canals, and through the northern quarter, great damage was done, while to the southward the mischief was comparatively slight. In parts of the town where large churches and other solidly-constructed edifices were ruined, other and slighter buildings placed near them escaped almost without injury. This was particularly noticed in the parish of Quiapo, where the church was

* The wood of one very large species, according to Padre Blanco, was formerly used in building the famous Acalpulco and Manila galleons, from the circumstance that, when pierced by cannon shot, it does not splinter in the way most other timber is found to do.

destroyed, while two very tall and isolated houses at a short distance escaped. One of these houses has a side-wall nearly 60 ft. high, and another one supported by other houses. The same partial effect was observed in other places, the terrestrial disturbance having been, as it were, distributed in veins or currents, in the line of which everything went down; but outside of these limits the damage done was comparatively slight. The exaggerated accounts published of the loss of life and injury to the city have probably never been exceeded.

We hear from the province of Albay (the southern extremity of the island of Luzow) that the grand volcano, the Mayon, was again in eruption, though at the last advices no damage had been done. This is perhaps the most beautifully symmetrical volcano in the world. From almost every point of view the outline is equally elegant. A few years ago I was fortunate in witnessing a fine eruption of the Mayon, which lasted for many days. By means of a powerful telescope I was able to watch its progress from a station at the base of the mountain. The ejected matter appeared to be red-hot stones only,* nothing like lava streams being visible. Indeed most of the volcanos of the Philippines throw out only scoria, ashes, and, it is said, in some cases hot water; but all information on these subjects is so liable here to gross exaggeration, that little dependence can be placed on anything but personal observation.

Another volcano, about 20 or 25 miles from the Mayon, called the Bulusan, which has been dormant for many years, began to throw out columns of smoke soon after the eruption of the Mayon, which I witnessed.

I regret I have not been able to ascertain whether these volcanic disturbances have had any effect upon the thermal spring of Tivi at the base of the Mayon in causing an intermission in the flow, &c. The waters of these springs, which are very limpid, deposit large quantities of silicious scuter, which encloses anything thrown into them. I have a piece of ordinary mat, which, in vulgar phrase, is completely petrified. The temperature is nearly boiling; but it is dangerous to approach the openings too nearly, and thermometrical experiments are difficult. Some of the concretions from certain parts of these springs are very massive, and when broken appear to be a nearly transparent silex.

Manila, Oct. 7 W. W. WOOD

P.S.—The post brings further accounts of the new eruption of the Mayon, which has assumed a formidable character, and is said to be the most violent which has occurred for many years. Some lives have been lost among the natives, who have their Manila hemp plantation on the flanks of the volcano, and great apprehension prevailed in all the villages around the base of the mountain. The new volcano on the island of Camiguin remains in a semi-active state—smoking, but without any regular eruption. Those who have visited it lately report that it is steadily increasing in volume, the irregular mass becoming larger daily, and working towards the sea. The inhabitants have generally returned to the island, but the villages in the immediate neighbourhood of the volcano are still deserted. Camiguin is important from its plantations of Manila hemp (*Musa textile*), and a good deal of capital is invested in them.

Oct. 10

* These appeared as if slowly pushed up from the interior of the crater, and, rolling out over its edges, went thundering down the cone, throwing out showers of fire as they struck the rocks or each other. This eruption was well seen by me from two opposite stations, and was said to have been equally fine when viewed from all sides of the mountain.

Atmospheric Refraction

If Mr. Wallace is still in search of facts on unusual atmospheric refraction, I would refer him in the first place to "Scoresby's Arctic Regions," and Scoresby's "Greenland," in both of which works very full and accurate information is given as to facts observed by the author; in the second place to the Phil. Trans. for 1798, 1799, and 1800, containing papers by Latham, Vince, and Wollaston; thirdly, to "Annales de Chimie," first series, vols. 29 and 39; the former containing a paper by Monge at p. 207, and the latter a paper by Gorsse at p. 211.

More recent observations are described in NATURE for July 28 and August 25, 1870, and August 25, 1872.

If any of your readers can inform me of any important contributions to the literature of Mirage besides these above mentioned I shall be greatly obliged.

J. D. EVERETT

BIELA'S COMET*

"BIELA'S Comet is my subject this time. A startling telegram from Prof. Klinkerfues on the night of Nov. 30 ran thus:—'Biela touched Earth on 27th: search near Theta Centauri.'

"I was on the look-out from comet-rise (16^h) to sunrise the next two mornings, but clouds and rain disappointed me. On the third attempt, however, I had better luck. Just about $17\frac{1}{4}^h$ mean time, a brief blue space enabled me to find *Biela*, and though I could only get four comparisons with an anonymous star, it had moved forward $2^s\cdot5$ in four minutes, and that *settled* its being the right object. I recorded it as—'Circular; bright, with a decided nucleus, but no tail, and about 45″ in diameter.' This was in strong twilight. Next morning, Dec. 3, I got a much better observation of it; seven comparisons with another anonymous star; two with one of our current Madras Catalogue Stars, and two with 7734 Taylor. This time my notes were—'Circular; diameter 75″; bright nucleus; a faint but distinct tail, 8′ in length and spreading, a position angle from nucleus about 280°.' I had no time to spare to look for the other comet, and the next morning the clouds and rain had returned.

"If I get another view before posting this I may be able to add a hasty postscript. The positions, the first rough, the second pretty fair from the two known stars, are—

	Madras M.T. h m s	R.A. h m s	(Apparent) P.D. ° ′ ″
Dec. 2	17 33 21	14 7 27	124 46
3	17 25 17	14 22 2·9	125 4 28

* Extract of a letter from Mr. N. R. Pogson, Madras Observatory, to the Astronomer Royal, dated Dec. 5, 1872.

HINTS ON COLLECTING ARACHNIDA

IT having been suggested to me by Mr. Sclater that a few hints on the collecting of *Arachnida* might be of use for natural history collectors and travellers in foreign parts, I have had great pleasure in drawing up the following notes on the subject, and shall be glad to receive collections of these animals from any part of the world.

1.—What are *Arachnida*?

These are Spiders, Scorpions, Harvestmen, and Mites with several other allied groups (which have no English names), such as the *Thelyphonidæ*, semi-scorpion-like creatures with a slender palpiform tail, and of considerable size; the *Phrynidea*, short-bodied creatures of a somewhat spiderish appearance, but often of large size, with a horny skin, and fore-legs of immense length and great slenderness; and the *Solpagidæ*, creatures which, if they can be said to resemble any others, are perhaps more like abnormal-looking spiders with a heavy head and great double jaws than anything else.

2.—What places do *Arachnida* live in?

Little need be said on this, for there is no place so barren, or so fertile, or so wet, or so dry, or so stony, but that some, and generally most, of the *Arachnida* may be found in it. Collectors abroad are often prevented from collecting birds or insects by weather, but *Arachnida* may be got in any weather, even if the collector be confined to the house. Numerous species may be found in corners and crevices; beneath old bark, or detached rocks and stones, myriads of spiders haunt. They are also to be found among moss and *debris* in damp places, in holes, in banks and river-sides; among the lower stems of grass and rank herbage, and the borders of swamps and ponds; on tree trunks, among lichens, on bushes, in blooms of flowers—in fact, to repeat it, everywhere; often moving in the hottest sunshine, and often concealed during the day, coming abroad at dusk and in the night.

3.—How to collect *Arachnida*.

The mere modes of capturing them need not be much detailed; there is an advantage in respect to *Arachnida* over all the *Insecta* in their being unable to fly. The greater number may be seized with the fingers with a little practice, and immediately plunged into a bottle of spirits of wine, or any other strong spirit; but many large ones may be boxed with large pill-boxes (of course, only one in each box), and at the end of the day may be suffocated with brimstone or chloroform, and then put into the spirit. Where a collector is collecting insects, he may catch many swift-running or strongly-jumping spiders by placing his open net in front and driving them into it with the other hand. A large umbrella is a first-rate implement for beating boughs or long herbage into.

4.—What to do with *Arachnida* after having caught and bottled them.

All that need be done is to put as many into a bottle as can be fairly got into it. There is no need to put large specimens into one bottle and small into another; for it is found practically that a judicious mixture of large and small is of no disadvantage, but rather the contrary.

One special point to be always observed is to fill up the bottle, where the specimens do not quite do so, with small bits of soft paper crushed up and gently inserted, until the contents fail to move about with the motion and shaking of the bottle.

The best bottles are ½ oz. phials, 1 oz., 2 oz., and 4 oz. wide-mouthed ditto, all of which are kept in stock by chemists or bottle-makers in England. The smallest of these will hold a large number of small specimens, and the largest are large enough for all except a very few of the gigantic *Mygalidæ* and scorpions; for the latter it must be a barren region which will not furnish an empty pickle-bottle capable of holding some scores of the largest species. Tight corking is, of course, necessary, and in hot regions tying down of the corks.

Of course any notes on the sexes of species or their habits, &c. as well as on their colours, as these sometimes fade in spirits, are valuable; and where notes can be made, there should be a supply of test tubes of various sizes into which the example noted should be placed with a written card or letter, with a parchment number corresponding with the numbered note. The tube should then be filled with spirit and stopped firmly with a piece of cotton-wool, and placed *wool downwards*, in one of the wide-mouthed phials. A number of tubes may thus be packed into a phial, but spirits should also be always put into the phial as well as into the tube.

Where there is a fear of handling spiders of large size, or scorpions, a simple pair of forceps may be made of a piece of bent hoop-iron, rivetted at the bend through a piece of inserted tough wood, this gives sufficient spring to keep the digital joints always extended a little way. With these forceps *Arachnida* of a large size may be safely caught, or extracted from holes and crevices.

Mr. Bates' plan for killing the Mygales on the Amazons, was to get them into a tin pot or box, put the cover on, and place it for a few minutes upon the glowing embers of a charcoal fire. These means of killing may be used where neither brimstone nor chloroform are available.

From the above hints it will be seen that, compared to the trouble of collecting birds, mammals, or insects which require careful setting and drying, the trouble of collecting and preserving *Arachnida* is *nil*, and in all tropical regions an intelligent native would collect hundreds of specimens in a day if he were only furnished with two or three large bottles full of strong spirit.

Thus all that is necessary for the complete equipment of a collector of *Arachnida* is a large umbrella, a pair of forceps (such as are above described) about twelve inches long, two or three dozen of the bottles above-mentioned, a hundred or so of test-tubes of different sizes, a little cotton-wool, soft paper, and some strong spirit, which may be got on the spot nearly everywhere.

O. P. CAMBRIDGE

INTRODUCTORY LECTURE OF THE MURCHISON CHAIR OF GEOLOGY AT EDINBURGH, SESSION 1872–3*

BEFORE entering on the special subjects to be treated of in the following course of lectures, it is most desirable that we should definitely shape to ourselves the objects we have in view. By doing so we can the better take stock from time to time of our gains, and judge at the end how far we have succeeded in achieving any solid advantages.

Now, if I put the question frankly to you, What do you propose to accomplish by voluntarily placing yourselves under such a course of instruction as that which begins here to-day? you will, perhaps, reply that your desire is to know something more of a science which offers to your minds so many points of interest.

The task you have undertaken promises to be a pleasant one, and possibly all the more so since there may be a very general impression among my audience that your duties here will be rather an exercise of the memory than of the reasoning powers, and hence a not unwelcome relief from severer studies.

I should be sorry to dispel so pleasing a belief; on the contrary, it would give me some assurance that if our conjoint efforts fail the fault will lie with me, and not with you. Nevertheless, I have a deep conviction that, in seeking here merely an addition to your knowledge, you would neither do justice to the subject we are to study nor to yourselves.

I know only too well that the imparting of knowledge is popularly supposed to be the only aim and purpose of natural science teaching, and that this notion pervades our system of education. I believe it to be but a partial view of the truth; and even at the risk of being thought dull I would lay before you another view, that you may see what additional objects you may, in my opinion, accomplish here, besides storing your minds with facts.

No one who thoughtfully considers the state of public feeling in this country at the present time can doubt that we are on the eve of educational changes more momentous than any which have come to pass for centuries. It is not merely that education has become a political cry; that it forms a staple element in the declamations which fill the air from the halls of St. Stephen's to the village green; and that all this oratory finds further exposition and enforcement in the public prints. It is not merely that we believe it will be hard, a generation hence, to find a man or woman throughout the land who cannot at least read and write. These results, profoundly important as they are, do not fill up the whole measure of change which is impending, nor are they those which most nearly concern you and me at present.

It is impossible that such radical reforms should be worked in the primary education of the country without an influence, and perhaps an extremely potent one, upon the higher forms of culture. On every side, indeed, we can already descry indications of the coming changes—changes, however, which are not wholly, nor even, perhaps, chiefly, due to the disturbances of our primary educational system, but which would assuredly have been brought about, even had no sweeping Parliamentary legislation taken place.

Nowhere can these indications be more significantly seen than among those conservative educational centres, where it might have been supposed that the call for reform would have been longest in making itself heard and obeyed. Even there the old and time-honoured traditions are losing their hold. The young blood of a newer time has begun to quicken some of the most dormant of our institutions.

Uncompromising opposition is apt so to embitter a struggle, that what is at first only a desire for reform partakes in the end somewhat of the blind fury of a revolution.

* Given on Nov. 11 by Prof. Geikie, F.R.S.

It is, however, a happy omen for the future of higher education among us that some of the most strenuous champions of change are to be found among those whose vested interests and traditions might have been deemed likely to ensure their conservatism. These men are not in much danger of going too far, and yet their earnestness is a guarantee that they certainly have no intention of standing still. The foundations on which the culture of centuries has been built are not to be ruthlessly pulled up; but the time has assuredly come when they need to be broadened and widened.

Let no one imagine that such words as these imply any want of reverence for the time-honoured means of mental discipline. Literature and philosophy have ever taken, and must ever take, the foremost place in intellectual culture. They bring mind in contact with mind, and with all that is highest and noblest in the history of humanity. There was a time, indeed, when they comprised the whole sum of human thought. That time has long passed, and yet, in our traditional system of education, we still perpetuate its memory. But man has since then discovered that, although he be indeed a marvellous microcosm, there lies outside of him a great world full of infinite diversity wherein he can, nevertheless, discover such a unity of plan as links even his own being with every part of nature.

It is not now enough that man shall know what his forefathers have thought, or written or done, nor that he shall content himself with studying the nature and workings of his own mind, or busy himself with abstract principles of magnitude and number. Now why is this so? Because during the last two hundred years his relations to the external world have been so thoroughly altered. He is no longer a mere higher kind of animal, ignorant almost as other animals of the phenomena in progress around him, and well-nigh as helpless as they in the inevitable struggle with the elements. For thousands of years he had aspired to rule over but one, and that the least, of the domains of which he was made lord at the beginning:—he was content with undisputed dominion over the beast of the field, and the fish of the sea, and the fowl of the air. He has now claimed the right which was his by the same charter to have dominion over the earth and to subdue it. So that now his mastery is hardly less decisive over air, and land, and sea. He can bend the energy of nature to do his humblest offices.

What is it, then, which has made this difference between man's power in this present time and that which he possessed only a few generations ago? Can you trace it to the teaching of the schools? Is it the fruit of that traditional system handed down to us from older centuries? Assuredly not, it has sprung from a sphere of education outside of the schools. It is to be traced, without doubt or cavil, to the strides which modern physical science has taken. Man has gone to school elsewhere than in the class-rooms. He has proved himself too, to be an apt pupil, for in the comparatively short space of time in which he has given himself to these pursuits, he has gained such a mass of knowledge as has enabled him to work greater changes on the face of the globe and on his own relations to it than had been effected during all the previous centuries put together.

By this wide-spread dominion over nature we stand separated by a kind of gulf from our forefathers. And yet strange as it may seem, we have made no corresponding change in the range of subjects which are still prescribed for the higher education of the country. We send our young men and young women to be trained very much in the same modes which were in use a couple of centuries ago or more. We live in the days of railways and telegraphs, and we educate our youth as if they lived before the introduction of mail-coaches.

It is true that both in the higher schools and colleges, certain supplementary subjects, of which natural science is one, may be taken at the option of the learner. But these subjects are not made essential parts of our higher education, nor does any provision exist for making them more than mere sources of information. They are not in any way made use of as implements of intellectual training. And even the use to which they are put is so slight that a man may attain the highest academic honours and yet remain as ignorant as a school-boy of the commonest facts and phenomena around him, and of the causes which make his own age to differ so prodigiously from the ages which have gone before it.

I remember being much impressed with this fact, when as a boy, I met among the hills of Skye, a man who had not long taken his Master's degree at Cambridge and who had retired to that remote region for the purposes of further study. We happened to get into conversation regarding the origin of the mild climate of the north-west of Scotland. On being questioned, I referred to the influence of the Gulf-stream, My friend, however, had never heard of a Gulf-stream, refused to believe it to be more than one of what he called my "geological speculations," and would hardly even credit the schoolmaster, who, when appealed to, gravely assured him that he had heard of the Gulf-stream before I was born.

This may be an extreme case, but it is an actual one. It serves to show that though a man can hardly fail to pick up some acquaintance with science in the course of ordinary conversation or in reading the current literature of the day, no provision exists for making instruction in the meaning of the ordinary every-day facts of nature a necessary part of education, and that a man may gain his academic honours even without such instruction.

I am well aware that in one way or other a smattering of at least one science, sometimes a confused jumble of several, is very commonly carried away from school. The science-classes there, though they may be wholly optional, are often also popular with the scholars. Interesting experiments, pretty specimens and amusing diagrams are exhibited, and some amount of information is communicated, even if no special interest should be awakened in the subject, and no clear mental gain should be the result. But this is far from the sort of position which, as it seems to me, science ought to hold in higher education.

If culture is to be really liberal, that is, free and generous, surely it ought above all things to reflect fully and fairly the spirit and character of the time. If it shuts out this influence and continues to maintain the standard fixed for a wholly different time, does it not cease to be truly liberal? Full of reverence for the past, and striving after the fullest use of the heritage of wisdom which the past has bequeathed, a liberal culture, to be worthy of the name, must recognise that no standard however serviceable for the time in which it was erected, can be permanent; and that the limits which it sets for its own age cannot bind the ages to come. For the laws of continuity and evolution embrace the workings of the human mind as well as the operations of outer nature. And in the end it will be as impossible to keep the flow of youthful thought confined in one narrow and old-fashioned channel as it would be to restrain the river which is every moment rising to overflow its banks.

No great foresight is needed, therefore, to perceive that before many years are past the stereotyped curriculum for what is called a liberal education, whether in higher schools or in the universities, must be modified. It is not enough that a young man or a young woman should be permitted a choice as to the acquiring of some knowledge of science beyond that needed for the old standard. This knowledge, but still more the intellectual training by which it was originally obtained, should be an essential part of any system of education truly deserving now-a-days the name of liberal. And the want of this training should be regarded as quite as serious a defect in education as an ignorance of Latin or mathematics.

(*To be continued.*)

ON THE SPECTROSCOPE AND ITS APPLICATIONS

I.

WE now approach Newton's great discovery, which is this :—"*The light of the sun consists of rays differently refrangible* ;" that is to say, if we take a beam of sunlight, and make it pass through a prism, we shall get colours of different refrangibility. We see then that if, instead of two coloured beams, we pass one of perfectly white light through the prism, the action of the prism is at once to turn that beam into a beautifully coloured band, which will remind you of a rainbow. It was this which Newton did in a dark room, which led him to his important discovery. White light is compounded of light of different degrees of refrangibility. But how is it possible to show the truth of Newton's assertion that white light is compounded of these different colours? We can do so by simply placing in the path of the coloured beam which you see passing through the room, another prism placed in a contrary direction, as shown in Fig. 10; you see in a moment that we get back white light; for the second prism exactly neutralises the effect caused by the first, and the ray proceeds as if nothing had happened.

Possibly you may ask, is it true that white light is built up of all colours? That question can be answered to a certain extent by an experiment of a different order. If

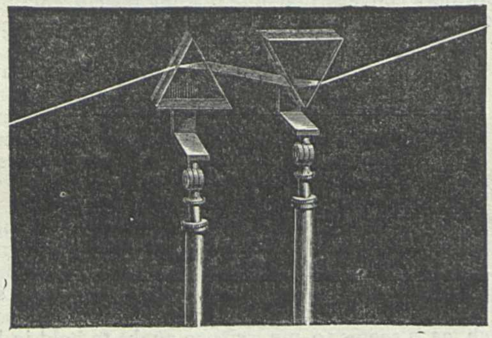

FIG. 10.—Recomposition of white light by means of a second prism.

a disc, divided into sections and coloured with the principal colours of the spectrum as shown in Fig. 11 be taken, and if it be true that the idea of white light is simply an idea built up by the eye, because we have all these multitudes of light waves perpetually pouring into it with a velocity that is very much greater than anything which can be translated into words, surely we should get something like this effect also if we were able, by rapidly rotating this screen, to obtain a more or less perfect substitute for white light. The coloured disc being made to rotate rapidly, you see we obtain something like an approximation to white light, though the white colour does not come out so clearly as it might do. Now I am very anxious that you should see that this is really an effect due to the flowing in of light from different parts of that wheel into the eye, and so forming this compound impression, which is conveyed to the brain; and so if instead of illuminating the disc continuously by the electric lamp, or by sunlight, it is illuminated intermittently, by an electric spark, you would see that although the disc is rotating rapidly all the time, each separate colour is now discernible, and the disc appears to stand still. The reason of this difference is, that in one case the rotation of the wheel builds up a compound image in the eye, and in the other case it cannot do so, because the flash of the light is much more rapid and instantaneous than the rotation of the wheel.

There is one more experiment which can be easily made, to show that all the beautiful colour which we get in nature is really reflected after all, and that if our sunlight, instead of being polychromatic—that is to say, compounded of all these beautiful colours—were monochromatic, or of one colour only, the whole expanse of creation would put on a very different appearance from what it does. If, instead of illuminating a diagram, the letters of which are of different bright colours, by the white light of the electric lamp, we illuminate it by a light that only contains one colour—by the yellow light of sodium, for instance, and then look at the diagram, you will see that some of the letters upon it are almost invisible, whilst others are very clear, the yellow light only allowing a difference to be seen of more or less depth of shade, there being no difference in colour. But when we allow the polychromatic light from the lamp, or as we get it from the sun, to shine upon the diagram, you at once see that all these letters are of different colours, and burst out, as it were, into beauty. This experiment feebly indicates the advantage we possess in living in a universe lit by white or polychromatic light, instead of light which is merely blue, or yellow, or any other single colour.

Hitherto we have spoken only of refraction. I now introduce the word *dispersion*, which represents simply a measure of different refractions, or the difference between the bending of the red and the violet rays of light. In an ordinary spectrum the difference between the red and the

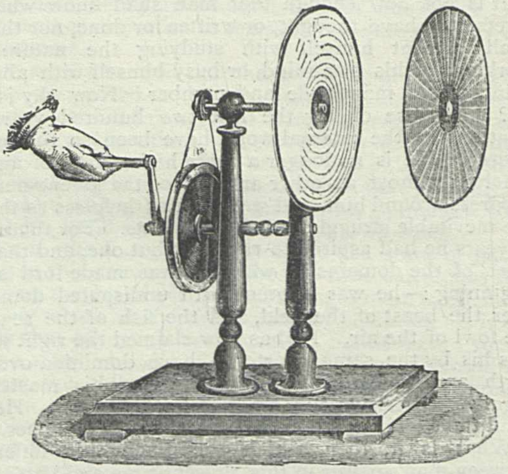

FIG. 11.—Recomposition of white light by means of a rapidly revolving disc coloured in sections.

violet is the difference of the refraction of those two colours by the prism, and the angle which the red, or yellow, or other colour forms with the original path of the compound-beam is called the *angle of deviation*.

There is one other consideration which we owe to Newton. In his very first experiments, that great philosopher discovered that the quality of the spectrum depended very much on the following consideration :—If I wish to get the best possible effect out of a prism and the purest possible spectrum, I have so to arrange it that the particular ray which I wish to observe, whether the yellow, the blue, the green, or any other, leaves that prism at exactly the same angle as the incident compound ray falls on it. This angle is termed the *angle of minimum deviation*.

The two things, therefore, of greatest importance in this subject which we owe to Newton are, first, the explanation of the dispersive power of the prism; and next, the pointing out the extreme importance of arranging the prism, so that if we want to observe any particular part of the spectrum, the rays constituting that part of the spectrum should leave the prism at the same angle as the white light falls on it.

It is very curious, however, that Newton, although he made many experiments on prisms, really omitted one of the most important points, which you will see carefully arranged for in every one of the spectroscopes used at the present day. And here again we get an idea of the enormous patience which is necessary in these matters, for we had to wait a century and a quarter before the next essential point was hit upon in the construction of a spectroscope. Newton made a round hole in a shutter for his experiments, but we now know that he ought not to have done that; he ought to have made a slit. But this did not come out until 1802, when Dr. Wollaston, by merely using a slit instead of a round hole, made a tremendous step in advance. You will see the importance of this in a moment. If we take a cylindrical beam of sunlight and put a prism in the path of the beam, we observe that the spectrum is not a pure one; but if we change the round hole for a slit, we obtain a spectrum of the greatest purity; the red, blue, green, and violet, instead of overlapping and destroying the beauty of the spectrum, show distinctly as simple colours, each one speaking for itself on the screen. By using this narrow slit instead of the round hole which Newton made in the shutter, we got the first idea of the tremendous importance of spectrum analysis; for no sooner had Dr. Wollaston examined the sunlight with the new arrangement, as Newton had done a century and a quarter before with the old one, than he found out that it was not at all as Newton had represented it. Newton told us in fact that the sunlight was continuous, that is to say, that the spectrum was one in which there was no break in the light which flowed out to every part of the spectrum, from the extreme red to the violet. When Dr. Wollaston tried the slit he found, however, that the spectrum, instead of being that rainbow band of light which you have seen, was really broken by a succession of fine—beautifully fine—black lines.

These lines were observed by Dr. Wollaston, but it was not till 1814 that we find them mapped out with the greatest care, to the number of 576, by a German optician named Fraunhofer; hence they are termed "Fraunhofer lines," the principal ones being lettered A, B, C, &c.

If we say, then, that spectroscopic inquiry dawned with Newton, certainly the sun began to rise with Fraunhofer, for he, no longer content with getting a sunbeam through this slit, and finding out and measuring with most admirable accuracy these 576 lines in that band of colour, turned his telescope to the moon and the planets, and the different stars; and he discovered that, in the case of the stars, the positions of the lines varied considerably from those they occupied in the spectrum of the sun; and this is one of the most important discoveries which has been made during the present century in these matters. Indeed, it is the foundation of very much of the later more detailed work.

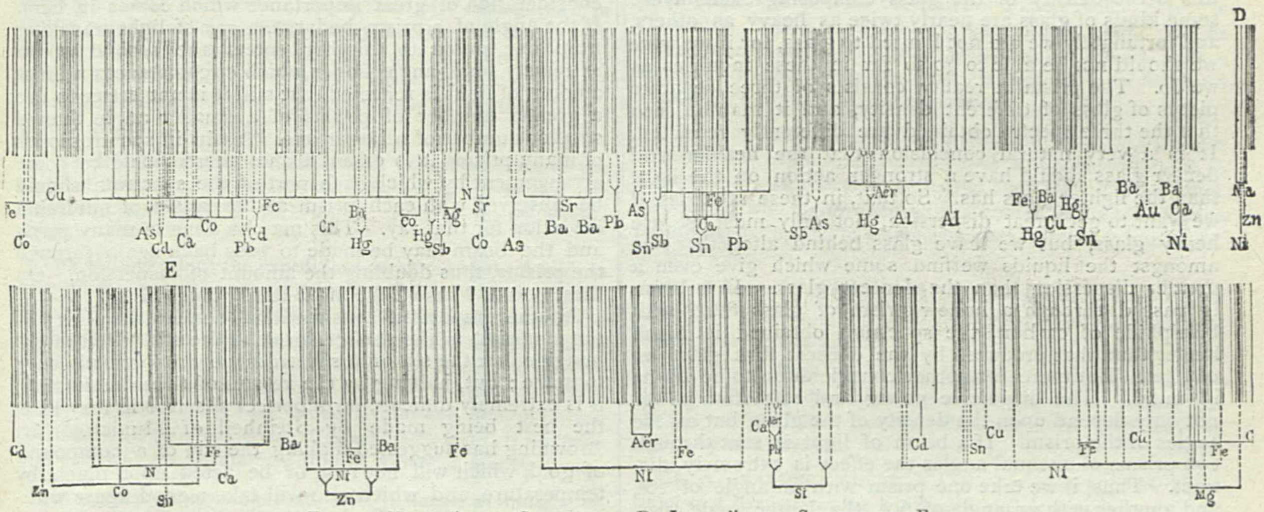

FIG. 12.—Upper diagram, Spectrum near D: Lower diagram, Spectrum near E.

The solar spectrum then, as we have said, far from being continuous, is crossed by an almost innumerable number of dark lines, some being fine and others thicker and blacker. Fig. 12 shows a small portion of the spectrum in the yellow and green. Other observers, such as Kirchhoff, Thalén, and Angström, have worked at these dark lines, and have drawn most beautiful and elaborate maps, showing at least 2,000 lines of various thicknesses.

We have now to pass on from 1812 to the year 1830, when Mr. Simms, an optician of world-wide reputation, made another very important improvement in the spectroscope. Instead of merely using a prism and observing the slit with the naked eye, he placed a lens in front of the prism, so arranged that the slit was in the focus of the lens. The light which is allowed to pass through the slit is thus turned into a cylindrical beam, and thus travels through the prism; then, instead of having merely the eye to observe the spectrum, there is another lens which grasps the circular beam and compels it to throw an image of the slit, which may be magnified at pleasure. The very great importance of this construction is at once obvious, if you think for one moment of the figure showing the lines in the solar spectrum. We now know, and it is not too early to place this before you, that these black lines indicate regions in the spectrum where there is no light. If the light is perfectly continuous, so that every ray of light is enabled to register itself at the end of the telescope, by painting an image of the slit, you will get a continuous spectrum; but supposing, for instance, that the whole of the yellow light were absent, it is clear that the spectroscope, if it does its duty well, will give you blackness where the yellow light is absent. We do not find that the whole of any particular colour is absent, but here and there, scattered over all the colours, there are these places where the rays of light do not come to tell their story. This is the explanation of the Fraunhofer lines in the solar spectrum. In the light which we get from the sun, certain of the rays which we may suppose ought to come to us, do not come, and we get no news from them. We do get news of some of the other rays, which show us the various shades of blue, of green, and so on; but here and there a ray, which possibly might have come if it were not better employed, does not come, and therefore the image of the slit cannot be painted.

I am glad to say that we know a little more about these lines than we did some years ago. You may imagine the enormous mystery—the wonderful reverence almost—with which this question of the Fraunhofer lines was approached, until they were thoroughly understood; and recollect that we owe the discovery of them—by which we are enabled now to determine the pressures acting in the atmospheres of the most distant stars—simply to the fact that Dr. Wollaston, instead of drilling a round hole, used a slit; and to the other additional fact, that Mr. Simms, instead of using that slit with a mere prism, used a lens and made the beam parallel, and then allowed that parallel beam, after it had passed through the prism, to pass into another telescope, and form an image of the slit. You see how closely connected are the grandest discoveries with the skill and suggestiveness of those who supply different instruments for our use.

Now I must ask you to come back again to the prism. I have already told you that dispersion is the measure of the difference of the refrangibilities. If we take a prism which appears like an ordinary one, but really is composed of several layers of different kinds of glass, and pass an ordinary beam of light through it, it will be differently acted upon by the various layers, and we shall get a difference in the spectra. We have here, in fact, three distinct spectra, showing that there is something in the different layers of which this prism is composed which turns the light out of its path, and which disperses it more in some cases than it does in others. The cause of this is the density of the glass composing each layer: some kinds of glass are nearly twice as heavy as others, and fortunately we are not limited to glass, for if we were we should not be able to go so far in these inquiries as we do. The prism in reality consists of three separate pieces of glass of different density, and it may be seen that the three spectra obtained are differently refracted. It is a very natural conclusion that the heavier and denser glass should have a stronger action on the light than the lighter glass has. So that, in these inquiries, if we want to get great dispersion, not only must we use heavy glass, but we leave glass behind altogether, as amongst the liquids we find some which give even a greater dispersion than the densest glass. If a beam is passed through a hollow prism of glass filled with bisulphide of carbon, the spectrum obtained is much longer than that produced by the densest flint glass we can get. But there is another consideration to be borne in mind. The dispersive power and refractive power not only depend upon the density of the glass, but on the angles of the prism. If a beam of light is sent through two prisms of unequal angles the effect is extremely distinct. Thus, if we take one prism with an angle of 20°, and another with an angle of 60°, the larger angle gives us a much greater deviation and dispersion; therefore, we not only have density to help us, but we have also the angle of the prism.

And now let us go on to a third important point in the matter. We are not limited to one prism if we wish to get a great amount of dispersion; if you will think the matter over, you will see that there is no good reason why we should not employ two, and then you will find that the dispersion will be considerable. So you see, first, we have a single prism of a dense substance; by increasing the angle we get increased dispersion, and then we get it still further increased by adding another prism, and so we might go on, adding prism after prism, until we get to any number of prisms arranged in the best possible manner for the light to be successively dispersed by each of them. First of all, you have the dispersive power of glass, then you have the angle of the prism, and then you have a number of prisms, all of them capable of being so arranged that we can make them all useful in these inquiries, until at last we get a dispersion of such an enormous amount that the spectrum of the sun, as mapped by Kirchhoff and Bünsen, is several yards in length, although it is nothing but a succession of images of one of the finest slits which our best opticians are able to make.

You see, therefore, that our spectroscope depends first of all on Newton's work with the prism in 1675, and on the fact which Newton found out incidentally, that it is important that the prism should be used at the angle of minimum deviation. We then get the slit added by Wollaston in 1812; then the collimating lens, added by Simms, in 1830. In this way we have arrived at the spectroscope improved and modified as an instrument, until at last we get spectroscopes so arranged that the glass is of the finest possible material, the angle being the largest possible, the glass the densest possible, and the number of prisms as great as possible.

There are some other considerations connected with the manufacture of spectroscopes which it is hardly necessary I should bring before you, as they are rather more in the nature of detail than of general principles; but I must point out that where liquids are employed, it is absolutely essential that the temperature should be as equable as we can get it. A current of warm air in a room is quite sufficient to render any spectrum obtained by these liquid prisms perfectly useless; hence, although their great dispersive power is of great value in some cases, where we want dispersion more than anything else, still, as a rule, we are limited for nearly all our researches to these dense glass prisms of great angle, to which I have already alluded. But there is another consideration of great importance which comes in here. If the angle of a prism be large, a ray of light travelling from one prism to another, enters the second at an extremely small angle, under which circumstances a large amount of light is reflected, but still it is not better to use a greater number of prisms of a smaller angle than a smaller number of a larger one. Again in spectroscopes of many prisms it is essential that there should be some arrangement by which each part of the spectrum should be observed with each prism at the angle of minimum deviation for that ray. This may be done in many ways, and the beam may be made to pass back again through the prisms, thus doubling the amount of dispersion. On these points I shall have more to say presently.

Another important consideration, besides the purity of the material, is the perfect figure of the slit. You might imagine that the slit of a spectroscope was perfectly easy to make; but, judging by the results of the manufacture, it is extremely difficult, for a perfect slit is still very rare, the best being made by Steinheil of Munich. Mr. Browning has suggested making the slit of a compound of gold, which will not rust, or be acted upon much by temperature, and which also will take a good figure without any very great difficulty.

NORMAN LOCKYER.

(*To be continued.*)

NOTES

THE Académie Royale de Belgique has elected Dr. Hooker "Membre associé." This has been done as their contribution to the Kew controversies. Prof. Monen, writing from Liege, is glad that Dr. Hooker has received "le plus haute distinction scientifique que notre pays peut conferer . . . dans une moment on vous (Dr. H.) soutenez une lutte vive et penible pour l'honneur de la botanique."

IN their desire to uphold the standard of medical teaching, the authorities of Charing Cross Hospital have committed an act which presents the appearance of an injustice. Not only have they not elected anyone to the vacant post of Demonstrator of Anatomy at their school, but they have sent the following announcement to each of the candidates:—"Resolved: That in the opinion of this Committee, the gentlemen who have offered themselves as candidates for the Demonstratorship of Anatomy have not had sufficient practical experience in teaching anatomy to justify the Committee in selecting any one of them." The Committee would, of course, have been perfectly warranted in setting aside all the applications; but it was surely, to say the least, unwise thus to challenge criticism on the soundness of judgment of the Committee, since it is generally known that among the candidates was at least one who has had quite exceptional opportunities, not only for practical work, but also in teaching—Dr. Jas. Murie, who has been Demonstrator in Anatomy and Pathology to several medical schools both in Scotland and in London, has filled for some years the post of Prosector to the Regent's Park Zoological Gardens, and whose original papers and monographs (upwards of seventy in number) are universally recognised as evidence of quite unusual powers of research and demonstration. Our original workers are so few, and their opportunities of emolument so slender, that it is doubly hard that they should receive discouragement of this nature at the hands of a body specially bound to encourage the practice of original research.

AT a meeting of the Bombay Geographical Society on October 16, it was resolved to make arrangements to amalgamate that Society with the Bombay branch of the Royal Asiatic Society.

THE following are the names on the Cambridge Natural Science Tripos:—First Class—Whitmell (Trinity), Saunders (Down.), Teall and Yule (John's), the last distinguished in Comparative Anatomy and Physiology, and the last three equal. Second Class—Gaskell (Trin. H.), and Ranking (Cuth.), equal, Hebert, (Caius). Third Class—(all equal), Barron (Caius), Dew-Smith (Trin.), Knubley (Mag.), Marshall, W. C. (Trin.), Smith, J. (John's).

THE elements of the new planet (No. 128), discovered on the night of Dec. 4-5, by M. A. Barrelly, are given in the last number of *Astronomische Nachrichten*. It is of the tenth magnitude.

THE stations which the expeditions organised by the American government intend to occupy for the purpose of observing the transit of Venus will be mostly on the islands and coasts of the Pacific Ocean, from New Zealand on the south to the Aleutian Islands on the north, and from the Sandwich Islands on the east to China on the west. Telescopes and photographic apparatus for eight stations have been ordered from the firm of Alvan Clark & Sons, Cambridgeport, Massachusetts, and it is probable that nearly all the apparatus will be of American manufacture.

WE regret to announce the death of W. J. Macquorn Rankine, on Dec. 24, 1872, Professor of Engineering in Glasgow University. We hope next week to give an account of his life and labours.

WE regret to have to announce the death of Mr. Archibald Smith, LL.D., F.R.S., of Jordan Hall, Lanarkshire. Mr. Smith was born in 1814, studied at Glasgow and Cambridge Universities, being in 1836 Senior Wrangler and first Smith's Prizeman in the latter; the second wrangler was Bishop Colenso. He afterwards went to the Chancery bar, devoting his leisure to mathematical studies, his contributions to science being of high practical value. He was employed by Government to make a magnetic survey of the Antarctic regions, in connection with which he, in 1862, published his "Admiralty Manual for the Deviation of the Compass," which was republished and translated into various languages. Mr. Smith received from the Royal Society one of its Royal Medals, from the Emperor of Russia a compass set with diamonds, and recently from Her Majesty's Government a gift of 2,000*l*. as a mark of their appreciation of the value of his researches.

WE learn that the Brighton Aquarium Company propose eventually to embrace in their building sections representing Zoology and Ornithology. There are now in course of construction a large tank for *Reptilia*, and a seal pond. On Monday last a fine young seal was brought from the London Zoological Gardens, and is now the centre of attraction to visitors. There are also some very fine specimens of Axolotl (*Axoloteles guttatus*) lately received from Mexico Considering the short time the aquarium has been in working order, and the loss of the late manager, Mr. Lord, the present efficient state of the building reflects great credit on all concerned.

AN examination will be held in Exeter College on Tuesday, January 28, 1873, and the following days, for the purpose of filling up four Scholarships and three Exhibitions. Two of the Scholarships are of the annual value of 80*l*. each, and two of them of 60*l*. each. To the latter, candidates born or educated for the three years last past in the diocese of Exeter have a prior claim, but only if they are duly qualified by their attainments to be scholars of the college. Otherwise these Scholarships also will be open. Of the Exhibitions one is worth 63*l*. per annum, the second is worth 50*l*. per annum, the third is worth 45*l*. per annum, and the holder of it, as also of the first, must apply himself to the study of Divinity. Candidates for the Scholarships must not have exceeded the twentieth year of their age on the day of election. There is no limit of age for the Exhibitions. One of the Scholarships and one of the Exhibitions will be given for proficiency in Natural Science, if sufficiently good candidates present themselves. Papers will be set in Chemistry, Physics, and Biology, but special weight will be given to excellence in Biology. Candidates in Natural Science must satisfy the College that they possess sufficient Classical knowledge to be able to pass responsions.

THE exhibition for National Science at St. John's College, Cambridge (51*l*. for three years), has been awarded to Mr. W. B. Lowe, who was educated at Rugby, and Mr. Taylor equal. McAllister, who highly distinguished himself in the examination for this exhibition and in mathematics, was elected to one of 40*l*. for four years.

MR. DITTMAR, of Edinburgh University, has been appointed Assistant-Professor and Junior Demonstrator of Chemistry at Owens College, Manchester.

MR. J. J. TAYLOR, of Giggleswick Grammar School, was elected on Wednesday, December 25, to a Natural Science Exhibition, at St. John's College, Cambridge, for proficiency in chemistry and physics.

MR. ALEXANDER PEDLER, F.C.S., has been appointed Professor of Chemistry in the University of Calcutta.

WE are favoured by Prof. Griffis with a copy of the *Japan Daily Herald*, which contains some notes of the ascent of the volcanic mountain Fuji Yama, on September 8 and 9, 1872, by an officer stationed at Subashiri. From his own very careful observations, compared with that of others, and corrected by instruments at the Lighthouse Department at Benten, the officer estimates the total height at 13,080·32 ft. The only vegetation found on the summit was small lichens, while icicles hung from the rocks all round. There are a few stone huts on the summit, in which people live during the summer. The sides are lined with woods, principally firs, larch, birch, and mountain ash. The approximate diameter of the crater is given as 1,770 ft., and its depth 440 ft. The bottom of the crater appeared to consist of a small patch of sand, though it might have been dirty snow. The sides are all loose clinker, affording no foothold, unless with the assistance of a rope.

THE *Bulletin de la Société de Geographie* contains a paper by M. H. Duveyrier, on Livingstone's explorations, from 1866 to 1872, accompanied by a very pretty provisional map, which will no doubt require some alteration in the future. A paper on the Gulf Stream by M. E. Masqueroy, seeks to combat the theories advanced by Dr. Petermann in Nos. 6 and 7 of the *Mittheilungen* for 1870.

THE advanced sheet of the *Mittheilungen*, which Dr. Petermann has been good enough to send us, is occupied with an exceedingly interesting and carefully compiled abstract of the history of discovery in the most northerly region of Asia, between the Lena and Yenisei, from the year 1734 to 1866. This forms No. 73 of the papers on the geography and exploration of the Polar Regions, and is accompanied by one of those admirably constructed maps which form so enjoyable and valuable a feature of Dr. Petermann's invaluable periodical. The sheet also contains part of a second paper on Dr. Livingstone's exploration of the Upper Congo.

THE last number of *Le Tour du Monde* contains a "Revue Geographique" of 1872, devoted chiefly to African discovery.

AT a meeting of the managers of the Edinburgh Royal Infirmary, held on December 23, the following resolution was passed :—"That the managers of the Royal Infirmary resolve to admit females already enroled in the students' register for Scotland to receive clinical instruction, at a separate hour from that at which male students are admitted into the hospital, and in a stated number of wards, containing eighty beds, to which the female students must confine their visits ; and remit to a subcommittee to make the requisite arrangements and alterations."

AT a meeting of the new Medical Microscopical Society held on December 6, Mr. Jabez Hogg was elected President, and a code of rules was adopted. The meetings will take place on the third Friday of each month, from October to July inclusive.

A MICROSCOPICAL *soirée* was given on the evening of Dec. 19, to the students of St. Thomas's Hospital, by the President and Secretary of the physical staff of that hospital (Mr. Wagstaffe and Dr. Evans).

WE learn from the *Athenæum* that the Earl of Derby would have formed one of the Arctic deputation, had he not been unavoidably detained in the country, and that he has expressed his cordial wishes for the success of the representation that has been made to Government.

THE *Revista del Sur*, of Chile, states that showers of sand occurred on July 3, in Araucaria, of sufficient extent to cover up all the planted fields of the Indians, and oblige them to take refuge on the north side of the mountain. This rain, supposed to have come from an eruption of Mount Llaima, distressed the Indians so much as to drive them into the neighbourhood of the white settlements.

THE Court of the Haberdashers' Company recently granted five exhibitions of 50*l*. each, for three years, to assist the holders (at Oxford, Cambridge, and London Universities) in their further educational or professional pursuits. Besides these exhibitions, 150*l*. was voted with a view to assist the education of children and grandchildren of liverymen. The same company has under its management five schools, new schemes for which are progressing with the Endowed Schools Commissioners.

THE November number of *Silliman's Journal* contains the first part of a very able paper by Prof. Joseph LeConte, in which he proposes his "Theory of the Formation of the great Features of the Earth's Surface." It is an admirable example of clear scientific reasoning and deserves the attention of all geologists, especially of those who believe the earth to be an extremely thin crust enveloping a molten and gaseous mass. He believes that Humboldt's formula, that all the effects of igneous agency are the result of "the reaction of the interior on the crust of the earth," must form the point of departure of every true theory ; but in departing from this vague formula, only the most confused and contradictory notions seem to prevail among geologists. Mr. LeConte has for many years thought much on the subject, and his paper is an attempt to emerge from the chaos which now exists into something like clearness of perception on this supremely interesting point. He is convinced that the whole theory of igneous agencies—which is little less than *the whole foundation of theoretic geology—must be reconstructed on the basis of a solid earth.* Another very valuable article in this number is Mr. C. A. Young's "Catalogue of Bright Lines in the Spectrum of the Solar Atmosphere," which has already appeared in NATURE.

THE number of *La Revue Scientifique* for December 21, contains Prof. Hackel's introductory lecture on his taking possession of the chair of Zoology, recently founded in the University of Jena ; the subject is "the Progress and Object of Zoology." The same number contains a notice of the institution recently founded at Haarlem, named "Bureau Scientifique central Néerlandaise," which proposes to do for Europe what the Smithsonian Institution does for America, effect with certainty, regularity, and a minimum expense, exchange of publications between the now very numerous European scientific societies. Any Society wishing to benefit by this mode of exchange, sends a sufficient quantity of its publications to the *Bureau*, which in return sends back to it copies of the publications of all the societies connected with it. At the end of the year the necessary expenses are divided among the various participating societies. The scheme looks plausible, and if well conducted might turn out to be very useful.

AS usual at this season of the year the Royal Institution is doing its best to purvey for eager holiday-making youth a judicious mixture of the *utile* and the *dulce*, and as usual it has been eminently successful, if we may judge from the delight with which the hundreds of boys and girls who filled the well-known theatre last week listened to Prof. Odling's fascinating story of Air and Gas. It will be seen from our diary that the second and third on the same subject will be given on Tuesday and Thursday next.

THE *Scientific American* contains some interesting statistics concerning the extremes of heat to which various parts of the world are subject. Probably the hottest country is Thibet, though its most southern part is 30° from the equator, its extreme summer temperature reaching to the height of 150°. The fact that the night temperature, even in summer, sometimes sinks to the freezing point, only serves to aggravate the discomfort of this extreme heat. Next comes Senegal and Guadaloupe, with a maximum temperature of 130°, that of Persia being 125°, while the maximum of Calcutta and the delta of the Ganges is 5° less. In Cape Colony and the African diamond diggings the midsummer heat is 105°, that of Greece being only one degree less, while that of the comparatively far north city of Montreal is only one degree less than Greece, and one more than New York. In Great Britain, Siam, and Peru, the extreme does not exceed 85°, while that of Siberia is as high as 77°, two degrees higher than in Scotland, and four above that of Italy. In Patagonia and the Falkland Islands the highest is 55°, ten degrees above that of Southern Iceland. In Nova Zembla the maximum temperature is only 34°, two degrees above the freezing point of water.

WE learn from the *Times of India* that while Mr. T. T. Cooper is about to make another attempt to penetrate into China from Momein, the well-known French traveller, M. Garnier, who was the leader of the French expedition through Yunan into China, is about to start on another exredition from China through Thibet to India. M. Garnier has already left Hongkong for Shanghai to commence preparations for his journey.

WE have received the prospectus of a new monthly half-crown magazine, to be commenced in January, and which we are told, has already received a large number of subscribers. It is entitled the *Practical Magazine*, and will be supported by original contributions from the pen of distinguished writers on commercial subjects and applied sciences. It will also be an illustrated cyclopædia of industrial news, inventions, and improvements, collected from Foreign and British sources, for the use of those concerned in raw materials, machinery, manufactures, building, and decoration. It will carry out what is greatly needed—a careful and systematic survey of the industrial activities of America, Germany, and France; in order to present such information, as it is useful for British practical men to obtain, at the earliest possible moment. Judging from the prospectus it seems calculated to serve a very excellent purpose, and we heartily wish it abundant success. We have also received the first number of a new sixpenny monthly entitled the *Workman's Magazine*, published by Messrs. Kent and Co., and edited by the Rev. Henry Solly, and chiefly devoted to articles connected with the social condition of the class whom it addresses. The editor, we think, might find a corner for science, the influences of which are now felt among all classes.

MR. WILLIAM STOKES, JUN., surgeon to the Richmond Hospital, has been elected to succeed Mr. Hargrave as Professor of Surgery to the Royal College of Surgeons, Dublin.

THE *British Medical Journal* understands that the University of Dublin, the King and Queen's College of Physicians, and the Royal College of Surgeons, have agreed upon a scheme for a joint examining board. The Queen's University, however, and the Apothecaries' Hall still stand aloof.

THE *Journal of Horticulture* says that a French farmer has discovered that the use of tan is an efficient preventive against potato disease. For three years he has introduced a small quantity of the residue of the bark used in tanning into each hole on planting his potato crop, and each time he has been completely successful in preserving his fields free from the annoying disease.

WE have received the catalogue of the mathematical and scientific works of the library of the late Mr. Babbage, which are in the hands of Messrs. Sotheby, Wilkinson, and Hodge. If not sold by private contract before February 1, 1873, they will then be sold by auction. The collection is one of rare value, and its dispersion would be an event much to be regretted. The catalogue fills 190 pages, and does great credit to the compiler.

THE *feuilleton* of the number for December 28, of the *Gazette Médicale de Paris*, contains the concluding part of M. Dumas' admirable *éloge* on the late Isidore Geoffroy Saint-Hilaire.

WE learn from the *Engineer* that Mr. Eden, indoor engineer in the Edinburgh Telegraph office, has invented a system by which, with the existing instruments, it has been found practicable to send messages from both ends of a single wire simultaneously The invention has been tested between Edinburgh and Glasgow, and it has been found that one wire is capable of doing double work.

WE learn from *Ocean Highways* that considerable anxiety prevails in Sweden respecting the safety of the vessels attached to the expedition which were to have returned at the close of the navigable season. The brig *Gladan*, and steamer *Onkel Adam*, took out stores for the *Polhem*, and were to have returned before the winter set in. They are totally unprepared for wintering in the ice; and should they not be able to return, it will be necessary for the crews to abandon the vessels and take refuge in the *Polhem*, which in that case will be overcrowded, and crippled in her resources. The Norwegian Government has despatched to their relief the seal steamer *Albert*, which will make an energetic attempt to reach Spitzbergen. She takes out two wooden houses, to erect inshore at the most likely places for stragglers to find them, and abundant supplies.

TERRESTRIAL MAGNETISM *

I.

IN bringing before you this evening, gentlemen, the subject of terrestrial magnetism, it is not my intention to attempt to present you with an exhaustive paper on so wide a subject. It would be idle to pretend to give in a few short pages an adequate idea of all that has been ascertained on this subject, or even to present a satisfactory historical sketch of the progress made from earliest ages to the present time. Nor will I trouble you with a bare enumeration of the many facts, and methods, and theories that have gradually led scientific men to their present knowledge in this matter. But I will try rather to state, as clearly as I am able, what is the actual condition of our knowledge respecting the magnetism of the globe, and what the nature of its complex variations, without, however, entering much into details which, though they might perhaps be most convincing when reviewed at leisure, would be entirely out of place here, since they would only serve to encumber a paper intended for public perusal.

But, before treating of the special subject of terrestrial magnetism, allow me briefly to recall a few of the well-known properties of magnets.

That certain bodies possess the power of attracting iron was not unknown to the most ancient people; and men who had noticed this could not long have failed to observe the disturbing power that iron, in its turn, exerts upon the magnet when brought into its immediate neighbourhood.

But the duality of the magnetic force was doubtless a discovery of much more recent times, though now equally familiar as the former. That this twofold force ever seeks the opposite extremes, or poles, of a magnetic body, and that these poles, whilst possessing alike the power of attracting iron, are diametrically opposed in their action upon the poles of any other magnet, is expressed in the trite law that, "likes repel, and unlikes attract." Again, the law of magnetic intensity was unknown until the middle of last century, when it was found by Michell to be identical with that of universal gravitation, namely, to diminish inversely as the square of the distance of the body attracted. That this was not discovered at an earlier date is partly due to the complexity of the phenomena arising from the duality of the force, combined with the inseparable nature of the two energies. For, unlike electricity, to which in most other points it is so near akin, neither the positive nor the negative element of magnetism can ever exist alone in any body.

Now, since we know that magnets and iron act mutually upon each other, and that one magnet attracts or repels any other according to certain fixed laws, if we remove all disturbing bodies from the vicinity of a magnet, and leave it perfectly free to move by floating it on a liquid, or suspending it by a thread, we might expect to see the magnet remain at rest in whatever position we place it. But we perceive at once that this is not the case, and the magnet we thought to be free is found to be subject to a directive power, which forces it to take a fixed direction, without in the least interfering with the position of its centre of gravity. Disturb the magnet, and when it comes to rest it will again lie in the same direction as before. The earth, therefore, exerts a certain influence on the magnet, not producing any translation from one position to another, but only forcing the poles of the magnet to assume a definite direction. That this power possessed by the earth is precisely similar to that of an ordinary magnet, is easily shown by counteracting the earth's action by means of a magnet, placed at a suitable distance from the free magnetic needle, and with its marked end in the same direction as that of the needle, the latter will then rest in any position in which it is placed.

This polarity, or directive power of the earth, is said to have been known to the Chinese 1,000 years at least before the Christian era, and to have aided them in their long journeys across the trackless wastes of their vast empire. The use that has since been made of this simple fact, the growth of commerce, the spread of civilisation, and the thousand other blessings that it has brought to our very doors, need no long comment here. We may well marvel that such a source of wealth and prosperity was allowed by mankind to remain almost fruitless during such a long succession of ages.

The horizontal direction taken by the freely suspended needle

* By the Rev. S. J. Perry, F.R.A.S., F.M.S., Director of the Stonyhurst Observatory. Extracted from the *Journal of the Liverpool Polytechnic Society*, by the permission of the Council. Communicated by the author.

is nearly north; but it generally deviates somewhat from the astronomical meridian. This deviation is termed the declination or variation of the compass. The existence of the declination was not unknown in remotest times, although its discovery is sometimes erroneously attributed to Christopher Columbus. To this great man we are, however, indebted for our knowledge of "the variation of the variation," since he was the first who noticed its change as he altered his geographic position in his great voyage of discovery across the Atlantic.

The first and most important fact in terrestrial magnetism, viz., the declination or horizontal lie of the freely suspended magnet, being established, we may take an unmagnetised piece of iron, similar in weight and form to our magnet, and balancing it on an axis passed through its centre of gravity, allow it to rest on the extremities of this axis. We shall find that the unmagnetised needle will remain at rest in whatever position we choose to place it, since we have taken care to suspend it by its centre of gravity. But if we now substitute the magnetised instead of the unmagnetised needle, and place it in the plane of the horizontal magnet, we shall perceive at once that at whatever angle we place it on its supports it will invariably take up a definite position with respect to the horizon, the marked end, which points W. of N., dipping down until it stands in this country at an angle of about 70° to the horizon. The earth, therefore, not only tends to bring the magnetic needle into a certain azimuthal plane, but it also forces it to take a fixed position in that plane. The direction of the magnet is thus wholly determined by the earth's magnetic force.

Our next care will, therefore, naturally be to discover, if possible, what is the intensity of this terrestrial force which acts upon the needle. This might be determined by finding the resistance it is capable of overcoming, or the weight it will balance, the weight being attached to a thread wrapped round the axis of the needle. But the intensity of the earth's pull is more accurately found by a method similar to that which has been used with such success in observing the force of gravity at different points of the surface of the globe, in view of ascertaining the amount of its compression. A magnetic needle is suspended by a thread, from which all torsion has been removed, and then an oscillatory movement at right angles to the plane of minimum dip is imparted to the needle in such a manner as to leave the point of suspension at rest. The square of the time of a single oscillation is a sure measure of the intensity of the force producing the vibration, which in this case is the product of the magnetism of the needle by the horizontal component of the earth's magnetism. The factor due to the magnetic strength of the needle can be eliminated at once if the power of our needle is known, and the horizontal component of the terrestrial magnetism divided by the cosine of the dip of the needle will then give the required total intensity. But if the power of the magnet is unknown, and on account of slight but continual changes, it is always safest to consider it as doubtful within certain limits, the quotient of the earth's horizontal force by the magnet's power can easily be found by measuring the deflection of a free magnet produced by the attraction of the vibration needle at given distances. The result of these experiments is to place in evidence that the intensity of the earth's magnetism follows laws as constant as those of its directive force.

Having thus made ourselves acquainted with the three essential elements of the magnetism of our globe, viz, the dip and declination, which determine the direction, and the third, which expresses the intensity of the a tracting force, our next step in the study of the earth's magnetism, as a whole, is to secure the most trustworthy observations of these three elements at as many different stations as possible. The instruments used must be of the most delicate description, as the differences to be measured are often excessively minute. For this purpose the needles are suspended by the slenderest thread of unspun silk, or the smoothest axis rests on knife edges of polished agate. The care with which the observations have to be taken may be judged of from the fact that, to obtain the time of a single vibration of the needle, twelve sets of 100 or 200 vibrations are taken, and each estimated to the twentieth of a second; or, again, for a single observation of the dip, the needle, which is balanced by the maker with scrupulous care, is so far suspected that readings are taken of each end, the needle is turned on its Ys, the whole instrument is reversed, and finally the poles are altered, and each of these readings repeated at least twice before the observer has satisfied himself that all necessary caution has been taken to secure a perfect observation. An apparatus of greater delicacy than those in general use has lately been invented by Dr. Joule, of Manchester, which we may hope will furnish results of still greater accuracy than those already obtained.

'Twas not until towards the middle of the sixteenth century that accurate determination of any of the magnetic elements were attempted; but since that time the declination has continued to be observed with some regularity, and before the end of the seventeenth century Halley had already made two long voyages to observe this element at different parts of the globe.

The dip, whose discovery is due to Norman, was first observed in 1576, but it does not seem to have attracted much attention until two centuries later.

The determination of the intensity, by means of the vibrations of a magnet, was first suggested in the last century by Graham, and the first maps of the isodynamics, or curves of equal intensity, are the fruits of the labour of General Sir Edward Sabine, who is now devoting the declining years of his life to the publication of the results of his life-long study of terrestrial magnetism.

From the above observations of the three magnetic elements, taken at different positions on the surface of the globe, the first general conclusion we are able to draw is one of no little importance. For, starting from any point of the earth, and following the direction of the horizontal needle, we are invariably led to one or other of two points, situated respectively in the Northern and Southern hemispheres. The entire globe is, therefore, traversed from N. to S. by a system of magnetic lines, all meeting in the same two points, resembling in this respect our geographical meridians and poles, and therefore termed the magnetic meridians and the magnetic poles of the earth. Our second conclusion is of scarcely inferior importance to the first. For if, instead of following the direction of the horizontal needle, we carefully observe the dip, and travel along the line, where we find the inclination invariable, we shall always be led, not up to a magnetic pole, but in a more or less circular path around the pole. These curves of equal dip, generally called isoclinals, bear a close resemblance to our geographic parallels of latitude; and as the geographic latitude varies from zero at the equator to 90° at the poles, so in like manner the dipping needle, which is horizontal at the magnetic equator, gradually increases its inclination until it becomes vertical at the magnetic poles.

From these angles of position of the dipping needle we can conclude at once that the horizontal component of the earth's magnetism must be zero at the poles, and probably maximum at the magnetic equator, where the terrestrial force is wholly horizontal.

We may, therefore, describe the magnetic poles in the words of the Astronomer Royal, "as the common points for the convergence of magnetic meridians, for the verticality of the dip, and for the evanescence of the horizontal force."

But there are other points on the earth's surface which merit our most special attention. I will not call them poles, as they have little in common with the two poles of which we have just been speaking, but I will describe them as points of maximum intensity. The isodynamics, or lines of equal intensity, are not found to follow such simple laws of distribution as the meridians and the lines of equal dip and horizontal force, though these latter are far from being arranged with the same regularity as the meridians and parallels of latitude of a geographic globe. None of the magnetic curves are perfect circles, the poles are not coincident with the geographic poles, nor are they opposite to each other, one being situated north of Baffin's Bay, and the other in South Victoria, but still there is a general approach to regularity in the magnetic lines, if we except the isodynamics, and the law of variation of the dip was found to be fairly represented by the formula, tan. $\delta = 2.$ tan. L (the magnetic latitude), a law discovered by Krafft in 1809. The greatest departure from the general regularity of the curves we have been mostly considering, is the indication of a second pole in the Southern Hemisphere from the peculiar distribution of the lines of equal horizontal force. But in the case of the isodynamics we find three well-marked points of maximum intensity, one N.W. of Hudson's Bay, another in Siberia, and the third not far from the South magnetic pole in Victoria. Besides these there are also two maxima of small intensity, one situated slightly north, and the other at about 15° S. latitude. We are still, however, able to trace a rough approximation to a law in the change of the intensity, the value at the principal maximum being about double what is found to be on the curve of minimum intensity.

The distinction between points of maximum intensity and the true magnetic poles has not always been attended to with sufficient care, and this is partly to be accounted for by the considerable and often preponderating influence of these maximum points on the several magnetic elements. A consequent doubt was for a long time entertained respecting the number of the magnetic poles. Halley, from a careful study of an extensive series of declination observations, made partly by himself in 1698-9, was led to the conclusion that the earth has four magnetic poles. The same opinion has been most ably advocated within our own days by Prof. Hansteen of Christiana, who had previously collected together a vast mass of observations of the declination, dip, and horizontal force. But the interesting series of results which Hansteen has brought forward in support of his view, are most readily explained by the evident changes that have taken place in the magnetic state of the region of maximum intensity situated in Siberia, where Hansteen himself specially observed. The Northern regions, where the magnetic force is greatest, abound in ferruginous strata, and there too the intensity of the cold far exceeds anything that is experienced in other lands on the same parallel of latitude. These regions may therefore not only be charged with a most abundant supply of permanent magnetism, but they may also be affected to a very considerable degree by atmospheric changes, and by those electric currents that are continually passing to and fro in the upper crust of the earth, and are doubtless producing very important changes in the subpermanent magnetism of certain layers of softer ferruginous matter. Whatever may be the nature of terrestrial magnetism, we cannot ignore the great influence exercised on its distribution by what may be termed local magnetism, the magnetism of volcanic formations, of mountain chains, of ferruginous beds; some harder than others and therefore less subject to magnetic influence, but retaining its effects the longer; some more affected by the extremes of heat and cold, and hence exposed to more rapid and radical changes in their magnetic condition.

But the question of the number of magnetic poles is leading us to another point of scarcely less importance, viz., the investigation of the changes that take place in the magnetism of the globe. The first point of inquiry is whether terrestrial magnetism as a whole is subject to continual change, and if so, are these changes periodical? Do they move in cycles? Do they follow any fixed laws that may lead to a knowledge of their causes?

The difficulty in answering these questions arises mainly from the irregular distribution of the points of maximum intensity; but, granting that we meet with numerous exceptional cases, which no doubt will finally be discovered to depend on local influences, we can trace a very regular and periodic change in all the magnetic elements.

The first accurate observations that have come down to us are those of the declination, or variation of the compass, taken in Paris in 1541, when the needle pointed 8° to the east of the astronomical meridian. From that period the easternly deviations gradually increased, until it attained a maximum value of 11° 30′ in 1580, when it returned slowly on its path and vanished in the year 1660, Paris being then on the curve of "no variation." Pursuing its westernly course, the needle pointed more and more west of north each year, and only reached its greatest western elongation of about 23° in 1814. The needle is at present returning towards the east, at the yearly rate of about 9′·5, and actually points rather less than 17° west of north. The variations of the declination at London have followed much the same order as those at Paris, nor has there been any great difference in the extent.

The dip observations have unfortunately not been carried on so continuously during such a long series of years, and in consequence the secular variation of this element is less well determined than that of the declination. With the exception of a single observation by Norman in 1576, who found the inclination of the needle at London to be 71° 50′, we have scarcely any reliable data previous to 1720, when the dip had increased in London to 74° 42′. Since the latter epoch this element has always continued to decrease, being 70° 35′ in 1800, and now less than 68°, with an annual diminution of about 2′·5.

Of the secular variation of the intensity we know even less than of that of the dip, since the first observations date only as far back as the end of the last century; and we have no less an authority than that of Sir Edward Sabine for the statement, that "at commencement of the present century the bare fact of there being any difference whatsoever in the intensity of the magnetic force in different parts of the earth was unattested by a single published observation." The results, however, of modern research supply us with the important fact that the horizontal component of the intensity is at present rapidly increasing, its yearly rate of change being one 600th of its total value.

Now each and all of these gradual variations in the several elements of the earth's magnetism force upon us the conclusion that the magnetic pole must be endued with a motion of rotation in a more or less circular path around the pole of the earth's axis. The results of such a rotation apparent to an observer situated for example in England will be easily understood if we consider for a moment the similar movement of any of the inferior planets in its orbit round the sun as viewed from the earth. Take Venus, for instance, which is the most conspicuous of the planets. At one time it may be seen moving away from the sun towards the east, when it is called the evening star, since i sets later than the sun. This outward movement continues for a time, until the planet reaches the point of its maximum elongation; it then returns towards the sun, and after a time becomes lost to sight in the brilliancy of the solar rays, or on very rare occasions is visible in transit over the solar disc, as it will be for the first time this century in 1874, and again in 1882. Having passed the sun, Venus becomes the morning star, rising earlier and earlier until it has attained its greatest western elongation, when it again returns towards the sun. An analogous movement of the magnetic pole around the geographic pole has been clearly indicated by the secular variations of the declination, dip, and horizontal force. At the middle of the 16th century the bearings of the needle which would lead us to the magnetic pole were some 10° east of north. As time went on this deviation diminished, whilst the dip increased, showing that the magnetic pole was approaching us, as it got nearer and nearer to the meridian. About the middle of the 17th century, or rather somewhat later, the magnetic pole crossed our meridian, which thus for the moment partly coincided with the "line of no variation." From that time the needle has always pointed west, the western declination increasing more and more until the pole reached its maximum elongation in 1815. During this period there was a gradual decrease in the dip, manifesting a recession of the pole, and this has continued steadily, though with diminished acceleration, ever since the needle commenced its backward journey towards the geographic meridian. The present secular increase of the horizontal force also shows that the pole is receding, and that it will cross our meridian next on the further side of the geographic pole. This will take place, according to the calculation of M. Quetelet, director of the Brussels Observatory, about the year 1940, and thus a complete revolution of the magnetic pole will occupy a period of some 560 years. Other physicists make this period longer. Local magnetism must of course interfere greatly with the position of the pole, and with its velocity of revolution, but this disturbing cause will affect still more the movements or form of the "curve of no variation."

This rotation of the magnetic pole round the extremity of the earth's axis bears so striking a resemblance to the motion of the pole of the heavens round the ecliptic, that we are led at once to inquire if anything can be detected in the magnetic rotation that corresponds with the inequalities in the precession of the earth's axis, with the nutation caused by the action of the sun and moon. Are there, in other words, any annual, semi-annual, or monthly inequalities? The observations of the declination, taken during a series of years, and grouped together according to months, led to a variety of conclusions respecting the influence of the sun on the deflection of the needle. Arago agreed with Cassini in placing the sun in the vernal equinox at the maximum western variation, and in the summer solstice at the minimum; whilst Bowditch, in America, and Beaufoy, in England, both found that a maximum occurred in August and a minimum in December, though a second maximum and minimum were placed by each in different seasons. The fact of some yearly range of the needle about its mean position appeared to be established; but local influence seemed to have a large share in determining the nature of the annual curve.

(To be continued.)

SCIENTIFIC SERIALS

THE *Geological Magazine* for December (No. 102) opens with a description by Mr. James Cartro of a new genus and species of fossil crustacea from the Upper Greensand of Lyme Regis, which the author proposes to name *Orithopsis Bonneyi*. The fossil which appears to be nearly allied to *Necrocarcinus*, is figured on a plate accompanying the paper. Mr. C. Lapworth communicates a note on the Graptolitic black shales of the south of Scotland, in which he reiterates his opinion that there si but a single group of these shales, divisible, however, into three divisions—the Lower, Middle, and Upper Moffat shales. The first he regards as of Lower Llandeilo age, the second as equivalent to the Upper Llandeilo of Builth, and the third as Caradoc.—From Mr. S. Allport we have a valuable paper on the microscopic structure of the pitchstones and felsites of the island of Arran, in continuation of a former note published in the *Geological Magazine*. The number also contains a reprint of an interesting paper by Dr. Carpenter on the temperature and other physical con ditions of inland seas, in their relation to geological inquiry.—Among the reports, &c., we find Mr. Woodward's sixth report on fossil crustacea, presented to the last meeting of the British Association. This contains a genealogical tree of the Crustacea.

Annalen der Chimie und Pharmacie, Nos. 11 and 12, 1872. —This double number contains a paper by Dr. Abeljanz on bichlorether, in which some of Lieben's results are called in question. The writer discusses chiefly the preparation of bichlorether, the action of pentachloride of phosphorus upon it, and its decomposition by water and by alkali.—In an essay on diphtalyl, Dr. Ador describes the preparation of this substance, through the action of finely-divided silver on dyphtalyl chloride. It has the formula $C_8 H_4 O_2$. It is insoluble in water, and soluble largely only in heated phenol and cold concentrated sulphuric acid. It fuses at 300°. The action of alkalies on dyphtalyl, dyphtalyl acid, its salts, and capability of oxidation, action of pentachloride of phosphorus and bromine on diphtalyl, and some of the by-products of preparation are among the points taken up.—J. Wislicenus communicates some observations on the so-called anhydrides of lactic acids. He finds that before all the water is evaporated from a solution of lactic acid, some anhydride is always present (with the acid), the quantity of which increases with the decrease of the water, and that, therefore, pure lactic acid of the formula $C_3 H_6 O_3$ does not exist. Further, that when lactic acid is kept in a dry atmosphere at ordinary temperature, there is formed not only the so-called anhydride, but also a lactide. —Th. Zincke and A. Franchimont describe nonylic acid, a colourless oily fluid, having the formula $C_9 H_{18} O_2$, boiling about 253; specific gravity at 17·5° = 0·9065. It is little soluble in water, but distils slowly over with the vapour of boiling water. At a low temperature it solidifies to a crystalline mass, and it melts at + 10°.—Among the remaining papers in this number are lengthy monographs on some of the cyanogen derivatives of aceton, by Dr. F. Urech, and on the reduction products of silicic acid ether and some of its derivatives, by A. Ladenburg; also notes on the action of sodium on dibrombenzol, by Dr. Riese, and the constitution of sodium ethylate, by A. Laubenheimer.

Nos. 3 and 4 of the *Proceedings of the Swedish Academy of Sciences* for the present year, contains the proceedings of the Academy for March and April. The first paper is an account of an experimental investigation upon the electromotive and thermo-electric forces of certain metallic alloys in contact with copper, by M. A. F. Sundell. The alloys employed in these experiments consisted of bismuth and tin, and bismuth and antimony in various proportions, and of a white metal (*Nysilven*) the composition of which is not given. The action of bismuth is lessened in proportion to the amount of tin, and also by $\frac{1}{32}$ of antimony, but increased by $\frac{8}{32}$ of the latter metal. Iron is very low in the scale, which is similar for the electromotive and thermo-electric powers of the different metals and alloys.—Dr. C. Stål communicates a synopsis of the European genera of Pentatomidæ in Latin, from which, curiously enough, the Cydnina are omitted.—Dr. H. D. J. Wallengrew furnishes a further contribution to the Lepidopterous fauna of South Africa, founded upon a small collection sent home by M. Akerberg, Swedish Consul at the Cape. His list, which includes species belonging to the groups from the butterflies to the Crambidæ, numbers seventy-one species, several of which are described as new, whilst descriptions and notes on synonymy are appended to many of the others. A new genus of Lycœnide butterflies, *Arrugia*, is proposed for *Zerythis basuta* Wall, *protumnus* Lin. The new species are all Geomitrina,—they are *Conchylia pactolaria*, *Camptogramma quaggaria*, *C. sylvicultrix*, *Macaria grimmia*, *M. getula*, *Tephrina nemorivaga*, *Panagra platyrhyncata*, *P. octomaculata* and *Mesotype textilis*.—A new species of mica called Manganophyll, from the iron and manganese mines of Paysberg in Wermland, is described by M. L. J. Igelström,—It contains 21·40 per cent. of protoxide of manganese, and varies from bronze to bright copper colour.—Prof. Angström enumerates and describes some mosses and Hepaticæ collected by Prof. N. J. Anderson, during the voyage of the frigate *Eugenie*, in 1851-53. The specimens are from Port Famine, from near Wollongong in Australia and from Honolulu. A great many of them are described as new species, and these belong to the genera *Gymnostornum*, *Orthotricum*, *Dicranum*, *Tortula*, *Bartramia*, *Gottschea*, and *pungermanina* (from Port Famine), *Thamnium* and *Lejeunia* (from Wollongong) *Hypnum*, *Plagiothecium*, *Omalia*, *Campylopus*, *Macromitrium*, *Fissideus*, *Jungennanina*, *Shagnœcetis*, *Lejeunia* and *Frullania*, (from Honolulu). M. C. A. F. Sädbour notices the nocturnal migratory habits of *Myodes schisticolor* Lilljeb. The number concludes with a report by the secretary on the activity of the Academy during the year 1871-72.

SOCIETIES AND ACADEMIES

London

Royal Society, Dec. 13, 1872.—"Researches in Spectrum Analysis in connection with the Spectrum of the Sun."—No. I. By J. Norman Lockyer, F.R.S.

The author, after referring to the researches in which he has been engaged since January 1869 in conjunction with Dr. Frankland, refers to the evidence obtained by them as to the thickening and thinning of spectral lines by variations of pressure, and to the disappearance of certain lines when the method employed by them since 1869 is used. This method consists of throwing an image of the light-source to be examined on to the slit of the spectroscope.

It is pointed out that the phenomena observed are of the same nature as those already described by Stokes, W. A. Miller, Robinson, and Thalen, but that the application of this method enables them to be better studied, the metallic spectra being clearly separated from that of the gaseous medium through which the spark passes. Photographs of the spark, taken in air between zinc and cadmium and zinc and tin, accompany the paper, showing that when spectra of the vapours given off by electrodes are studied in this manner, the vapours close to the electrode give lines which disappear from the spectrum of the vapour at a greater distance from the electrode, so that there appear to be long and short lines in the spectrum.

Maps of the following elements have been mapped on this method:—Na, Li, Mg, Al, Mn, Co, Ni, Zn, Sr, Cd, Sn, Sb, Ba, and Pb, the lines being laid down from Thalen's maps, and the various characters and lengths of the lines shown.

In some cases the spectra of the metals, enclosed in tubes and subjected to a continually decreasing pressure, have been observed. In all these experiments the lines gradually disappear as the pressure is reduced, the *shortest lines disappearing first, and the longest lines remaining longest visible.*

Since it appeared that the purest and densest vapour alone gave the greatest number of lines, it became of interest to examine the spectra of compounds consisting of a metal combined with a non-metallic element. Experiments with chlorides are recorded. It was found in all cases that the difference between the spectrum of the chloride and the spectrum of the metal was, that under the same spark-conditions all the short lines were obliterated. Changing the spark-conditions, the final result was, that only the very longest lines in the spectrum of the metallic vapour remained. It was observed that in the case of elements with low atomic weights, combined with one equivalent of chlorine, the numbers of lines which remain in the chloride is large, 60 per cent. *e.g.*, in the case of Li, and 40 per cent. in the case of Na; while in the case of elements with greater atomic weights, combined with two equivalents of chlorine, a much smaller number of lines remain—8 per cent. in the case of barium, and 3 per cent. in the case of Pb.

The application of these observations to the solar spectrum, to elucidate which they were undertaken, is then given.

It is well known that all the known lines of the metallic elements on the solar atmosphere are not reversed. The author states what Kirchhoff and Angström have written on this subject, and what substances, according to each, exist in the solar atmosphere. He next announces the discovery that, with no exception whatever, *the lines which are reversed are the longest lins.* With this additional key he does not hesitate to add, on the strength of a small number of lines reversed, zinc and aluminium (and possibly strontium) to the last list of solar elements given by Thalen, who rejected zinc from Kirchhoff's list, and agreed with him in rejecting aluminium. It need scarcely be added that these lines are in each case the longest lines in the spectrum of the metal.

The help which these determinations afford to the study of the various cyclical changes in the various solar spectra is then referred to.

Geological Society, Dec. 18.—Mr. Warington W. Smyth, F.R.S., vice-president, in the chair.—The following communications were read:—"Further Notes on the Punfield Section," by C. J. A. Meyer. This paper was supplementary to one read before the society by the author in March of the present year (see "Quart. Journ. Geol. Soc." xxviii. p. 245), and contained the results of a fresh examination of the section at Punfield, and of the Wealden and Neocomian strata of the Isle of Wight. He described the section exposed at his visit to Punfield as presenting:—1, True Wealden beds; 2, a grit-bed with limestone and paper-shales, containing fish-bones and Cyprides; 3, apparently argillaceous beds; 4, a thin band of hard ferruginous sandstone with Atherfield fossils; 5, a clay bed, the upper part regarded as representing the "Lobster Clay" of Atherfield, the lower sandy portion containing an abundance of marine fossils belonging to common Atherfield species; 6, the so-called "marine band;" and 7, laminated clays and sands with lignite. The author indicated the accordance of this arrangement with what is observed elsewhere, and maintained that the grit-bed (No. 2), with its limestone and paper-shales, containing *Cypris* and *Cyrena*, was really to be regarded as the passage-bed between the Wealden and the Neocomian.—"On the Coprolites of the Upper Greensand Formation, and on Flints," by W. Johnson Sollas. The first part of this paper was principally occupied in an endeavour to explain the perfect fossilisation of sponges and other soft-bodied animals. It was shown that the hypothesis which considered that sponges had become silicified by an attraction of their spicules for silica was altogether untenable. Mr. H. Johnson's supposititious reaction, according to which the carbon of animal matter is directly replaced by silicon, was shown to be inconsistent with the known facts of chemistry. The author's explanation was not intended to be final. The first fact pointed out was the very remarkable way in which the silica or calcic phosphate of the fossils under consideration followed the former extension of organic matter. This was explained for silica by the fact that, when silicic acid is added to such animal matters as albumen or gelatin, it forms with them a definite chemical compound; and it was assumed that in process of time this highly complex organic substance would decompose, its organic constituents would be evolved, and its silica would remain behind. In such a way flints might be produced, and dialysis would lend its aid. The same explanation was applied to account for the connection between calcic phosphate and animal matter in the case of the "Coprolites." The Blackdown silicified shells were next explained, and it was reasoned that the state of their silica offered arguments tending to prove a passage of silica from the colloidal to the crystalline state. The second part of the paper discussed the Coprolites specially; their exterior appearance is extremely sponge-like, almost exactly resembling some species of modern sponges. They are marked by oscules of peculiar characters. The so-called "pores" of palæontologists are well marked. Spicules, triradiate, hexradiate, sinuous, defensive and connecting, have been observed. They are siliceous in composition. On dissolving the coprolites in acid, the spicules are set free, associated with *Polycystina* (*Haliomma hexacantha*, &c.) and *Xanthidia* (*X. furcatum*). The genera and species of coprolites described were as follows:—*Rhabdospongia communis*, *Bonneyia bacilliformis*, *B. cylindricus*, *B. Jessoni*, *B. scrobiculatus*, *B. verrongiformis*, *Acanthophora Hartogii*, *Polycantha Etheridgii*, *Retia simplex*, *R. costata*, *Ulospongia patera*, *U. calyx*, *U. Brunii*. The external appearance of these forms, which constitute a vast number of the coprolites, their curious oscules and siliceous spicules, were said to leave no doubt as to ther spongious origin.

Chemical Society, Dec. 19.—Prof. Williamson, F.R.S., vice-president, in the chair.—Analyses of water of the river Mahanuddy, by Mr. G. Nicholson. The author finds that the water of this river contains less dissolved matter than that of any other river in India.—Researches on the polymerides of morphine and their derivatives, by Mr. E. Ludwig Mayer and Dr. C. R. A. Wright; an account of the various derivatives obtained from morphine by acting on it with zinc chloride, hydrochloric acid, and sulphuric acid respectively, and also of the physiological properties of the compounds produced.—Three communications by Dr. H. E. Armstrong, from the laboratory of the London Institution, were then read. Derivatives of β-dinitrophenol; note on the action of bromine in presence of iodine on trinitrophenol (picric acid); preliminary notice on iodonitrophenols. The last paper, by Mr. C. E. Groves, was on the formation of napthaquinone by the direct oxidation of napthaline, which the author effects by means of chromic anhydride.

Anthropological Institute, Dec. 17.—Dr. Charnock, vice-president, in the chair. A paper was read by Mr. C. Staniland Wake on the origin of serpent-worship. After referring to various facts showing the existence of serpent-worship in many different parts of the world, the paper proceeded to consider the several ideas associated with the serpent among ancient and modern peoples. One of its chief characteristics was its power over the wind and rain. Another was its connection with health and good fortune, in which character it was the *Agathodæmon*. The serpent was also the symbol of life or immortality, as well as of wisdom. It was then shown that that animal was viewed by many uncultured peoples as the re-embodiment of a deceased ancestor, and that descent was actually traced by the Mexicans and various other peoples from a serpent. The serpent superstition thus became a phase of ancestor worship, the superior wisdom and power ascribed to the denizens of the invisible world being assigned also to their animal representatives. When the simple idea of a spirit ancestor was transformed into that of the Great Spirit, the father of the race, the attributes of the serpent would be enlarged, and it would be thought to have power over the rain and the hurricane, which provide the moisture requisite for life. Being thus transferred to the atmosphere, the serpent would come to be associated with nature, or solar worship. Hence we find that the sun was not only a serpent-god, but also the divine ancestor or benefactor of mankind. Seth, the traditional ancestor of the Semites, was the serpent-sun-god, the *Agathodæmon*, and facts were cited to establish that the legendary ancestors of the peoples classed together as Adamites was thought to possess the same character. It would appear to follow from this and other facts mentioned in the paper that serpent worship, as a developed religious system, originated in Central Asia, the home of the great Scythic stock from which the civilised races of the historical period sprung, and that the descendants of the legendary founder of that stock, the Adamites, were in a special sense serpent-worshippers.—Major W. H. Godwin-Austin contributed a paper "On the Garo Hill Tribes." The Garos occupy the extreme west point of the range of hills south of the Brahmaputra, and which terminate with the great bend of that river on long. 90° east. The paper entered into a comparison of the Garos with the kindred tribes of Duars, Kackari, and Kopili; and gave detailed descriptions of the physical characteristics, religious rites, manners, and customs, and peculiar dwellings of that people.

VIENNA

I. R. Geological Institute, Nov. 19.—The first meeting of the winter season was opened by the director, Fr. v. Hauer, with the report on the progress of the geological survey made during last summer. It was carried on in three different regions in the north-western part of Tyrol and Vorarlberg, including also the dominion of Prince Liechtenstein, on the Carlstadt military frontier, and in the south part of Bukowina. The exact investigation of the limestone chain in the first region, by Dr. v. Majsisovics, gave very unexpected results; not only did he discover Silurian (Grauwacke) strata and dyassic strata (Schwatz-limestone and Gröden-sandstone) unknown hitherto in the Rhäticum, but he stated also that the large limestone range of the Drusenflah, Salzflah, and Weisplatten belongs to the cretaceous formation—a very important fact, which changes essentially our ideas as to the geological structure of the curious region which separates the eastern and western Alps. Not less important are the observations of Dr. Stache on the crystalline rocks of the Oetzthal massive. He denies the existence of any more recent and eruptive "Central Gneiss" in this region, and asserts that strata of the so-called rock alternate regularly with mica-schist, amphibolic schists, &c. in the middle part of the massive as well as towards its outer margins. In the southern part of Bukowina, a region very little known till now, Mr. Paul stated that the crystalline schists, forming the basis of a series of sedimentary formations, are divisible into two members; the lower, consisting chiefly of quartz-slates and quartzites, contains ores of copper and iron; the upper, formed by mica-slates, red gneiss, calcareous and amphibolic slates, includes the so-called black iron ores and manganese ores of Takobeni and Dorna. The sedimentary rocks are red sandstone, triassic limestone, lower and upper Neocomian, Cenomanian, Nummulitic rocks, and higher up the large masses of Carpathian sandstone. Besides the regular survey, almost all the members of the Institute made particular inquiries in different parts of the empire, partly for exclusively scientific purposes, but chiefly for the solution of questions of practical interest. An important discovery was thus made by Dr. Stache; he found in the slates south of the Gaiethal in Carinthia numerous Graptolites, the first certain proof of the existence of Silurian rocks in the southern Alps.

Paris

Academy of Sciences, Dec. 16.—M. Faye, president, in the chair. The president of the Institute informed the Academy that its first general meeting for 1873 would be held on January 8, and wished the Academy to appoint a member to represent it as reader on that occasion.—General de Cissey, Minister of War, announced that his department had decided on the re-determination of the French meridian which has at present many errors, as it is advisable that the French section of the great line extending from Shetland to the Sahara should equal in accuracy the English, Spanish, and Algerian portions. Captain Perrier is to have charge of the work, and the Academy is asked to appoint a committee of revision.—The president then read an addition to his physical theory of the sun explaining the nature of the spots. He defends his theory against some recent criticisms of Messrs. Spencer and Kirchhoff. He regards the spots as produced by cyclones which form a funnel-shaped cavity in the photosphere. Round the edge of this hole the photosphere and chromosphere are heaped together, and into it masses of cooler atmosphere are drawn by the vortex, and they then exert their absorptive power.—M. Jamin read a note on the distribution of magnetism.—M. Belgrand then read a second note on the floods of the Seine.—M. Daubrée read a note on a meteorite which fell near Bandong, Java; the governor of the Dutch Indies had sent a portion to the museum. An analysis has been published in the Archives Néerlandaises of Haarlem, vol. vi. 1871, by Mr. Von. Baumhauer. The meteorite contains iron, nickel, cobalt, chromium, manganese, magnesium, aluminium, sodium, potassium, calcium, oxygen, sulphur, and silicon.—M. Fréd. Kuhlmann then read an account of a search for iodine and bromine in some phosphatic minerals, iodine was distinctly recognised, but bromine if present was only there in inappreciable quantities.—M. F. Perrier read a note on a new determination of the French meridian.—The *Phylloxera* Commission presented extracts from two papers by MM. Max Cornu and E. Duclaux: they also asked permission to present their report at an early date. Notes on the same subject were received from MM. R. Shore and Alderly.—M. de Wissocq presented a paper entitled "A Study of the Works required to prevent the Floods of the Loire.—M. Sacc sent a letter on the preservation of food, which was referred to the commission on that subject.—M. F. Perrier read an answer to a note of M. Laussedat on the prolongation of the Spanish meridian into Algeria. The answer related partly to questions of priority as concerns the proposed prolongation.—M. F. Lucas presented some observations on a note on mathematical physics, by M. Quet.—M. Gernez sent a note on the supposed action of thin films of liquids on supersaturated solutions. The author asserts that Tomlinson and Van der Mensbrugghe are deceived in their idea that films cause crystallisation. M. Gernez states that this is not caused by a film *per se*, but by crystalline particles contained in it.—M. A. Treve read a note on magnetism, which was followed by a note by MM. Troost and Hautefeuille on some derivatives of the oxychlorides of silicon.—M. A. Boillot read a note on a new method of preparing ozone by means of carbon. The carbon is employed as the conducting film on the surface of the ozoniser. M. Gérardin presented a note on the amount of oxygen dissolved in rain water and in that of the Seine. Fine and persistent rain contains less oxygen than that of heavy and short showers.—Next came a note from M. Lortet on penetration of *leucocytes* into the interior of organic membranes.

DIARY

FRIDAY, January 3.

Geologists' Association, at 8.—On the Cambrian and Silurian Rocks of Ramsey Island, St. David's: Henry Hicks.—On the Diprionidæ of the Moffat Shale: Charles Lapworth.

SUNDAY, January 5.

Sunday Lecture Society, at 4.—The next Transit of Venus, and the measurement of the distances of the Planets from the Sun: W. J. Lewis.

MONDAY, January 6.

London Institution, at 4.—On Air, Earth, Fire, and Water: Prof. Armstrong (Holiday Course, II.)
Entomological Society, at 7.
Society of British Architects, at 8.
Medical Society, at 8.
Victoria Institute, at 8.

TUESDAY, January 7.

Pathological Society, at 8.—Anniversary.
Anthropological Institute, at 8.—The Atlantean Race of Western Europe: The late J. W. Jackson.—The Kojahs of Southern India: Dr. John Shortt.—Primordial Inhabitants of Brazil: M. H. Gerber and Capt. Burton.
Society of Biblical Archæology, at 8.30.
Zoological Society, at 8.30.—Contributions to a general History of the Spongiadæ (Part IV): Dr. Bowerbank.—Report on a Collection of Sponges found at Ceylon, by E. W. H. Holdsworth: Dr. Bowerbank.—On the Value in Classification of a peculiarity in the anterior margin of the Nasal Bones of some Birds: A. H. Garrod.
Royal Institution, at 3.—Juvenile Lectures—On Air and Gas: Prof. Odling.

WEDNESDAY, January 8.

Geological Society at 8.—On the Secondary Rocks of Scotland.—Part I. The Strata of the Eastern Coast: J. W. Judd.—Observations on the more remarkable Boulders of the North West of England and the Welsh Borders: D. Mackintosh.
Graphic Society, at 8.
Royal Society of Literature, at 8.
Archæological Association, at 8.

THURSDAY, January 9.

Royal Society, at 8.30.
Society of Antiquaries, at 8.30.
Royal Society Club, at 6.
Mathematical Society, at 8.—On Parallel Surfaces: S. Roberts.—Summation of certain Series: Prof. Wolstenholme.
Royal Institution, at 3.—Juvenile Lectures—On Air and Gas: Prof. Odling.

BOOKS RECEIVED

English.—Faith and Free Thought: S. Wilberforce (Hodder and Stoughton).—A Series of Botanical Labels for Herbaria: J. E. Robson (Hardwicke).—The Coal-Fields of Great Britain. 3rd edit.: E. Hull (Stanford).—Reprint of Papers on Electrostatics and Magnetism: Sir William Thomson (Macmillan & Co.).

CONTENTS