F. Galton

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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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THURSDAY, DECEMBER 14, 1905.

A GREAT NATURALIST.

My Life: a Record of Events and Opinions. By Alfred Russel Wallace. Vol. i., pp. xii+435; vol. ii., pp. viii+459. With facsimile letters, illustrations, and portraits. (London: Chapman and Hall, Ltd., 1905.) Price 25*s.* net.

EVERYONE will be glad that the Nestor of the evolutionist camp has been able himself to tell us the story of his life. It has been a long life of over fourscore years, full of work, rich in achievement, starred with high ideals, and the story of it must have been pleasant to write as it is pleasant to read. It has been many-sided to a greater degree than that of most scientific investigators, for Alfred Russel Wallace has always had more than professional irons in the fire, and has always been as much interested in practising biology as in theorising about it. At the editor's request we have confined our attention, however, to what the author tells us of his work as naturalist and biologist, though it is difficult, and not altogether legitimate perhaps, to abstract off one aspect of a life in this fashion.

There does not seem to have been anything definable in Wallace's inheritance to account for his becoming a great naturalist. Nor was there much in his nurture to lead him in that direction except that he was country-bred in beautiful and interesting places. Thrown early on his own resources to make his way in life, he began when about fourteen to work at surveying—in which Herbert Spencer had also his early discipline—and it was in trying to understand his instruments and the earth he measured that he first became scientific. He tells us that in his solitary rambles, nature gradually laid hold of him, claiming to be understood as well as enjoyed. From the stars and the earth his interest spread to flowers, and, with the help of Lindley's "Elements" and Loudon's "Encyclopædia of Plants," he became a keen field-botanist. He began to feel "the joy which every discovery of a new form of life gives to the lover of nature," and this was the turning-point of his life.

During a year of school-teaching at Leicester (1844), Wallace got to know Bates, who made him an enthusiastic entomologist, "opening a new aspect of nature," and he also read Malthus's famous essay, "without which I should probably not have hit upon the theory of natural selection." Another book that impressed him was Humboldt's "Personal Narrative of Travels in South America," which awakened a desire to visit the tropics, a desire soon strengthened by Darwin's "Voyage of the *Beagle*." It is interesting to find that as early as 1845 Wallace was speculating upon the origin of species, and had a warm appreciation of the "Vestiges of the Natural History of Creation."

Early in 1848, when he was twenty-five, Wallace set out, along with Bates, to explore and collect on the Amazon, and on the tale of his adventures, long since told, the "Life" throws some sidelights. There is a vivid description of the disastrous fire on board the rubber-laden ship which brought Wallace part of the way home in 1852. The holocaust of all his treasures was hard to bear, but what had been sent on during his journey, and those notes and drawings which were saved from the fire, sufficed to lay the foundations of his scientific reputation, and, perhaps, as he says, the disaster was, for him, a blessing in disguise, for it made him continue his *Wanderjahre*.

The "central and controlling" chapter in Wallace's life was his eight years' wandering throughout the Malay Archipelago, the story of which has fascinated many thousands of readers. He had found his vocation, and enthusiasm grew upon him. "Who ever," he wrote, "did anything good or great who was not an enthusiast?" The love of solitude grew upon him; it was so "very favourable to reflection." For though he was earning a competency by collecting, and though his knowledge of many groups of animals became expert, he was always pondering over big problems, and some of his friends at home shook their heads at his "theorising." "The problem of the origin of species was rarely absent from his thoughts," and at Sarawak, in 1855, he wrote what Huxley called a "powerful essay" on "The law which has regulated the introduction of new species"—a hint of what was coming. At Ternate, in 1858, when ill with intermittent fever, he began thinking over what he had learned from Malthus, and the theory of natural selection "suddenly flashed upon him." He wrote straight off to Darwin, and everyone knows how the two papers were read on the same day at the Linnean Society, and how the two discoverers were united in a friendship than which there has been nothing finer in the history of science.

From 1862 to 1871 Mr. Wallace lived in London, and the "Life" gives an account of his scientific and literary labours, and interesting glimpses of many scientific men whom he came to know, such as Lyell, Spencer, Huxley, W. B. Carpenter, and St. George Mivart. He tried for various posts, *e.g.* the secretaryship of the Royal Geographical Society (which Mr. Bates obtained), and the guardianship of Epping Forest (in connection with which he had some luminous ideas), but he was left free to continue his literary and scientific work, and to try to make things better for his country. Soon after his marriage, in 1866, he began to migrate by stages into the country—to Grays (where he wrote his "Geographical Distribution"), to Croydon (where he wrote his "Island Life"), to Godalming, to Parkstone, and was able to live quietly on his earnings and on a well-merited Civil List pension. Apart from his tour in America, where he gave the Lowell lectures in 1886, occasional holidays, *e.g.* at Davos, and occasional unprofitable scrimmages, his life was very uneventful, as men count events. By nature quiet, gentle, and reflective, he had no ambitions save for truth and justice; he was satisfied with plain living and high thinking, and the esteem of all who really knew him. Thus for many years he has cultivated his garden and served his fellow-men.

The "Life" contains many interesting appreciations of other naturalists, but we must confine ourselves to the relations between Darwin and the author. From his solitude in Malay Wallace wrote home in regard to "The Origin of Species":—

"I have read it through five or six times, each time with increasing admiration. It will live as long as the Principia of Newton. Mr. Darwin has given the world *a new Science*, and his name should, in my opinion, stand above that of every philosopher of ancient and modern times."

To Mr. Bates he wrote:—

"I do honestly believe that with however much patience I had worked and experimented on the subject, I could *never have approached* the completeness of his book, its vast accumulation of evidence, its overwhelming argument, and its admirable tone and spirit. I really feel thankful that it has *not* been left to me to give the theory to the world."

As everyone knows, Wallace parted company with Darwin over the possibility of giving a "natural history" interpretation of man's highest qualities, and in one of his letters Darwin expressed the fear that his selectionist interpretation would quite kill him in Wallace's good estimation. But the author writes:—

"I never had the slightest feeling of the kind he supposed, looking upon the difference as one which did not at all affect our general agreement, and also being one on which no one could dogmatise, there being much to be said on both sides."

Wallace also differed from Darwin in regard to the reality of sexual selection through female choice, as to the distribution of Arctic plants in south temperate regions, as to the feasibility of the provisional hypothesis of pangenesis, and as to the transmissibility of acquired character. On the whole, however, he admits that those critics are not far wrong who describe him as more Darwinian than Darwin, and even in the title of one of his most effective books he persisted in his magnanimous subordination of himself. The fact is, the friends were too keen in the pursuit of truth to trouble about the boundaries of their personal credit. Neither begrudged the other his due meed of praise. Thus, if we may quote once more, we find Darwin writing to Wallace:—

"I hope it is a satisfaction to you to reflect—and very few things in my life have been more satisfactory to me—that we have never felt any jealousy towards each other, though in some sense rivals. I believe I can say this of myself with truth, and I am absolutely sure that it is true of you."

In addition to his statement of the theory of natural selection, his travels, and his work on distribution, Mr. Wallace has in many ways enriched natural history in the wide sense. There is his theory of the "warning colours" of inedible insects, his theory of the correlation between the colours of female birds and the nature of the nest, his theory of "recognition-marks," his criticism of sexual selection by choice on the female's part, his argument that much that is called "instinctive" is due to instruction and imitation, his conclusions as to the Arctic elements in south temperate floras, his emphasis on mouth-gesture as a factor in the origin of language, his strong opinions as to the part natural selection has played and still plays in the social evolution of mankind. We might mention other contributions—as to the permanence of oceanic and continental areas, as to the causes of glacial epochs, as to the glacial erosion of lake-basins, as to the affinities of the Australian aborigines—but we have said enough. It may be of interest, however, to notice that while Wallace many years ago sided with Weismann, he cannot see his way to recognise the validity of the recent theories of discontinuous variation and mutation.

In thinking of the work of Alfred Russel Wallace, we see him as a "synthetic type," combining the virtues of the old naturalist traveller with those of the modern biologist. On the one hand, we see him with a rich experience of the forms and species of animal life, their distribution, habits, and inter-relations, but with a wide outlook, equally interested in palms and orchids, lakes and mountains. With "a positive distaste for all forms of anatomical and physiological experiment," he never took to any of the usual methods of analysis, and even when he was most preoccupied with species he tells us that he was determined not to become a specialist. So, on the other hand, we see him from first to last as a generaliser, "inquisitive about causes," intent upon "solving the problem of the origin of species," and contributing much thereto. His "Life" also discloses what many have had the privilege of knowing—the delightful personality of one who has had the honour of being "Darwinii æmulum, immo Darwinium alterum," and no ætiologist merely, but a warm-hearted humanist thinker, a fearless social striver, and one who realises the spiritual aspect of the world. He has the satisfaction of a retrospect on a long and happy life of work.

J. A. T.

A HIGHER TEXT-BOOK OF ELECTRICITY AND MAGNETISM.

Magnetism and Electricity for Students. by H. E. Hadley. Pp. x+575. (London: Macmillan and Co., Ltd., 1905.) Price 6*s*.

THE object of this volume is to carry students a stage further than that reached in the author's "Magnetism and Electricity for Beginners." It has been written in response to numerous requests from teachers. Its scope is roughly that of a second- or even third-year college course. Elementary differential and integral calculus is employed, but even this is avoided whenever reasonably practicable. Technical applications are dealt with in a minor way only, the author considering, rightly in our opinion, that they are best relegated to a special treatise.

Turning to the detailed treatment we find many things to attract us. The method adopted for describing electrical phenomena may be alluded to as the "lines of force method." There are a large number of carefully thought out diagrams showing the play of Faraday tubes in various cases. These are in the main very accurate and suggestive as sketch diagrams. In Fig. 112, however—illustrative of Faraday's ice-pail experiment—care should have been taken to make the lines emanating from the charged ball fall normally upon the vessel. The properties of these lines are not dogmatically asserted, but in general are derived, in the usual way, from the inverse square law of force; exception must, however, be made with respect to the lateral pressure exerted by such tubes. In stating that the inverse square law was experimentally verified first by Coulomb the author seems to have forgotten Cavendish, who, fully twelve years earlier, proved that the index cannot differ from two by more than 1/50th part.

We have alluded already to the diagrams; more care than usual has been exercised in regard to these. We are particularly attracted by one showing the lines of force and induction of a horse-shoe magnet. Compared with the usual paltry sketches of these lines this is most excellent. The student ought to be warned, however, that it represents rather an artificial case, since the poles are taken as concentrated at points. In the absence of this warning the student may be puzzled to account for the peculiar configuration of the system of lines shown. Another diagram which is now finding its way into text-books is one (Fig. 354) showing the lines of *electric* force due to a current. Much emphasis is usually placed on the magnetic field, but the electric field is almost entirely ignored. We are glad to see it now beginning to take its proper place. It may be mentioned that if the conductors be taken as infinitely deep, so as to reduce the problem to a two-dimensional one, the lines of force are a family of rectangular hyperbolæ, while the equipotential lines are the orthotomic hyperbolæ.

Several omissions and errors require attention. In the chapter on mechanics there is no definition of *mass*—we are not even told that it is the quantity of matter in a body. It is erroneous to state that electrification and electric currents are forms of energy (p. 22). A hollow soft iron cylinder does not act as a perfect screen to magnetic force for points inside it (p. 65). The proof of the formula for the ballistic galvanometer (p. 282) is imperfect, since it assumes that the current is constant while it flows; whereas it essentially is never so in cases for which this kind of galvanometer is used. A very little change in the proof will put this right. In the formula for simple pendulum or suspended coil the time period should not be written with sin θ/θ in the denominator, since when so written the idea is conveyed that this is the proper form when the difference between sin θ and θ is too large to be neglected. In calculating the temperature of a wire when heated by a current the emissivity should not be taken as a constant, for Messrs. Ayrton and Kilgour confirmed Péclet's proof that it depends on the radius; for very thin wires the values go up to many times that quoted, except, of course, in a vacuum. Kelvin's proof of the existence of an E.M.F. *distributed* in a circuit of two metals parts of which are at different temperatures depended on the first law of thermodynamics, and not upon the properties of a Carnot cycle (p. 374). The definition of units is antiquated; those described (p. 515) are now obsolete. On p. 531, in connection with displacement currents the word *displacement* is used on adjacent lines in two senses, with consequent confusion to the meaning. The treatment of the calculation of the propagation of electrodynamic effects (p. 534) which is professedly applicable to the case when the exciting current is travelling along a wire is inapplicable to this case. The display of mathematics in this calculation will convey the erroneous impression of a thorough investigation. The result must be disastrous to a student who is feeling his way toward a knowledge of the subtleties of line-integration round a closed curve. The error arises in part from forgetting that the magnetic induction varies in the direction y as well as in the direction x. Everything is, we believe, put right if the conductor be taken as an infinite plane sheet; the variation which is omitted is in such a case zero.

These few errors are the more unfortunate since we think that the book will prove a very useful one. We frankly think that it has been attempted to put too much into small compass; most sections would be improved by amplification in explanation of principle at the sacrifice of detail. A little excision when this edition is exhausted, a little more attention to logical order and to the development of principles—such suggestions are worth attending to, for the book has the making of a very useful volume.

BUNSEN'S COLLECTED WORKS.

Gesammelte Abhandlungen von Robert Bunsen. Edited by Wilhelm Ostwald and Max Bodenstein. Vol. i., pp. cxxvi+535; vol. ii., pp. vi+660; vol. iii., pp. vi+637. (Leipzig: Engelmann; London: Williams and Norgate, 1904.) Price 2*l.* 10*s.* net.

THE appreciative and critical notices of Bunsen and his work which appeared shortly after his death hardly leave room for a review of the volumes before us. In the Chemical Society memorial lecture, which is justly given the place of honour in the prefatory part of the first volume, Sir Henry Roscoe has given a comprehensive survey of Bunsen's work, and has described the personality of the man in such a way as to earn the gratitude of all old Heidelberg students.[1]

In these three stately volumes we have a complete collection of Bunsen's contributions to science and a book that will form part of the permanent literature of chemistry. It is, indeed, a most striking fact that all Bunsen's writings are in their nature permanent scientific literature, a fact that well deserves pondering at the present time. He made some mistakes, he advanced some conclusions now untenable, but his writings are of faithful observations, careful experiments, laboratory methods. Of speculative theory there is nothing, and of strictly polemical writing also nothing. The books that are included in his writings are accounts of methods of doing things that he him-

[1] An account of Bunsen's scientific work was given by Sir Henry Roscoe in NATURE of April 28, 1881 (vol. xxiii. p. 597), as a contribution to our series of "Scientific Worthies."—EDITOR

them, and savour so strongly of the prairie or the river bank, that the lover of an outdoor life must be hard indeed to please if he cannot find matter of interest on almost any page to which he may happen to turn. The chapter-headings in some instances appear to be designed, at least to an English reader, to conceal rather than to elucidate the author's subjects, and we venture to think that some less recondite titles than "The Witchery of Wa-Wa" and "A Matter of Mascalouge" might have been selected without detriment to the picturesque style which the author apparently favours. But when once this little difficulty has been overcome, the reader will be able to find his way about the book, and select those sections in which he may be more specially interested.

The greater part of the book is devoted to fishing—both in sea and river—and feathered game shooting, and the English reader who desires to know the kind of sport afforded by ruffed grouse and "bob white" will find his requirements fully satisfied in the author's pages. Nor will the naturalist fail to find matter well worth his notice; and personally we have been specially interested in the account of the death-feigning instincts exhibited by the Carolina rail. Seemingly, when it thinks itself unable to escape, one of these birds suddenly "stiffens, topples over, and apparently expires. It may be taken up and examined for a considerable time without its betraying any signs of life. Place it among its dead fellows in the shooting-boat, and after a longer or shorter interval it may astonish its captor by either starting to run about, or by taking wing and fluttering away in the characteristic flight."

This is only one of many instances where strange habits of animals are recorded, and if not new they are always interesting and worth the re-telling. As a sample of the better class of sporting literature Mr. Sandys's work would be difficult to beat. R. L.

Ships and Shipping. By Commander R. Dowling. With a preface by Lieut. W. G. Ramsay Fairfax, R.N. Second Edition. Pp. xv+423. (London: A. Moring, Ltd., 1905.) Price 5s. net.

A VERY excellent little volume and a most handy addition to any shipping office. The naval information makes it also a very useful book to naval officers. One slight improvement would be useful—port-to-port distances round the coast of Great Britain and Europe; for example, London to Plymouth.

H. C. LOCKYER.

LETTERS TO THE EDITOR.

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

The late Sir John Burdon-Sanderson.

THE account of the life of Sir John Burdon-Sanderson in NATURE of December 7 is so admirable that any addition to it may seem superfluous. Yet, as one who knew Burdon-Sanderson for more than thirty-seven years, and who owed more to him than language can well express, I shall be grateful if you will allow me to say a few words more about him. It seems to me that in one respect men may be likened to mountains. The Matterhorn rises sharply to a single peak, and there can be no doubt as to its summit. Monte Rosa has more than one summit, so nearly on a level that a stranger would be unable to say which is highest, and although each is higher than the Matterhorn, the enormous bulk of the mountain takes away from their apparent height and makes them less imposing. In the same way it is easy to say what the great work has been of any man who has distinguished himself in a limited subject, but when a man's work ranges over a wide sphere it is not so easy. The account of Sir John Burdon-Sanderson's life in last week's NATURE clearly shows the wide extent of his activity and the great number of epoch-making discoveries which he made. If a scientific man were asked which of these is the greatest, he would probably answer according to his own personal bias. One man would name his unique researches on motion in plants; another his discovery of the possibility of attenuating anthrax virus and thus producing immunity from the disease; a third his researches on circulation and respiration; and a fourth his work on muscle and nerve. But all these things, important as they are, each one being sufficient to make a man famous in a special department, were only isolated outgrowths of his great work, and did not constitute it. I believe that I am right in saying that Burdon-Sanderson's life-work may be defined in three short sentences:—(1) He revolutionised physiology and pathology in this country; (2) he found them consisting of book-learning and microscopic observation; (3) he left them experimental sciences.

When he first constructed a kymographion in 1867 by the aid of a tin-plate worker near the Middlesex Hospital, to which he was then attached, there was not, with the exception of a few specimens of Marey's sphygmograph, a single recording physiological instrument in use in the whole of this country. Now they are to be found in every physiological laboratory, and every student knows how to use them. When he began to work at pathology, it consisted chiefly in descriptions of the naked-eye and microscopical appearances of specimens of morbid anatomy. Now the action of disease-germs and of toxins and the reaction of the organism to them, the processes of disease and not its results, engage the chief attention of pathologists, and the knowledge which experiments on these processes have afforded regarding the means of producing immunity and of curing by antitoxic sera has lessened, and is daily lessening, the wholesale destruction of life by epidemic diseases.

How Burdon-Sanderson accomplished his great work by his researches, by his writings, by his example, and by his personal influence was well described in last week's NATURE, but I may perhaps be permitted to mention my own case as an example of what Burdon-Sanderson did for young men. I came to London knowing only one man, who from age and infirmity was unable to help me; but fortunately for me I had a letter of introduction to Burdon-Sanderson. Instead of merely saying a few civil things and then leaving me alone, as he might well have done, he invited me to his house, advised me as to my career, obtained for me a lectureship in the Middlesex Hospital, to which he was then attached, gave me the free use of his laboratory, afforded me facilities for both experimental and literary work, and, in short, laid for me the foundation of any success I may since have had, so that it is mainly to him that I owe it. How many there are whom he has treated as he did me I do not know, for he did not let his left hand know the good his right hand was doing, but I do know that at least two others, Dr. Ferrier, who has done such splendid work in physiology, and Dr. Klein, who has done the same in pathology, owe, like me, their first establishment in London to Burdon-Sanderson. Such personal help as this in enabling young men to pursue a scientific career must not only be regarded as an evidence of the kindness and benevolence of his character, but must be reckoned along with his researches, his writings, his example, and his personal influence as a means whereby he accomplished his great work of revolutionising physiology and pathology in this country.

LAUDER BRUNTON.

Nomenclature of Kinship; its Extension.

THE method I adopted in your columns, August 11, 1904, of briefly expressing kinship has proved most convenient; it has been used in a forthcoming volume by Mr. E. Schuster and myself on "Noteworthy Families." I write now to show that it admits of being *particularised* by the use of foot-figures, as in the following example, which refers to the more highly placed relatives of the newly elected King of Norway.

Haakon VII., King of Norway (*b.* 1872).

fa_{1s}	Frederick, Crown Prince of Denmark (*b.* 1843).
$fa_{1s}\ fa$	Christian IX., King of Denmark.
$fa_{1s}\ bro_2$	George I., King of the Hellenes (*b.* 1845).
$fa_{1s}\ si_2$	Dagmar, widow of Alexander III., Tsar of Russia, who *d.* 1894.
$fa_{1s}\ si_2\ son_1$	Nicholas II., Tsar of Russia (*b.* 1868).
$fa_{1s}\ si_1$	Alexandra, Queen of England (*b.* 1844).
$fa_{1s}\ si_1\ son_1$	George, Prince of Wales (*b.* 1865).
$fa_{1s}\ si_1\ da_3$	also *wife*, Princess Maud (*b.* 1869) of England.

The formulæ are to be read thus:—"his (the K. of Norway's) father is the 1st (eldest) son, and is Frederick, C.P. of Denmark; "his (the K. of Norway's) father's father is Christian IX."; . . . "his father's 2nd sister's 1st son is Nicholas II."; . . . "his father's 1st sister's 3rd daughter, who is also his (the K. of Norway's) wife, is the Princess Maud." These foot-figures need not interfere with the simplicity of the general effect, while they enable a great deal of additional information to be included.

FRANCIS GALTON.

Atomic Disintegration and the Distribution of the Elements.

MR. DONALD MURRAY'S letter (p. 125) deals with a subject which I have been attempting, now for more than a year, to attack experimentally. A similar experience to that which Mr. Murray describes as the experience of a lifetime occurred to me eighteen months ago in a visit to the gold mines of Western Australia. Since then my thoughts have been less concerned with the radio-elements than with those like gold, platinum, thallium, indium, &c., which resemble radium in the minuteness and approximate constancy of the proportion in which they occur in nature.

It is wonderful to reflect that mankind for thousands of years has been passionately and determinedly engaged in the search for gold, not on account mainly of its useful qualities, but on account of its comparative scarcity. The history of gold-getting presents a strange uniformity. The search has been rewarded always with about the same qualified measure of success, never with such success that the value of gold has seriously depreciated. The common saying that about the same amount of gold has to be put into the earth in order to dig it out holds an economic and probably a scientific truth. For may we not consider that the history of these centuries of search, carried on with a tenacity of purpose and a continuity approached in the case of no other element, shows clearly that a natural law is here involved no less than in the case of radium or polonium? The history of gold-getting appears to be substantially the same in all countries in all times. We have the initial prospecting in which the chances and difficulties are so great that only the most adventurous attempt it; the discovery of surface gold and the rush from all parts of the earth; the phenomenal finds and the invariably much greater proportion of failure; the tracing of the gold to its source and the discovery of some cubic acres, or it may be miles, of gold-bearing earth. Then at first only the deposits averaging several ounces to the ton are thought worthy of attention; but these rapidly give out, and attention is directed to the poorer and still poorer veins, while at the same time the steady progress and evolution of the pioneer camp, where often gold seems to be commoner than water, into the civilised community served with railways, electric power, and often elaborate water supply, cheapens the cost of extraction to such an extent that deposits averaging only a few grains to the ton can be made to yield a profit. Finally, we have the same inevitable end when science and organisation have done all in their power, and the remaining ore contains just so much gold as *not* to pay.

Let the case be stated a little differently. What would be the effect of the sudden discovery in any one place of some really large quantity of gold? There seems no doubt that utter chaos would ensue in the commercial world, which might involve before it was got under control a re-arrangement of the map of the world. Since nothing of the sort has ever happened, in spite of the most unprecedented struggles to that end, it is in accord with the principles of natural evolution to conclude that such a contingency probably violates some law of nature. Thus the gentlemen in charge of the national exchequer and of the Bank of England, who on a casual examination appear to be placing the most blind and implicit confidence on the future continuance of the existing order of things, are in reality secure in a fundamental if previously unrecognised law of nature. Eighteen months ago, after my visit to the gold deposits of Western Australia and New Zealand, and by the information which all concerned in the industry so readily placed at my disposal, I became convinced that in all probability gold, like radium, is at once the product of some other parent element, and is itself changing to produce "offspring" elements, so that its quantity, and hence its value, was fixed simply as the ratio of these two rates of change.

My experiments with gold have been both by the direct and indirect methods. The former have been dogged by misfortune and have so far been without result, while in the indirect experiments on ancient gold the results until now have been conflicting. Certainly some nuggets did not contain helium in appreciable quantities, while in others I did find a minute quantity of helium. This, however, was before the elaborate precautions afterwards employed had been adopted, and as I can now repeat the experiments with certainty as soon as occasion permits I am keeping a quite open mind. On the other hand, I have established to my own satisfaction that helium is an invariable constituent of native platinum in all the samples I have tried. The above reasoning, from rarity, after extended search, applies to platinum to a degree only less complete than in the case of gold.

The experiments with the other elements have not yet been proceeding long enough to have furnished results, but I have made a great many experiments with uranium and thorium in the attempt to detect directly the production of helium from these elements. These elements have been, in fact, the standards, for their rate of change is accurately known, and, assuming with Rutherford that the α particle is an atom of helium, may be expected to yield helium at a known rate. The methods of search have been perfected in the case of these two elements, and I am glad to be able to say that it is now only a question of time and patience before the rate at which helium is being produced from these two elements is accurately measured. On the other hand, if helium is not being produced, the experiments will indicate a maximum possible limit of the rate of production (set by the smallest quantity of helium detectable) far below the rate to be expected from theory. This method, which is, of course, applicable to any other element, would detect any other gas of the argon-helium family if produced. So far, however, I have only had one completely successful experiment with each element. In the case of uranium the result was positive, and indicated a rate of production of the same order as that required by theory. In the case of thorium, the experiment was of the nature of a blank test, and it proved that the rate of production is certainly not greater than ten times that required by theory.

Mr. Murray's letter induces me to put on record these imperfect results, and I do this the more readily as they may perhaps serve to emphasise and support his suggestion that experiments along the lines and on the scale he suggests should be carried out. But what laboratory in England could deal with ten tons of lead over a term of ten years?

After a year's work, I confess I am less hopeful than I was of the ability of the individual worker to carry out direct experiments in this subject of atomic disintegration. I wonder if the individual with his humble kilogram and his single lifetime is not starting on an almost forlorn hope, and is unduly and unnecessarily handicapped. Due consideration should be given to the supreme consequences that must follow from successful discoveries in this field. Not only is there to be considered the effect such results must exert on the whole trend of philosophic thought, but certain definite economic problems would be solved. For example, the proof of the disintegration of gold would reduce the doctrine of bimetallism and the theory of currency to a branch of physical science, while in the mining industry the results would possess a fundamental significance. For the first time in the history of mineralogical chemistry it is possible, thanks to the researches of Boltwood, Strutt, and McCoy, to predict with considerable certainty the percentage of one element (radium) present if the percentage of another (uranium) is known; and one asks to what this discovery may not grow.

It seems to me that the individual and his single lifetime is too small a stake for the prize in view. Such a work should be national, and carried on from century to century if necessary; and what nation has such a right or such a duty as the one in which the subject of atomic disintegration originated? I confess to a feeling of impatience, to the sense of the inadequacy of the single lifetime, in my experiments on such small quantities of gold as I can purchase, when, disintegrating at the same rate, if disintegrating at all, tons of gold are lying useless in the national bank, their secret—possibly one that it much concerns the race to know—guarded from knowledge by every cunning invention that the art of man may devise. I confess to a sense of indignation that I should have to purchase for my experiments coins and other objects of known antiquity when within the walls of the National Museum lie—mere dead relics as they at present are—one of the finest collections in existence, capable of affording evidence perhaps of a longer history than any dreamed of by the antiquarian, and guarded by those who cannot interpret the cypher, and who, officially at least, are unaware of its existence. I confess to a feeling of misgiving in starting experiments where, on the scale possible to the individual, the chances are all against their yielding a positive result in a lifetime. Surely considerations of this character, the availability of the national resources and antiquities for the purpose of scientific investigations under due safeguards, and the provision for and care of experiments of long period with great quantities demanded by this new subject, are worthy of the attention of the nation, and of the British Science Guild as its newly formed adviser.

FREDERICK SODDY.

The University, Glasgow, December 9.

THE suggestion which Mr. Murray has put forward (p. 125) in explanation of the constancy of association of lead and silver has occurred to me also, and is indicated in an article which will probably appear shortly in the "Jahrbuch der Radioactivitat und Elektronik"; some calculations are contained therein which may be of sufficient interest to justify reproduction here.

Some recent experiments[1] have afforded evidence that the activity of the ordinary metals is caused by the emission of α particles. On the assumption that these α particles have an ionising power similar to that of those from radio-active elements, it appears that lead should emit less than one such particle per second. In order to find the maximum rate of change that we can attribute to this metal, we will assume that the emission of one such particle involves the breaking up of one atom of lead and the formation of one atom of silver; thus one atom breaks up per second. Now a gram of lead contains about 4×10^{21} atoms, and therefore to transform one ten-millionth part of the lead would require 4×10^{14} seconds or more than ten million years. Since it would be impossible to detect a smaller proportion than this by chemical tests, I fear that the experiment which Mr. Murray suggests is impracticable. The earth would probably have ceased to be a habitable globe by the time that the lead was ripe for examination; perhaps we may trust posterity to settle the matter with greater expedition!

But the slowness of the change in lead presents serious difficulties to the theory that the silver in galena is a disintegration product. Even so small a proportion as one in ten thousand (3½ ounces to the ton) would mean that the silver had been accumulating for a thousand million years—a period longer than that usually assigned as the age of the earth. But until we know more of the processes by which deposits of ore were formed, it is impossible to say whether the lead could have retained its silver through all the vicissitudes of its career. I believe that the silver cannot be separated from galena by any physical means; it may be so intimately associated that geological processes cannot affect it; but against this we have to set the fact that cerussite often contains much less silver than the galena from which it is obviously derived. But here chemical separation may have taken place involving the passage of the metals into solution.

There are problems connected with the "traces of impurity" constantly associated with certain minerals which await solution by some laborious chemist; it would be interesting to see whether there is any tendency to proportionality like that which holds between uranium and radium. But the absence of such a relation might be explained on the grounds that radio-active equilibrium had not yet been attained.

There is one other point to which attention may be directed. Rutherford has shown that the loss of heat from the earth by conduction would be compensated by the energy evolved by radium distributed throughout the mass of the earth in the ratio of 1 to 2×10^{13}; it appears that this amount of energy might be supplied by the disintegration of the actual constituents of the earth even if no radium were present. It is becoming clear that the older estimates of the age of the earth, based on physical data, are wholly erroneous; but if the radio-activity of all elements can be established rigidly, and the time constants of their decay measured with sufficient accuracy, it may be possible to use the evidence to which Mr. Murray has directed attention to gain some information as to the period that has elapsed since the solidification of the earth's crust.

NORMAN R. CAMPBELL.

Trinity College, Cambridge, December 10.

[1] The accounts of these should be included in an early number of the *Philosophical Magazine*.

IN NATURE, December 7, p. 125, Mr. Donald Murray suggests that the constant association of different elements arises from the slow transmutation of one into the other. The idea is certainly a reasonable one, and I presume has long been in the minds of all who have followed recent work. The writer discussed this question last year (*Chem. News*, 1904, lxxxix., 47, 58, 118), and arrived at Mr. Murray's opinion.

Now interest in the matter is reviving, perhaps I may be allowed to direct attention to this discussion.

Kiel, December 10. GEOFFREY MARTIN.

Action of Wood on a Photographic Plate.

I HAVE recently seen some photographic plates used at the last eclipse which have on them, not only pictures of the sun, but also pictures of the wood forming the dark-slides in which they had been placed.

At a former eclipse I understand a similar disaster occurred. It may, therefore, be well for me again to state that wood in contact with, or in near proximity to, a photographic plate, even in the dark, can impress upon the plate a clear picture of itself.[1] This action is much stimulated by high temperature and brilliant sunshine. It can, however, be stopped in several ways; probably the simplest one would be to make the slides of copper in place of wood.

WILLIAM J. RUSSELL.

Davy-Faraday Laboratory.

[1] *Phil. Trans.*, vol. cxcvii. p. 281; *Proc. Roy. Soc.*, vol. lxxiv. p. 131.

Magnetic Storms and Auroræ.

THE interesting paper by Dr. Chas. Chree in your issue of November 30 (p. 101) is inaccurate in one particular. He states that the storm of November 12 was not accompanied by auroræ. My friend Mr. John McHarg, of Lisburn, writes me that "it was fairly prominent, to be seen easily above the moonlight, the usual type, a steady glow brighter than the Milky Way, extending half round the horizon and fading off upwards at an altitude of 20°, or 30° in the west."

From that station auroræ were also observed on November 14, 15, 16, 17, 20, 21, 22, 23, 26, 27, and 30, and it is reported also that a bright crimson arch was seen on the early morning of December 1.

F. C. DENNETT.

6 Eleanor Road, Hackney, N.E.

NOTES ON STONEHENGE.[1]

IX.—FOLKLORE AND TRADITIONS.

SO far in these notes I have dealt chiefly with stones, as I hold, associated with, or themselves composing, sanctuaries. We have become acquainted with circles, menhirs, dolmens, altars, viæ sacræ, various structures built up of stones. Barrows and earthen banks generally came afterwards.

The view which I have been led to bring forward so far is that these structures had in one way or another to do with the worship of the sun and stars; that they had for the most part an astronomical use in connection with religious ceremonials.

The next question which concerns us in an attempt to get at the bottom of the matter is to see whether there are any concomitant phenomena, and, if there be any, to classify them and study the combined results.

Tradition and folklore, which give dim references to the ancient uses of the stones, show in most unmistakable fashion that the stones were not alone; associated with them almost universally were many practices such as the lighting of single or double fires in the neighbourhood of the stones, passing through them and dancing round them; there were also other practices involving sacred trees and sacred wells or streams.

Folklore and tradition not only thus may help us, but I think they will be helped by such a general survey, brief though it must be. So far as my reading has gone each special tradition has been considered by itself; there has been no general inquiry having for its object the study of the possible origin and *connection* of many of the ancient practices and ideas which have so dimly come down to us in many cases and which we can only completely reconstruct by piecing together the information from various sources.

I now propose to refer to all these matters with the view of seeing whether there be any relation between practices apparently disconnected in so many cases if we follow the literature in which they are chronicled. We must not blame the literature since the facts which remain to be recorded now here, now there, are but a small fraction of those that have been forgotten. Fortunately, the facts forgotten in one locality have been remembered in another, so that it is possible the picture can be restored more completely than one might have thought at first.

It will be noted at once that from the point of view with which we are at present concerned, one of the chief relations we must look for is that of time, seeing that my chief affirmation with regard to the stone monuments is that they were used for ceremonial purposes at certain seasons, those seasons being based first upon the agricultural, and later upon the astronomical divisions of the year.

But in a matter of this kind it will not do to depend upon isolated cases; the general trend of all the facts available along several lines of inquiry must be found and studied, first separately and then *inter se*, if any final conclusion is to be reached.

This is what I now propose to do in a very summary manner. It is not my task to arrange the facts of folklore and tradition, but simply to cull from the available sources precise statements which bear upon the questions before us. These statements, I think, may be accepted as trustworthy, and all the more so as many of the various recorders have had no idea either of the existence of a May year at all or of the connection between the different classes of the phenomena which ought to exist if my theory of their common origin in connection with ancient worship and the monuments is anywhere near the truth.

This question of time relations is surrounded by difficulties.

I give in Fig. 23 the Gregorian dates of the beginning of the quarters of the May year, if nothing but the sun's declination of 16° 20′ N. or S., four times in its yearly path, be considered. These were:—

	May Year	Greek Calendar	Roman Calendar
End of Winter ... ... / Beginning of Spring ...	Feb. 4 ...	Feb. 7 ...	Feb. 7
,, Summer ...	May 6 ...	May 6 ...	May 9
End of Summer ... ... / Beginning of Autumn ...	Aug. 8 ...	Aug. 11 ...	Aug. 8
,, Winter ...	Nov. 8 ...	Nov. 10 ...	Nov. 9

In the table I also give, for comparison, the dates in the Greek and Roman calendars (p. 20).

There is no question that on or about the above days festivals were anciently celebrated in these islands, possibly not all at all holy places, but some at one and some at another; this, perhaps, may help to explain the variation in the local traditions and even some of the groupings of orientations.

The earliest information on this point comes from Ireland.

Cormac, Archbishop of Cashel in the tenth century, states, according to Vallancey, that "in his time four

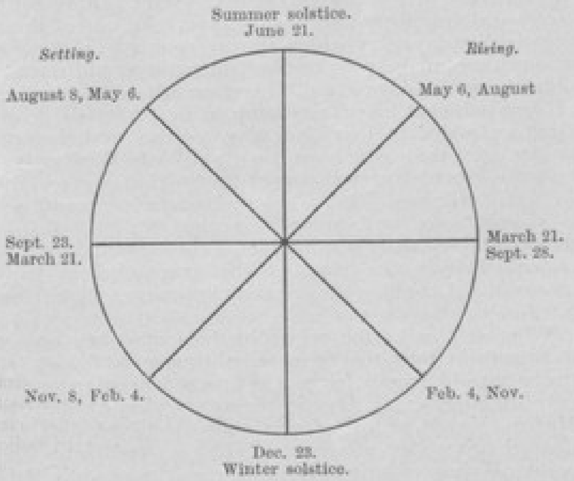

FIG. 23.—The farmers' and astronomical years.

great fires were lighted up on the four great festivals of the Druids, viz., in February, May, August, and November."[1]

I am not aware of any such general statement as early as this in relation to the four festivals of the May year in any part of Britain, but in spite of its absence the fact is undoubted that festivals were held, and many various forms of celebration used, during those months.

From the introduction of Christianity attempts of different kinds were made to destroy this ancient time system and to abolish the so-called "pagan" worships and practices connected with it. Efforts were made to change the date and so obliterate gradually the old traditions; another way, and this turned out to be the more efficacious, was to change the venue of the festival, so to speak, in favour of some Christian celebration or saint's day. The old festivals took no

[1] Continued from vol. lxxii. p. 272.

[1] Hazlitt, "Dictionary of Faiths and Folklore," under Gule of August.

account of week-days, so it was ruled that the festivals were to take place on the first day of the week; later on some of them were ruled to begin on the first day of the month.

When Easter became a movable feast, the efforts of the priests were greatly facilitated, and indeed it would seem as if this result of such a change was not absent from the minds of those who favoured it.

The change of style was, as I have before stated, a fruitful source of confusion, and this was still further complicated by another difficulty. Piers[1] tells us that consequent upon the change "the Roman Catholics light their fires by the new style, as the correction originated from a pope; and for that very same reason the Protestants adhere to the old."

I will refer to each of the festivals and their changes of date.

February 4.

Before the movable Easter the February festival had been transformed into Ash Wednesday (February 4). The eve of the festival was Shrove Tuesday, and it is quite possible that the ashes used by the priests on Wednesday were connected with the bonfires of the previous night.

It would seem that initially the festival, with its accompanying bonfire, was transferred to the first Sunday in Lent, February 8.

I quote the following from Hazlitt[2]:—

"Durandus, in his 'Rationale,' tells us, Lent was counted to begin on that which is now the first Sunday in Lent, and to end on Easter Eve; which time, saith he, containing forty-two days, if you take out of them the six Sundays (on which it was counted not lawful at any time of the year to fast), then there will remain only thirty-six days: and, therefore, that the number of days which Christ fasted might be perfected, Pope Gregory added to Lent four days of the week beforegoing, viz. that which we now call Ash Wednesday, and the three days following it. So that we see the first observation of Lent began from a superstitious, unwarrantable, and indeed profane, conceit of imitating Our Saviour's miraculous abstinence. Lent is so called from the time of the year wherein it is observed: Lent in the Saxon language signifying Spring."

Whether this be the origin of the lenten fast or not it is certain that the connection thus established between an old pagan feast and a new Christian one is very ingenious: 24 days in February plus 22 days in March (March 22 being originally the fixed date for Easter) gives us 46 days $(6\times7)+4$, and from the point of view of priestcraft the result was eminently satisfactory, for thousands of people still light fires on Shrove Tuesday or on the first Sunday of Lent, whether those days occur in February or March. They are under the impression that they are doing homage to a church festival, and the pagan origin is entirely forgotten not only by them but even by those who chronicle the practices as "Lent customs."[3]

Finally, after the introduction of the movable Easter, the priests at Rome, instead of using the "pagan" ashes produced on the eve of the first Sunday in Lent or Ash Wednesday in each year, utilised those derived from the burning of the palms used on Palm Sunday of the year before.

Further steps were taken to conceal from future generations the origin of the "pagan" custom due on February 4. February 3 was dedicated to St. "Blaze." How well this answered is shown by the following quotation from Percy.[4] "The anniversary of St. Blazeus is the 3rd February, when it is still the custom in many parts of England to light up fires on the hills on St. Blayse night: *a custom antiently taken up perhaps for no better reason than the jingling resemblance of his name to the word Blaze.*"

[1] "Survey of the South of Ireland," p. 232.
[2] Under Ash Wednesday.
[3] Frazer, "Golden Bough," ii., 247 *et seq.*
[4] "Notes to Northumberland Household Book," 1770, p. 333.

This even did not suffice. A great candle church festival was established on February 2. This was called "Candlemas," and Candlemas is still the common name of the beginning of the Scotch legal year. In the Cathedral of Durham when Cosens was bishop he "busied himself from two of the clocke in the afternoone till foure, in climbing long ladders to stick up wax candles in the said Cathedral Church; the number of all the candles burnt that evening was 220, besides 16 torches; 60 of those burning tapers and torches standing upon and near the high altar."[1]

There is evidence that the pagan fires at other times of the year were also gradually replaced by candles in the churches.

May 6.

The May festival has been treated by the Church in the same way as the February one. With Easter fixed on March 22, 46 days after Easter brought us to a Thursday (May 7), hence Holy Thursday[2] and Ascension Day. With Easter movable there of course was more confusion. Whit Sunday, the Feast of Pentecost, was only nine days after Holy Thursday, and it occurred, in some years, on the same day of the month as Ascension Day in others. In Scotland the festival now is ascribed to Whit Sunday.

It is possibly in consequence of this that the festival before even the change of style was held on the 1st of the month.

In Cornwall, where the celebrations still survive, the day chosen is May 8.

August 8.

For the migrations of the dates of the "pagan" festival in the beginning of August from the 1st to the 12th, migrations complicated by the old and new style, I refer to Prof. Rhys' Hibbert lectures, p. 418, in which work a full account of the former practices in Ireland and Wales is given.

The old festival in Ireland was associated with Lug, a form of sun-god. The most celebrated one was held at Tailltin. This feast—Lugnassad—was changed into the Church celebration Lammas—from A. S. hláfmaesse—that is loaf-mass, or bread-mass, so named as a mass or feast of thanksgiving for the first fruits of the corn harvest. The old customs in Wales and the Isle of Man included the ascent of hills in the early morning, but so far I have come across no record of fires in connection with this date.

November 8.

The fact that November 11 is quarter day in Scotland, that mayors are elected on or about that date, shows, I think, clearly that we are here dealing with the old "pagan" date.

The fact that the Church anticipated it by the feast of All Souls' on November 1 reminds us of what happened in the case of the February celebration, later I give a reference to the change of date; and perhaps this change was also determined by the natural gravitation to the first of the month as in the case of May, and because it marked at one time the beginning of the Celtic year.

[1] Quoted by Hazlitt.
[2] Much confusion has arisen with regard to the Holy Thursday in Rogation week because there is another Holy or Maundy Thursday in Easter week. Archæologists have also been often misled by the practice of many writers of describing the May festivals as midsummer festivals. The first of May, of course, marked the *beginning* of summer.

f. 9r

But what seems quite certain is that the feast which should have been held on November 8 on astronomical grounds was first converted by the Church into the feast of St. Martin on November 11. The "Encyclopædia Britannica" tells us

"The feast of St. Martin (Martinmas) took the place of an old pagan festival, and inherited some of its usages (such as the Martinsmännchen, Martinsfeuer, Martinshorn, and the like, in various parts of Germany."

St. Martin lived about A.D. 300. As the number of saints increased, it became impossible to dedicate a feast-day to each. Hence it was found expedient to have an annual aggregate commemoration of such as had not special days for themselves. So a church festival "All Hallows," or "Hallowmass," was instituted about A.D. 610 in memory of the martyrs, and it was to take place on May 1. For some reason or another this was changed in A.D. 834. May was given up, and the date fixed on November 1. This was a commemoration of all the saints, so we get the new name "All Saints' Day."

There can be little doubt that the intention of the Church was to anticipate and therefore gradually to obliterate the pagan festival still held at Martinmas, and it has been successful in many places, in Ireland, for instance; at Samhain,[1] November 1 "the proper time for prophecy and the unveiling of mysteries; . . . it was then that fire was lighted at a place called after Mog Ruith's daughter Tlachtga. From Tlachtga all the hearths in Ireland are said to have been annually supplied, just as the Lemnians had once a year to put their fires out and light them anew from that brought in the sacred ship from Delos. The habit of celebrating *Nos Galan-galaf* in Wales by lighting bonfires on the hills is possibly not yet quite extinct."

Here, then, we find the pagan fires transferred from the 8th to the 1st of November in Ireland, but in the Isle of Man this is not so. I will anticipate another reference to Rhys by stating that Martinmas had progressed from the 11th to the 24th before the change of style had brought it back, "old Martinmas," November 24, being one of the best recognised "old English holidays," "old Candlemas" being another, at the other end of the May year, which had slipped from February 2 to February 15 before it was put back again.

With regard to the Isle of Man Rhys writes[2] that the feast is there called Hollantide, and is kept on November 12, a reckoning which he states "is according to the old style." The question is, are we not dealing here with the Martinmas festival *not* antedated to November 1? He adds, "that is the day when the tenure of land terminates, and when serving men go to their places. In other words it is the beginning of a new year." This is exactly what happens in Scotland, and the day is still called Martinmas.

There is a custom in mid-England which strikingly reminds us of the importance of Martinmas in relation to old tenures, if even the custom does not carry us still farther back. This is the curious and interesting ceremony of collecting the wroth silver, due and payable to his Grace the Duke of Buccleuch and Queensbury, on "Martinmas Eve." The payment is made on an ancient mound on the summit of Knightlow Hill, about five miles out of Coventry, and in the parish of Ryton-on-Dunsmore. One feature about this singular ceremonial is that it must be observed before sun-rising. The money is now paid as a sort of highway rate for the privilege of using certain roads in the Hundred of Knightlow, and, according to the ancient charter, the penalty is a fine of twenty shillings for every penny not forthcoming, or the forfeiture of a white bull with red nose and ears. There are no defaulters nowadays, and if there were it would certainly be difficult, if not impossible, to find a beast answering the above description, as this breed of cattle has become extinct. When the short ceremony is over, those taking part adjourn to a wayside inn, and there with glasses charged with hot rum and milk they toast the Duke's health.

NORMAN LOCKYER.

1 Rhys, "Hibbert Lectures," p. 514.
2 "Celtic Folklore," p. 315.

AN AUSTRALIAN STORY BOOK.[1]

SHOULD any reader of NATURE desire to give a Christmas present to a boy or girl he might do much worse than buy Mrs. Jeanie Gunn's little book, but before parting with it he should himself look through it. The author has a great sense of humour, and seizes on salient features of native life and describes them in a few words; these gifts, combined with a real sympathy with the blackfellow, have enabled her to write a little book that is full of human interest. This is not an ethnographical treatise, and no matters are gone into in detail, yet the reader will learn somewhat of the life of Australian aborigines and of their relations with the white man, and if he should not acquire any deep knowledge he will have nothing to unlearn, and that is something to be thankful for.

A few examples culled at random will give a good idea of this most excellent little book.

"The blacks' sign language is very perfect. They have a sign for every bird, beast, fish, person, place and action. They have long talks without uttering a word. There are many times when a blackfellow must not speak, unless by signs. For instance, if he is mourning for a near relative, or has just come from a very special corrobboree. Often he must keep silent for weeks, and occasionally for months, and it is because of this and many other reasons that the sign language is so perfect. Everyone can speak it, and everyone does so when hiding in the bush from enemies, and then there is no fear of voices being heard."

"It is very wonderful, but then the blacks *are* wonderful. To have any idea of how wonderful they are, you must live among them, going in and out of their camps, and having every one of them for a friend. Just living in a house that happens to be in a blackfellow's country is not living among blacks, although some people think it is."

"I had plenty of Eau de Cologne, and used it freely. One day when Bett-Bett smelt it, as I was sprinkling it over my dress, she screwed up her little black nose, and after half-a-dozen very audible sniffs, said—'My word, Missus! That one goodfellow stink all right!'"

"Anyone can 'sing magic,' even lubras, but of course the wise old magic men do it best. It never fails with them, particularly if they 'sing' and point one of the special Death-bones or Sacred stones of the tribe. Generally a blackfellow goes away quite by himself when he is 'singing magic,' but very occasionally a few men join together, as they did in the case of Goggle Eye. . . . Of course the man who has been 'sung' must be told somehow, or he will not get a fright and die. There are many ways

1 "The Little Black Princess: A True Tale of Life in the Never-never Land." By Jeanie Gunn. Pp. vii+107; illustrated. (London: The De La More Press, 1905.) Price 5s. net.

of telling him, without letting him know who has 'sung' him; but the man who leaves the bone about must, of course, be very careful to destroy his own tracks. Have you ever heard of faith-healing? Well, dying from bone-pointing is faith-dying! Goggle Eye, after he had found the bones lying about, knew exactly what was going to happen to him—and of course it did."

"You cannot change a blackfellow into a white man, if you try; you only make a bad, cunning, sly old blackfellow. I don't mean you can't make a blackfellow into a better blackfellow. I know that can be done, if he is kept a blackfellow, true to his blackfellow instincts." A. C. H.

FIG. 1.—Tree-burial, south of the Roper River. From "The Little Black Princess."

NOTES.

THE Nobel prizes in science have this year been awarded as follows:—The prize for physics to Prof. P. Lenard, of the University of Kiel, for his investigations on kathode rays; the prize for chemistry to Prof. Adolf von Bäyer, of the University of Munich, for the development in organic chemistry and chemical industry resulting from his works on organic colouring matters and hydro-aromatic compounds; the medical prize to Dr. Robert Koch, for his discoveries in connection with tuberculosis. The prizes, consisting of a sum of about 7700*l*., an illuminated diploma, and a gold medal with an appropriate inscription, were presented by King Oscar on December 10 at the annual ceremony in commemoration of the founder of the institution.

THE following note appeared in the *Times* of December 7:—Sir William Thiselton-Dyer, whose resignation of the post of director of the Royal Botanic Gardens at Kew is announced, has held that appointment since 1885, and for ten years—1875-1885—before his promotion he was assistant director. His successor, Lieut.-Colonel David Prain, had a distinguished university career at Aberdeen and Edinburgh before he entered the Indian Medical Service in 1884. Three years after his arrival in India he was nominated curator of Calcutta Herbarium; in 1895 he became professor of botany at the Medical College, Calcutta, and superintendent of the Royal Botanic Garden there, and in 1898 he was appointed director of the Botanical Survey of India. He is forty-eight years of age.

THE German Anatomical Society has decided to erect a memorial of its honorary president, the late Prof. Albert von Kölliker. The memorial will be erected in Würzburg, with which the famous teacher and investigator was intimately associated.

PROF. E. RIECKE, professor of experimental physics and applied electricity in the University of Göttingen, and also director of the Physical Institute, celebrated his sixtieth birthday on December 1; whilst Prof. R. Fittig, emeritus professor of chemistry of the University of Strassburg, celebrated his seventieth birthday on December 6.

THE committee appointed to carry the proposal of a memorial to the late Prof. Virchow into execution has now, we learn from the *British Medical Journal*, a sum of 4000*l*. at its disposal. Of this amount, 1800*l*. has been contributed by subscribers and 2200*l*. by the city of Berlin. Three prizes, of the value respectively of 150*l*., 100*l*., and 50*l*., are offered for the best design of a memorial. Drawings must be sent in before April, 1906.

THERE is a movement on foot in German chemical and technical circles to erect a statue in Freiburg, Saxony, to the memory of the late Prof. Dr. Clemens Winkler, who was professor in the Royal Mining Academy at Freiburg, and died in Dresden last year. The proposed memorial is to take the form of a large block of granite decorated with a medallion picture of the deceased investigator and a short account of his life's work.

THE French Académie des Inscriptions et Belles Lettres has elected Dr. Arthur Evans, keeper of the Ashmolean Museum, and Mr. Barclay, head keeper of the department of coins and medals in the British Museum, corresponding members of the academy.

THE thirteenth meeting of the International Congress of Prehistoric Anthropology and Archæology will be held at Monaco, under the patronage of Prince Albert the First, on April 16-21, 1906. Particulars as to the congress may be obtained from the general secretary, Dr. Verneau, 61 Rue de Buffon, Paris.

AT a meeting of the British committee for the Marseilles International Exhibition of Oceanography and Sea

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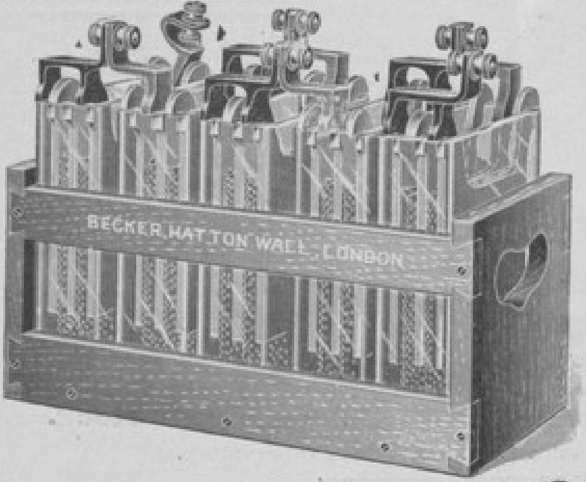

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Fisheries held last Friday, a central committee was nominated, consisting of Sir John Murray, K.C.B., the honorary president, Captain D. Wilson-Barker, Mr. W. E. Archer, Dr. H. O. Forbes, Mr. E. W. L. Holt, Dr. H. R. Mill, Dr. P. C. Mitchell, Prof. D'Arcy W. Thompson, C.B., Mr. J. W. Towse, and Dr. G. H. Fowler as honorary secretary.

A CONFERENCE on smoke abatement and an exhibition of smoke-preventive appliances, arranged by the Royal Sanitary Institute and the Coal-Smoke Abatement Society, were opened at the large hall of the Horticultural Society on Tuesday. At the conference parts of an address by Sir Oliver Lodge, who was prevented by illness from being present, were read by Sir William Richmond; and at the conclusion of the reading a paper entitled "Is London Fog Inevitable?" was contributed by Dr. W. N. Shaw.

THE dinner of the Institute of Chemistry was held on Monday at the Hotel Metropole, the president, Mr. David Howard, being in the chair. Responding to the toast of the institute, the president said that they had a very high ideal when they founded the institute; they wished to raise the standard of the chemist to something like the same level as that of the other learned professions. The position of the professional chemist was higher in England than it was anywhere else, and why? Because there was that independence of thought, that individual excellence and individual devotion to duty which was required in a true professional spirit.

THE seventeenth annual dinner of the Institution of Electrical Engineers took place on December 8 at the Hotel Cecil. A distinguished gathering assembled. Short speeches, in proposing and responding to the various toasts, were delivered by Mr. Babington Smith, the president (Mr. John Gavey), Sir Alexander Kennedy, F.R.S., Mr. E. Cunliffe Owen, Mr. Alexander Siemens, Mr. John G. Maydon, Mr. W. M. Mordey, Sir Alexander Binnie, and Dr. Budde, president of the Verband Deutscher Elektrotechniker of Berlin. Dr. Budde remarked that, speaking on behalf of his fellow electricians in Germany, he gratefully acknowledged the thought and the spirit expressed in the invitation to himself to be their representative as guest at the institution. Contact, he said, between the scientific and technical men of all countries cannot be too close. There are matters enough tending to separate nations, and therefore it cannot be too strongly pressed that research and intellectual labour form a tie which will always draw together the best spirits of the world, and must tend to promote international solidarity.

ON Saturday, December 9, a very interesting ceremony took place at the Royal Forest Hotel, Chingford, when a presentation was made to Mr. Wm. Cole, the founder of the Essex Field Club, in honour of the completion of his twenty-five years of service as hon. secretary, editor of the publications, and curator of the two museums founded by the club. At the instigation of the president, Mr. Miller Christy, a "recognition fund" was started a few months ago with Prof. Meldola as chairman, Mr. David Howard as treasurer, Mr. Christy as secretary, and a committee. The invitations issued on behalf of the movement were most cordially responded to, and the fund asked for was exceeded long before the subscription list was closed. At the dinner at Chingford Prof. Meldola presided and made the presentation on behalf of the subscribers, Mr. Cole and his brothers and sisters, all of whom had cooperated with him in carrying out the work of the club during the whole period of its existence, being present as the guests of the evening. The presentation took the form of an illuminated address and a purse. Among those who were present to support the chairman, and who bore testimony to the value of the work of the club and of the services of the hon. secretary and his family, were Mr. Victor Buxton, the High Sheriff of Essex, Mr. Christy and Mr. David Howard, the president and treasurer of the club, Mr. T. V. Holmes and Prof. Boulger, past-presidents, Mr. Gellatly, representing the verderers of Epping Forest, Messrs. W. Whitaker and Horace B. Woodward, hon. members of the club, Mr. W. M. Webb, representing the Selborne Society, and others. A very large number of appreciatory letters had also been sent, and were read from the chair, among the writers being the Countess of Warwick, Lord Rayleigh, Sir John Evans, Mr. E. N. Buxton, Profs. Ray Lankester, Marshall Ward, E. B. Poulton, and J. B. Farmer, Dr. Horace Brown, Mr. F. W. Rudler, Dr. J. C. Thresh, the chairman of the Essex County Council, the chairman of the Epping Forest committee, and all the past-presidents of the club other than those who were present. After the reading and presentation of the address by the chairman, and the handing of the purse by the treasurer, Mr. Cole returned thanks on behalf of himself and family. In the course of his remarks he laid emphasis on the services which the chairman of the evening had specially rendered to the club as their first and eighth president, and who had ever taken the keenest interest in their work. He produced a copy of the original inaugural address delivered by Prof. Meldola in 1880, and pointed out that the general policy of the club had been sketched out therein, and that it, with subsequent addresses, had been to them as models laying down the lines on which the work of their own and of all kindred societies ought to be conducted. In concluding, Mr. Cole also directed attention to several branches of work which he hoped to see the club take up in the future, among these being the establishment of a marine biological station, and the preservation, in connection with the photographic survey, of Essex folklore and dialects by means of phonographic records.

AT a meeting of the Institution of Civil Engineers on December 5, the Hon. Charles A. Parsons, C.B., F.R.S., and Mr. G. G. Stoney, in a paper read before the institution, traced the evolution of the steam-turbine from the time of Hero of Alexandria, following the chief steps in development that have led to the types in present use. After describing and discussing the chief characteristics of the three types of steam-turbine, which practically cover the whole field of useful turbine inventions, viz. the Parsons turbine, introduced in 1884, the De Laval turbine in 1888, and the Curtis turbine in 1902, the development of the Parsons turbine was dealt with. A good vacuum is required for the economical working of steam-turbines, and certain special conditions and arrangements must be observed in order to obtain a vacuum of $27\frac{1}{2}$ inches to 28 inches. An apparatus called a vacuum-augmenter has been designed by the authors, and consists of a steam jet placed in a contracted pipe between the condenser and the air-pump. With this apparatus, a total net reduction of steam-consumption of about 8 per cent. at full load has been obtained. Experience gained from cross-Channel steamers and yachts shows that the propellers of turbine vessels do not race in a heavy seaway, that the vessels maintain their smooth-water speed to a remarkable extent in heavy seaway, and that they start, stop, and manœuvre promptly.

IN a recent issue of *Scientific Investigations (Irish Fisheries)*, 1904, Prof. G. H. Carpenter describes the

the molecule, whilst a consideration of the chemical properties leads to the conclusion that the two atoms of hydrogen are functionally different, and that in reality water has a disymmetric formula.

A VERY interesting paper by M. T. Godlewski on certain radio-active properties of uranium is contained in No. 5 of the *Bulletin International* of the Cracow Academy of Sciences. A re-investigation has been made of the anomalous phenomena encountered by Meyer and Schweidler in studying the activity of uranium X. These authors had concluded that the decay curve of uranium X is not complementary to the recovery curve of uranium, but M. Godlewski considers that this only holds when the uranium nitrate containing the UrX is separated from its solution by crystallisation; when it is separated by evaporation to dryness at a temperature sufficiently high to remove the water of crystallisation, an abnormally high rate of decay is not observed. In fractionally crystallising uranium nitrate, uranium X, which is easily soluble in water, accumulates in the mother liquors; several crystallisations will completely deprive uranium nitrate of UrX. The author explains the increase of activity observed in the crystallisation of uranium nitrate as being due to an accumulation of UrX in the upper surfaces of the crystals; this appears to be confirmed by the observation that the activity of a crystal when turned over was found to be only one-third of the activity measured from the upper side. Experiments are brought forward to show that the first rapid decay of activity after crystallisation, which causes an uneven distribution of UrX throughout the plate, is due to the diffusion of UrX from the upper layers of the crystal, where it is more concentrated, to the lower, where the concentration is smaller. The view is held that the uranium X is dissolved in the crystals and the total mass of uranium in the form of a solid solution.

A SECOND and revised edition of the section of the report issued by the Engineering Standards Committee dealing with standard locomotives for Indian Railways has been published by Messrs. Crosby Lockwood and Son at 10*s*. 6*d*. net.

WE have received from Messrs. John J. Griffin and Sons, Ltd., a copy of their "H" list dealing with apparatus for use in the teaching of hydrostatics and pneumatics. The excellence of the illustrations and the lucidity of the brief descriptions make the catalogue a very serviceable one.

A CIRCULAR from the bio-chemical department of the University of Liverpool announces that the first number of a new periodical—the *Bio-Chemical Journal*—will be issued in January. Contributions are invited, dealing with all portions of the subject of bio-chemistry in its widest sense. The journal will be issued monthly, in so far as material is available.

THE University of Chicago Press has published a second edition of Dr. C. J. Chamberlain's "Methods in Plant Histology." The first edition of the book was reviewed in our issue for November 28, 1901 (vol. lxv. p. 75). The new issue contains both alterations and additions; and some of the improvements suggested in the review referred to have been made.

IN noticing the illustrated catalogues of makers of scientific apparatus in this country from time to time, we have directed attention to the excellence of the illustrations accompanying the descriptions of the different instruments. A revised price-list of microscopes and accessories which has been received from the Bausch and Lomb Optical Co., Rochester, N.Y., is another instance of a carefully arranged and admirably illustrated catalogue. The catalogue provides information concerning microscopes made by this firm suitable for general laboratory work, advanced work, bacteriology, photomicrography, and a physician's needs. The necessary accessories are detailed fully, and clear descriptions make their special characteristics easily understood. The sole representatives of the company in this country and the colonies are Messrs. A. E. Staley and Co., 19 Thavies Inn, Holborn Circus, E.C.

OUR ASTRONOMICAL COLUMN.

ANOTHER NEW COMET, 1905*c*.—A telegram from the Kiel Centralstelle announces the discovery of a new comet, by Prof. Giacobini, of the Nice Observatory, on December 6·080.

At 16h. 53·7m. (Nice M.T.) the comet's position was

$$R.A. = 14h.\ 21m.\ 39{\cdot}4s.,\ dec. = +20^\circ\ 59'\ 29'',$$

and subsequent observations showed that its daily movement in R.A. amounted to $+1^\circ\ 08'$ (=+4m. 32s.) and in dec. to $-0^\circ\ 26'$.

From the above it is seen that, when discovered, the comet was about 10m. east and $1^\circ\ 15'$ north of Arcturus, and that it is apparently travelling slowly towards the constellation Serpens.

A second telegram from Kiel announces that the comet was observed at the Lick Observatory on December 8. The position at 17h. 16·5m. (Lick M.T.) was determined as R.A. = 14h. 32m. 58s., dec. = $+19^\circ\ 55'\ 36''$.

Circular No. 82 from Kiel states that the following elements and ephemeris have been computed by Mr. Morgan (Glasgow, Mo.) from observations made on December 6, 7, and 8, and communicated to the Centralstelle by Prof. E. C. Pickering:—

Elements.

T = 1906 January 16·20 (G.M.T.).

$$\left.\begin{array}{l} \omega = 213^\circ\ 56' \\ \Omega = 93\ \ 21 \\ i = 44\ \ 23 \end{array}\right\} 1905{\cdot}0$$

$$q = 0{\cdot}0928$$

Ephemeris 12h. G.M.T.

1905		α h. m. s.		δ ° ′		Brightness
Dec. 14	...	15 1 28	...	+17 1		
18	...	15 24 56	...	+14 22		
22	...	15 50 48	...	+11 13	...	4·22

The computed brightness for December 10 was 1·66, the brightness at time of discovery being taken as 1·0.

COMET 1905*b*.—A number of observations of comet 1905*b* (Schaer's) are recorded in No. 4057 of the *Astronomische Nachrichten*.

Using the Bruce telescope, and exposing for fifty-five minutes, Prof. Wolf photographed the comet on November 21, and obtained an image which showed the object to be unsymmetrical. A fine, faint tail was seen to issue from the coma in a position angle of 92°, reckoning from the direction of the comet's path. This tail was curved, with the concave side preceding, and at a distance of 22′ from the nucleus it was broken, the second part having a slightly different direction to the first.

On November 20 Prof. Wolf was able to see the comet with the naked eye, and estimated its magnitude to be about 5·5. On November 21 he found it to be about 6·3m., and on November 24 observed that it had decreased to 7·0.

The ephemeris calculated by Herr M. Ebell gives the position of this comet on December 15 as

$$\alpha = 23h.\ 32m.\ 16s.,\ \delta = -10^\circ\ 30'{\cdot}5,$$

and its brightness as about 0·04 of that at the time of discovery.

ORBITAL ELEMENTS OF TWO METEORS.—From a number of observations of a meteor which was seen on August 3 Dr. P. Moschick, of Heidelberg, has calculated the radiant point, the earth point, the velocity, and the height of the meteor, and also the elements of its orbit. For the apparent radiant he obtained $\alpha = 317° 56'$, $\delta = -11° 54'$, and for the mean velocity 47.93 ± 8.37 km. per second, the probable value for the absolute velocity being 52·74 km. per sec. The elements show the orbit to be hyperbolic, and the meteor's motion in the orbit to be direct.

A second meteor was seen by numerous German observers on September 28, and Dr. Moschick has treated the observational results similarly. For the position of the radiant point he obtained $\alpha = 354° 54'$, $\delta = +22° 40'$, and therefore concluded that the object observed was a Pegasid. The relative and absolute velocities were respectively 21·51 and 36·4 km. per second, and the calculated elements show that the meteor moved, with a direct motion, in an elliptical orbit (*Astronomische Nachrichten*, No. 4057).

MAGNETIC DISTURBANCE DURING THE RECENT AURORAL DISPLAY.—In a paper communicated to the Paris Academy of Sciences, M. Th. Moureaux states that a strong magnetic disturbance took place about 9 o'clock on November 15, coinciding, in point of time, with the exceptionally fine auroral display which was so generally observed. From 8h. 59m. to 9h. 9m. (Paris M.T.) the declination, which was already below the normal, diminished by 34', and then quickly recovered, increasing 42' between 9h. 9m. and 9h. 24m. The horizontal and vertical components were simultaneously affected in the opposite direction. Similar disturbances took place on November 12. Numerous small groups of sun-spots were on the solar disc during this period, and the first large group seen in October, now much scattered and diminished, was due to cross the central meridian on the evening of November 13, during its second rotation (*Comptes rendus*, No. 21).

THE ZODIACAL LIGHT TO THE NORTH OF THE SUN.—Whilst in Switzerland recently, Prof. Newcomb ascended the Brienzer Rothorn in order to observe, if possible, the extension of the zodiacal light in the north and south direction. He found that the light was bright enough to be seen at a distance of 35° from the sun in the direction of the solar axis, and he assumes that it extends equally on both sides. Prof. Newcomb therefore suggests that the zodiacal light shall in future be described "as a luminosity surrounding the Sun on all sides, of which the boundary is nowhere less than 35° from the Sun, and which is greatly elongated in the direction of the ecliptic" (*Astrophysical Journal*, No. 3, vol. xxii.).

CANADIAN ELECTRIC POWER STATIONS AT NIAGARA.

ON January 2 of this year, in the power house of the Canadian Niagara Power Company, on the Canadian side at Niagara, the largest units used in the development of water-power were started. This great power house is situated in Victoria Park, and all the work of development is done under consent from the Government of the Province of Ontario and the commissioners of the park.

Fourteen years ago ground was broken on the New York side at Niagara for a power development by means of a wheel-pit and tunnel. The 105,000 horse-power thus developed has been a great inspiration to the growth of the American city, and Canadians looked forward to the time when they should profit by a similar development. Now their hopes are being realised, for three strong companies are actively at work on the Canadian side developing power from the water that speeds toward the Horseshoe or Canadian Fall. It was in 1892 that the Canadian Niagara Power Company secured its first rights to develop power in Canada, and since then it has paid the park commissioners more than 225,000 dollars in the retention of its privileges, while its first horse-power was developed on the date above mentioned.

The Canadian Niagara Power Company is allied to the Niagara Falls Power Company of the New York side of the river, but in its Canadian development it has given men of science and electrical engineers the most wonderful installation to study yet known in the field of any water power development. In the big power houses on the New York side the unit of development is 5000 horse-power, but on the Canadian side the unit is 10,000 horse-power. It was in 1890, at a meeting of the International Niagara Commission, held in London, that a unit of 5000 horse-power was adopted for the development on the American side at Niagara.

Ten years have elapsed since Rudolph Baumann, a Swiss engineer, turned the wheel that started the first 5000 unit on April 4, 1895, and since that day the installation has been doubled in size and output capacity, and is in every way a success. Now comes Canadian Niagara with its units of 10,000 horse-power, the largest in the world. Mr. William H. Beatty, of Toronto, Ontario, who is president of the Canadian Niagara Power Company, turned the small wheel that controls the flow of water from the penstocks to the turbines, and as he admitted the flood of water the monster generator began to revolve, and within a few minutes was making 250 revolutions a minute, the speed at which it is to be steadily operated. Unit No. 2 was also started, making 20,000 horse-power available in the station, and by May 1 three additional units of the same size were ready to run, giving off a total of 50,000 horse-power from the five machines. In all, eleven units will be installed in this station, so that its final output will be 110,000 horse-power, or 5000 horse-power more than is available from the twenty-one machines in the two power houses of the Niagara Falls Power Company on the American side of the river.

FIG. 1.—Site of the Power House of the Ontario Power Co., showing its nearness to the Horseshoe Fall.

In the wheel-pit and tunnel method of developing power at Niagara, a great slot, several hundred feet long, is excavated in the earth to a depth of about 180 feet and 21 feet wide. From the bottom of the wheel-pit a tail race or tunnel is driven through solid rock a distance of 2200 feet to the lower river or gorge. This tunnel is built in the form of a horseshoe, and is about 20 feet wide by 25 feet high. It is lined from end to end with vitrified brick and concrete, while the wheel-pit is also carefully lined. From the upper river a canal of short length diverts water from the main stream to a forebay at one side of the big power house. Near the bottom of the wheel-pit the turbines are installed, and these are connected to the generators in the power station over the wheel-pit by vertical shafts or tubes. From the forebay to the turbines penstocks 10 feet in diameter run to the turbines, and as the gates are raised the water pours from these penstocks into the wheels that give motion and life to the big generators. As the water passes through, or is discharged from, the turbines, it falls into the tunnel, and then flows through this tail race to the lower river and gorge. It is diverted from the main stream but a very few minutes, but in that time it serves to aid man in gaining control of thousands of electrical horse-power.

It is agreed between the power companies and the commissioners of Victoria Park that all power generated in the park limits must be transmitted outside the park boundaries for application and use, and so the electric current from the station referred to will pass to a transformer station not far distant, where, for transmission purposes, it will have its voltage raised to 40,000 or 60,000 volts, in order that it may successfully and economically be sent to Toronto and other distant places to meet the demand for electric power from Niagara. Toronto has long been anxious to be connected by a transmission line with the power development at the falls, and now a line for transmission purposes has been about completed, so that electric current from the generators in the station of the Canadian Niagara Power Company may be used in the

FIG. 2.—Power House of Canadian Niagara Power Co., being erected over the wheel-pit.

operation of the trolley cars and lighting systems of the Canadian city nearly 90 miles away from Niagara.

The Electrical Development Company of Ontario, Ltd., is also constructing a wheel-pit and tunnel power development in Victoria Park. The works of this company will be a short distance above the site of the development of the Canadian Niagara Power Company, but, for all this, the tunnel it is building will be slightly shorter than the tunnel of the company last named, because it will run right under the river-bed, over which the upper rapids toss, to a point behind the falling sheet of water of the Horseshoe Fall, where it will empty into the lower river. From the bottom of this wheel-pit there will be two short lateral tunnels that will carry the water from the pit to the main tunnel at a point 165 feet from the bottom of the slot. This company projects a development of about 125,000 horse-power, and the machinery it will instal will command general attention.

The Ontario Power Company is another concern that has secured a franchise for the development of power in Victoria Park. Its method of development will be quite different from that of the other two companies referred to. Its power house, a concrete and iron structure, has been built at the water's edge, in the gorge, a short distance below the Horseshoe Fall, and water will be carried to it by penstocks concealed from view in tunnels that have been driven through the rocky bank from a spillway or open relief on top of the bank. From this spillway great steel flumes will extend to the forebays, which are situated far up the river. There will be three of these steel flumes, each 18 feet in diameter and more than 6000 feet long. Each will divert 3900 cubic feet of water every second, which is an amount estimated to be sufficient to develop 60,000 electrical horse-power in the station at the water's edge. Thus from the three steel flumes and the water supply thus afforded, no less than 180,000 horse-power is to be developed. This power will pass from the generators to a transformer station located on the bluff in the rear of Victoria Park more than 250 feet above the power house, and more than 550 feet back from it.

ORRIN. E. DUNLAP.

INVESTIGATION OF THE UPPER AIR.

THE subjoined announcement has been received from the director of the Meteorological Office.

In response to representations from various quarters, the Meteorological Committee has assigned from the Parliamentary grant under its control a sum for promoting the investigation of the upper air by kites and other means.

The immediate objects in view are:—(1) To establish an experimental station where kite ascents and other experimental investigations can be carried out, especially on the days selected for international cooperation. (2) To develop and extend the instrumental equipment, so that facilities may be afforded for the cooperation of other observers upon sea or land. (3) To provide for the publication of the observations in combination with those of other countries, by a contribution to the cost of the international publication undertaken by the president of the International Commission for Scientific Aërostation, Prof. H. Hergesell, of Strassburg.

Mr. W. H. Dines, F.R.S., has undertaken the direction of the operations for the Meteorological Office. His experiments for the office are carried on at his house at Oxshott.

An endeavour will be made, with fair prospect of success, to enlist the cooperation of marine observers in correspondence with the office. Captain A. Simpson, of the S.S. *Moravian*, has already expressed his willingness to make a trial of this method of extending our knowledge of marine meteorology as soon as the necessary gear and instruments can be supplied.

It is hoped that through the assistance of others who are interested in such investigations, and have at their disposal the means of carrying them out, an effective scheme for the investigation of the upper air may be set on foot. Lieut.-Colonel J. E. Capper, C.B., R.E., of the Aldershot Balloon Companies, has already facilities for such purposes, and will take part; Mr. G. C. Simpson, lecturer in meteorology in the University of Manchester, is making arrangements for occasional observations on the Derbyshire hills; Mr. C. J. P. Cave, who has already made some interesting kite ascents in Barbados, has provided himself with the necessary equipment for experiments at Ditcham Park; and Mr. S. H. R. Salmon has arranged a station on the Downs near Brighton, and carries out ascents on the international days.

There is, accordingly, a prospect of an effective investigation being commenced.

BOTANY AT THE BRITISH ASSOCIATION.

THE president, Mr. Harold Wager, F.R.S., dealt in his address, which was delivered at Johannesburg, with some problems of cell structure and physiology. The text of this address has already appeared (September 21) in NATURE.

As was to be expected, there were fewer papers than usual this year in Section K, and of these relatively few were of a purely technical nature, the majority being either general accounts of recent work or else papers which possessed some special local interest.

General Papers.—Prof. R. W. Phillips opened the pro-

f. 15.

ceedings at Cape Town by delivering a semi-popular lecture on recent advances in our knowledge of seaweeds. Dealing first with the attached shore vegetation, the lecturer pointed out that, with the exception of a very few phanerogams, this consists entirely of blue-green, green, red, and brown algæ. In the red algæ the most important recent work is that of Oltmanns, who has shown, in opposition to the view maintained by Schmitz, that no real nuclear fusion takes place in the auxiliary cells. In the brown algæ Williams's work on the Dictyotaceæ has considerably modified the views previously held regarding them. Not only has he discovered motile antherozoids in this group, but his work on their cytology points to the existence of a definite alternation of generations. Farmer and Williams had shown that in the Fucaceæ the reduction of chromosomes takes place at the origin of the oogonium. In Dictyota, however, as originally shown by Mottier, and since confirmed by Williams, the reduction division occurs in the mother-cells of the tetraspores. There would thus appear to be in this plant two generations, precisely similar in their external morphology, but fundamentally distinct in respect of the number of chromosomes in the dividing nucleus. Our knowledge of the floating oceanic vegetation has been greatly extended by the members of the German plankton expedition, and other workers. The lecturer dealt with the distribution of this floating vegetation in the surface waters of the globe, and described some of the adaptations which prevent rapid sinking of the minute forms composing it.

Mr. R. P. Gregory discussed some of the problems of heredity. He first gave a general account of Mendel's principles of heredity, referring to some of the more recent work on Mendelian lines. He then dealt particularly with some new experiments conducted by Mr. Bateson and himself, on the inheritance of heterostyly in Primula. Although certain irregularities were observed, on the whole the characters of long and short style were inherited in the usual Mendelian ratio, the short style being dominant, the long recessive. Further experiments, conducted in the hope of throwing light on the fact, observed by Darwin, of the relative infertility in "illegitimate" as compared with "legitimate" crosses in Primula, were inconclusive.

Prof. F. E. Weiss contributed a paper on the value of botanical photographs. He pointed out that the mapping of the plant-associations of any given district, and the detailed study of the ecological factors concerned, can be most usefully supplemented by good photographs showing the general aspect and distribution of the vegetation. It is important to have, not only general photographs of various plant-associations, but also photographs of the different members of such associations. Plant photography can also be usefully employed in morphological, pathological, and other studies. The truth of the author's remarks was forcibly illustrated by a series of beautiful lantern slides. Two committees are now at work collecting botanical photographs and rendering them available for teaching and other purposes. One, recently established for the survey of British vegetation, is concerning itself with British ecological photographs; the other, the British Association committee for the registration of photographs of botanical interest, has adopted a wider scheme, and is anxious to receive help from scientific photographers in all parts of the world.

An interesting discussion took place on educational methods in the teaching of botany. The president (Mr. Harold Wager, F.R.S.), who opened the discussion, was of opinion that the methods usually employed, both in universities and schools, neither develop real interest in the subject nor afford an adequate training in scientific method. He emphasised the importance of basing all courses of botanical teaching on practical work, both observational and experimental, such work to be carried out by the students themselves. Lectures should be rather of the nature of discussions upon the facts learned during practical work than merely informational. A good deal of faulty educational method is due to the domination of examinations. It is almost impossible for satisfactory work to be done if teachers are compelled to follow set syllabuses, which are generally so extensive as to leave little room for originality on the part of the teacher.

Several speakers agreed with the general conclusions of the president, but Mr. A. C. Seward, F.R.S., and Prof. Douglas Campbell were inclined to lay more stress on the importance of lectures, particularly where advanced students are concerned.

Miss Lilian Clarke contributed to the discussion a most interesting account of her methods of teaching botany in the James Allen School for Girls at Dulwich. She gives no set lectures, but the girls make observations and conduct experiments, not only in the school garden, where each girl has charge of a plot, but also in the laboratory. The latter has been designed so as to admit as much light as possible; it can also be kept at a constant temperature, so that practical work on living plants can be carried on at all seasons of the year.

South African Botany.—Mr. A. C. Seward, F.R.S., in discussing the fossil floras of South Africa, gave a general account of the plants characteristic of the Lower Karroo, Stormberg, and Uitenhage series. He laid stress on the need for further field work, as more material, particularly petrified specimens for microscopical examination, is badly needed to render our knowledge of these floras more complete.

Prof. A. Engler and Dr. R. Marloth presented important papers on the floras of tropical Africa and South Africa respectively.

Prof. Engler dealt with his subject largely from the ecological point of view. Discussing first the meteorological conditions of tropical Africa, he pointed out that in every tropical country, where the altitude of the land surface varies from sea-level to high mountains, practically the same plant-formations can be distinguished, though, of course, their systematic composition may be very different in different cases. The author then enumerated the various halophilous, hygrophilous, xerophilous and other formations, with their subdivisions, finally discussing the affinities of the flora as a whole. The dominant element of the flora is one peculiar to tropical Africa, the plants composing which are more nearly related to those of India and Madagascar than they are to those of tropical America. But besides this native element, we find in tropical Africa other elements. Thus in the hygrophilous formations of East Africa, Indian and Madagascan elements abound, while in those of West Africa a distinct tropical American element is found. A South African element is present, particularly in the shrub-formations of Angola and East Africa; a Mediterranean element in the north-east, especially in Somaliland; and lastly, in the high mountains, many species belonging to a boreal element are found. From the entire absence on these mountains of many groups characteristic of northern regions, Prof. Engler concludes that such northern forms as are here found have entered by immigration, and are not the remnants of a once widely spread Old World flora.

The botanical regions proposed by Dr. Marloth in his paper on the phyto-geographical subdivisions of South Africa are somewhat similar to those suggested by Bolus, Engler, and others, though differing in detail. The two main divisions, very unequal in size, are A, the Cape province, characterised by many endemic plants of more or less south temperate affinities, and B, the palæo-tropical province. The latter is again subdivided, according to ecological conditions and floral constituents, into (1) the grass-steppe regions, including the Bush-veld, High-veld, Kalahari, and the Caffrarian countries; (2) the central districts of Cape Colony, including the Karroo, the Karroid plateau and Little Namaqualand; (3) the western littoral; (4) the forests of the south coast; (5) the south-eastern coast belt.

Mr. J. Burtt-Davy contributed a paper on the climate and life zones of the Transvaal. He divides the Transvaal, according to altitude and climate, into three zones, which he terms the High, Middle, and Low Veld respectively. Each is characterised, not only by its native vegetation, but also by the crops it is capable of producing.

Mr. F. B. Parkinson gave an interesting account of irrigation farming as carried on at the Orange River farm at Baviaankrantz. To raise the water, chain and bucket pumps are employed, working in shafts sunk at a sufficient distance from the river to be above flood-level. The shafts are supplied with water from the river by means of 10-inch syphons. By judicious watering, winter cereal crops, and summer crops of potatoes, peas, &c., can be profitably grown.

Mr. T. R. Sim discussed the distribution of South African ferns, and pointed out that the recent opening up of the Orange River Colony, the Transvaal, and Rhodesia has resulted in the filling up of many gaps in our knowledge of this subject.

Dr. Schönland gave a survey of our knowledge of South African succulent plants, chiefly from the historical and systematic points of view.

A paper was also contributed by Mr. J. Medley Wood on the indigenous plants of Natal.

Technical Papers.—Among these may be mentioned an interesting note by Dr. Horace T. Brown, F.R.S., on the dissipation of absorbed solar radiation by xerophilous plants. He pointed out that in ordinary foliage leaves the amount of heat necessary to vaporise the water of transpiration is so considerable that such a leaf may be subjected to intense solar radiation without acquiring a temperature of more than a very few degrees above that of the surrounding air. In xerophilous plants, however, transpiration is at a minimum, and therefore some other method of guarding against the risk of dangerously high temperatures is necessary. According to the author, this is to be found in the loss of heat due to thermal emission. Experiments have been conducted by him (in collaboration with Dr. W. E. Wilson) which show that a powerful cooling effect is produced by the high thermal emissivity of a leaf surface, even when transpiration is completely in abeyance.

Prof. H. H. W. Pearson communicated an interesting account of his investigations into the development and germination of the spores of Welwitschia. The results obtained show that some of the current views of the relationship of this extraordinary plant to the other genera of the Gnetaceæ must be considerably modified.

Prof. Douglas Campbell described the prothallium and reproductive organs of *Gleichenia pectinata*, and directed attention to the similarity that exists between them and those of Osmunda.

Prof. M. C. Potter presented two papers. In the first an account was given of some experiments which showed that amorphous carbon can be slowly decomposed by the agency of a soil bacterium, with the evolution of carbon dioxide.

The second dealt with the healing of parenchymatous tissues in plants. According to the author, the first step in this process (prior to the formation of cork) is the closing of the intercellular spaces by the formation of a "wound-gum" similar to that described by Temme in wounded xylem vessels. Thus the increased rate of gaseous interchange caused by the wound is very soon checked.

Mr. I. B. P. Evans, in a paper on infection phenomena in the Uredineæ, said that it is quite possible to identify different species of Puccinia by the shape of their infection vesicles.

Dr. G. Potts contributed a paper on the action of calcium compounds on *Plasmodiophora Brassicae* ("finger and toe"). Experiments show that an acid soil encourages the growth of the parasite, while alkaline substances inhibit it.

A most interesting feature of the Cape Town meeting was afforded by a fine collection of native plants, brought together with considerable trouble by Dr. Marloth. These included a number of the more striking succulents from the Karroo region, and also a great many plants from the south-west district of Cape Colony. The latter were, for the most part, in flower, the heaths and the Iridaceæ in particular presenting a beautiful blaze of colour. Dr. Marloth also exhibited a number of ecological photographs taken in various parts of Cape Colony.

But, apart from the meetings themselves, the over-sea botanists found considerable opportunities of observing the vegetation of the various districts passed through during the tour. It is true that much of the travelling was hurried, but even when passing rapidly through a new country a botanist is able to gather valuable impressions of the general facies, &c., of the vegetation.

At the Cape, though the season was still early spring, a considerable number of plants were in flower. Table Mountain and the slopes of the Lion's Head were explored so far as time permitted, and many plants characteristic of the Cape Peninsula flora were observed. Some of the most striking of these were plants belonging to the families Ericaceæ, Proteaceæ, and Restiaceæ.

Several members of Section K visited the Karroo, and spent some days in examining the many curious xerophilous desert plants to be found there.

In the Transvaal and elsewhere little or no rain had fallen for some five months before the visit of the association, and in consequence the country presented a very parched and brown appearance, except where irrigation had resulted in vivid patches of green crops, or groves of Eucalyptus trees had been planted. The latter, as well as other Australian plants, have been extensively imported, and promise to become of considerable economic importance in South Africa.

A very striking feature of the bush vegetation in various parts of the Transvaal was the extraordinary prevalence of parasitic Loranthaceæ, many of the acacia and other trees being loaded with the parasites.

At Pretoria the Government experimental grounds were visited, the visitors being received by Mr. Smith, the Director of Agriculture, and Mr. Burtt-Davy. Extensive experiments are being at present carried on here with a view to the introduction of new grasses to improve the pasturage of the Transvaal. Other useful introduced plants include several species of Atriplex (the Australian "salt-bush"). As these plants are markedly xerophilous, and at the same time good fodder plants, they will probably prove very useful in a climate such as that of the Transvaal.

The agricultural department in Pretoria had also arranged an exhibition illustrative of the vegetable products of the Transvaal.

Mr. Burtt-Davy arranged a special botanical excursion to the Magaliesberg, where the "Wonderboom," an exceedingly fine specimen of *Ficus cordata*, was visited.

Other areas of botanical interest passed through included the High Veld, the Bush Veld, the teak forest of Rhodesia, and the luxuriant so-called rain-forest immediately surrounding the Victoria Falls.

PRIZE SUBJECTS OF THE INDUSTRIAL SOCIETY OF MULHOUSE.

THE Industrial Society of Mulhouse has issued its programme of the prizes to be awarded by the society during the year 1906; excluding the subjects which are of a purely local or technical character, the following are the principal prizes open to competition to all nations.

In the section of chemistry medals of honour are offered for a memoir on the theory and manufacture of alizarin-red by the rapid process, for a synthesis of the colouring matter of cochineal, for a research on cochineal carmine, for an investigation of the colouring matter of cotton, of the transformation of cotton into oxycellulose, or of the composition of aniline blacks; also for a research on the chemical changes of wool under the action of hypochlorites or chlorine, for a synthesis of a natural dye, for a theory of the manner of formation in nature of any organic substance, or for a chemical study of the fat of Turkey-red. Several medals will also be awarded for special chemical studies of mordants and their action, for the production by artificial means of certain dyes, and for practical methods of fixing certain dyes to the fibre. A method of manufacturing carbon tetrachloride at a price such as will enable it to compete with carbon bisulphide and benzene is also required. A sum of 500 francs to 1000 francs will be allotted to the best compilation of the densities of inorganic and organic substances in the solid state and in cold saturated solution. Medals will be given for the production of substances capable of taking the place of certain named chemicals which have an industrial use, and for the solution of a number of specified problems in the bleaching, dyeing, and printing of textiles.

In the section of mechanical arts a prize of 500 francs with a silver medal is offered for a new method of construction of buildings suitable for cotton spinning, wool combing, or calico printing. The following subjects will receive medals:—a new type of steam boiler; an indicator of the total work done in a steam engine; new forms of gas generators for gas engines; new types of gas engines; a new method of heating boilers; new methods of spinning, weaving, and dyeing textile fabrics; a simple cut-out for electrical installations.

The following subjects in natural history and agriculture will be awarded medals:—a geological or mineralogical description of part of Alsace; a detailed catalogue of plants in the neighbourhood of Mulhouse, Thann, Altkirch, and Guebwiller; a treatise on the fauna of Alsace; a treatise on the plants and insects inimical to agriculture in Alsace and the methods of destroying them.

In commerce and statistics the prize subjects are:—a study of methods of insurance against risks of transport; a treatise on insurance against fire, with especial reference to the factories of Alsace; a memoir on the variation in the price of coal in Alsace during the last thirty years; a study of the effect of taxation on industrial development.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Vice-Chancellor has announced to the Senate the munificent gift of 1750*l*., made by Dr. Ludwig Mond towards the fund for increasing the stipends of the Stokes and Cayley university lecturers in mathematics.

The detailed proposals put for the diploma in forestry were to be discussed on Thursday last. Apparently they satisfied the members of the university, for there was no criticism made on them.

The degree of Master of Arts, *honoris causa*, is to be conferred upon Mr. R. I. Lynch, curator of the botanic garden. Mr. Lynch is well known as a writer on horticultural subjects.

On the nomination of the board of geographical studies, Dr. Guillemard and Sir G. D. T. Goldie, K.C.M.G., F.R.S., and on the nomination of the council of the Royal Geographical Society, Sir Clements R. Markham, K.C.B., F.R.S., and Dr. J. Scott Keltie, have been appointed members of the board of geographical studies for the year beginning January 1, 1906.

Mr. J. B. Peace has been appointed chairman of the examiners for the mechanical sciences tripos, 1906.

The general board of studies has approved Mr. H. J. H. Fenton, of Christ's College, for the degree of Doctor in Science.

The following notice of the next award of the Walsingham medal has been issued:—The medal is to be awarded for a monograph or essay giving evidence of original research on any botanical, geological, or zoological subject. The competition is open to graduates of the university who at the time fixed for sending in the essays are under the standing of Master of Arts. The essays for the ensuing year are to be sent to the chairman of the special board for biology and geology (Prof. Langley, The Museums) not later than October 10, 1906.

The special board for biology and geology give notice that the Gedge prize will be offered for competition in the Michaelmas term, 1906. The prize will be awarded for the best original observations in physiology, but a candidate who has received a certificate of research from the university will not be entitled to submit an essay which is substantially the same as the dissertation for which such certificate of research was granted. Candidates need not necessarily be graduates of the university. Essays are to be sent to the professor of physiology not later than October 1, 1906.

DR. A. J. EWART, special lecturer in vegetable physiology, Birmingham University, has been appointed professor of botany in the University of Melbourne in succession to the late Baron von Müller.

THE will of the late Mr. John Edward Taylor, part proprietor and a former editor of the *Manchester Guardian*, on which probate was granted in London on December 9, among numerous bequests, leaves, on the decease of the widow, 20,000*l*. to the Victoria University of Manchester.

AT a meeting of the council of the University of Birmingham held on December 6, the Chancellor announced that the family of the late Mr. Harding had offered 10,000*l*. to the Birmingham University for the erection of a library. The offer has been gratefully accepted by the council.

ON Tuesday, December 5, Sir W. Martin Conway distributed the prizes and certificates gained by the students at the Sir John Cass Technical Institute during the past session. Sir Owen Roberts, chairman of the governing body, presided. Mr. George Baker stated that the scope of the work of the institute and the number of students continued to progress steadily, and that a large proportion were studying subjects bearing directly upon the industries in which they were engaged. Sir Martin Conway, in the course of his address, pointed out that people in this country suffer from a confusion of ideas in respect to education, and that they do not believe sufficiently in the necessity of giving the highest possible education to the directing brains of industries, nor do they understand sufficiently the length of time and the experience that are required for skilful hands to receive their full equipment. He remarked that the real struggle with Germany in manufactures is due to the enormous number of highly educated men turned out at the German universities; it is not a question of technical education, but of scientific education. The German is not a whit more scientific or better than the Briton, but faith in science which exists in Germany is lacking in England, and this gives the Teutonic tortoise the advantage over the British hare.

THE following bequests and gifts for higher education in the United States are announced in *Science*. By the will of the late Mr. Stephen Salisbury, the Worcester Polytechnic Institute receives a bequest of 40,000*l*. This money comes without restrictions of any kind on the part of the testator. In addition to this bequest, Mr. Salisbury, at the time of his resignation a few weeks ago from the presidency of the board of trustees, made an additional gift to the institute of 20,000*l*., to be paid immediately. Formal announcement of the 50,000*l*. legacy to the Sheffield Scientific School from the estate of the late Mr. M. D. Viets has been made by Prof. Russell H. Chittenden, director of the school. The bequest will be used for the physical, mathematical, and general scientific needs of the school. The late Mr. Frank Harvey Cilley, the engineer, has bequeathed the residue of his estate, which will probably amount to 14,000*l*., to the Massachusetts Institute of Technology. Mr. T. P. Shonts, chairman of the Isthmian Canal Commission, has given to Monmouth College 2000*l*. as part of the 6000*l*. needed to obtain an additional 6000*l*. which Mr. Andrew Carnegie had promised to give the college for a library. The late Mr. Stephen Salisbury, of Worcester, Mass., has bequeathed 40,000*l*. to the Worcester Polytechnic Institute, 50,000*l*. to the American Antiquarian Society, and 1000*l*. and a site for a building for the Worcester Natural History Society.

PROF. W. J. ASHLEY, dean of the faculty of commerce in the University of Birmingham, distributed on December 6 the prizes gained by candidates at the examinations of the London Chamber of Commerce. During the course of a subsequent address, Prof. Ashley remarked that the science of commerce has yet to be made, but, in his opinion, a true science of commerce is capable of being created. At present, however, it does not exist. Its formulation should have been the task of the political economists; but hitherto English economists have been too content to pursue the results, the conclusions to be reached by a process of reasoning starting with certain assumptions. It is necessary that the problems which actually present themselves to a business man in the course of his operations should be realised and studied, and that the various ways in which they have been approached and faced ought to be brought together, grouped, criticised, and analysed. The function of the economist is not to arrive at general abstract conclusions and then look round in the world of business for examples or illustrations of the conclusions arrived at. He should condescend to a more concrete and a more patient survey of the actual facts of real life. Prof. Ashley considers it to be vitally important that the highest type of education shall be brought into close touch with the realities of economic life. If that is properly done it will not degrade education, but vivify it.

THE current number of the *Monthly Review* contains an article on public school education by Mr. A. C. Benson, in which some valuable testimony as to the inadequacy as a training for life of a purely classical education is given. The question as to what are the intellectual accomplishments of a boy of average intelligence who has been through a public school and a university is answered in the following words:—"He knows a very little Latin and Greek, and he endeavours to put them out of his mind as fast as he can; he knows a little science; perhaps a little history, mostly ancient. He cannot generally calculate correctly in arithmetic; he knows no modern languages to speak of; he cannot express himself in simple English, and his handwriting is often useless for commercial purposes." And later, we read, "he has learnt to think the processes of the mind dreary and unprofitable, to despise knowledge, to think intellectual things priggish and tiresome." Mr. Benson summarises his contentions in the following words:—"believing intensely, as I do, in the possibilities of intellectual education, I have tried to judge the classical system as fairly as I can by results, and I see that those results are in many cases so unsatisfactory and so negative that experiments are urgently needed. Simplification seems to me to be the one essential thing." If a writer who was formerly a master at our greatest public school finds it necessary to write in this plain manner, it is evidently high time that scientific methods were applied to obtain an answer to the question, what constitutes a suitable public school education, and how can it be secured?

A LARGE audience assembled at the Borough Polytechnic Institute on Monday evening, December 4, on the occasion of the thirteenth annual meeting and distribution of prizes and certificates. The chairman, Mr. Leonard Spicer, said the work of the institute was going forward with great strides, and he feared that, even allowing for the additions to the building which had recently been made, the governors would again be faced with the problem of knowing how to house the students. Although the word "polytechnic" is still associated in many minds with recreation and amusements, the chief work of institutes of this kind lies in an educational and technical direction, 15,000*l*. a year being the least sum upon which the work at the Borough can be carried on at present. Mr. C. T. Millis, the principal, read the annual report, which disclosed a very satisfactory state of progress of the institute. An experiment is being made in the direction of coordination with London County Council evening schools, and several new classes have been started. A satisfactory feature of the work of the institute is the readiness with which intending students ask for and follow advice given as to their courses of study, and the increasing number of students who attend for two, three, and four years. After the certificates, which numbered considerably more than five hundred, and the numerous prizes were distributed by Lady Lockyer, Sir Norman Lockyer, K.C.B., delivered an address. In a few remarks, Prof. Perry claimed for the polytechnic institutions of London that they were doing a work that was unprecedented, and which our colonies are now endeavouring to imitate. He had recently returned from South Africa, where he found the people following the lead which London was now giving in the matter of technical education. Votes of thanks were proposed and seconded by Sir Philip Magnus and Mr. W. F. Sheppard.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 16.—"The Electrical Conductivity of Dilute Solutions of Sulphuric Acid." By W. C. D. **Whetham**, F.R.S.

The equivalent conductivity of neutral salts when dissolved in water approaches a limiting value as the dilution is increased; with solutions of acids and alkalies, however, the equivalent conductivity reaches a maximum, and then falls rapidly as the dilution is pushed farther.

It has been supposed that this diminution of equivalent conductivity at extreme dilutions is due to interaction between the solute and the impurities which remain even in re-distilled water.

Kohlrausch has given evidence to show that the chief impurity in water carefully re-distilled is carbonic acid, and Goodwin and Haskell conclude that the diminution of equivalent conductivity of dilute acids is due to the presence of carbon dioxide.

In order to examine the real effect of carbonic acid and other impurities on the conductivity of an acid solution, the writer and his wife have carried out an investigation in which the amount of impurity was varied, and the result observed. The conductivity of dilute solutions of sulphuric acid and its variation with concentration was determined in four solvents:—(1) good quality re-distilled water; (2) the same water to which a trace of carbon dioxide had been added; (3) the same water with a trace of potassium chloride; (4) the same water which had been freed as far as possible from carbonic acid and other volatile impurities by repeated boiling under diminished pressure.

In each case the conductivity of the solvent was subtracted from that of the solution. The results may be summarised as follows:—

Within the limits of experimental error, the equivalent conductivity of a dilute acid is not affected by boiling the water under diminished pressure, though the conductivity of the solvent is thereby much diminished. The equivalent conductivity of the acid is also unaffected by the addition of a small quantity of potassium chloride to the water, though the conductivity of the solvent is thereby much increased. But, by the addition of a little carbonic acid, the equivalent conductivity of the sulphuric acid is diminished appreciably. It is natural to conclude that, while the presence of carbonic acid would produce a diminution of equivalent conductivity of the same character as that observed, it does not explain the total effect.

"The Accurate Measurement of Ionic Velocities." By Dr. R. B. **Denison** and Dr. B. D. **Steele**. Communicated by Sir William Ramsay, K.C.B., F.R.S.

The authors have succeeded in devising an apparatus with which it is possible to compare and measure the velocities of the ions of a given salt without using gelatin or other membrane during the actual experiment. This enables the method of direct measurement of ionic velocities to be extended to dilute solutions, and the results obtained are free from any error due to electric endosmose.

The transport number and the average absolute velocity of the ions of a number of salts have been measured at dilutions down to one-fiftieth normal, and at two temperatures, 18° C. and 25° C. It is easy to measure by this method the transport number of the ions of some salts which present great difficulty by the analytical method of Hittorf, *e.g.* $KClO_3$, $KClO_4$, $KBrO_3$. The following are some of the numbers obtained for the anion transport number:—KCl $n/10$, 0·508; NaCl $n/10$, 0·618; KCl $n/50$, 0·507; $CaCl_2$ $n/50$, 0·587. The corresponding numbers determined by the analytical method are 0·508, 0·617, 0·507, 0·59.

The values obtained by the authors for the average velocity of the ions in cm./sec. agree in a remarkable manner with those calculated by Kohlrausch from conductivity data, and form a striking confirmation of the ionic theory of solutions. The values of the ionic velocity of the potassium ion in KCl, KBr, and KI are, for example, found to be:—at $n/10$, 0·000563, 0·000562, 0·000564 cm./sec.; at $n/50$, 0·000606, 0·000598, 0·000599 cm./sec. at 18° C.

It is claimed that the method is at least as accurate as that of Hittorf, and an experiment can be performed in about one-tenth of the time. It also gives a means of comparing the degree of dissociation of salts containing a common ion.

Mineralogical Society, November 14.—Prof. H. A. Miers, F.R.S., president, in the chair.—The determination of the angle between the optic axes of a crystal in parallel polarised light: Dr. J. W. **Evans**. The crystal plate is rotated on the optic normal as axis, and the positions are determined in which the relative retardation is nil. This may be observed by using a gypsum plate or the double quartz wedge devised by the author. In the latter case the positions in question are marked by the coincidence of the bands in the two halves of the wedge. This gives a very exact reading if strictly parallel light be employed.—Mineralogical notes (diopside and albite): Prof. W. J. **Lewis**. A large tabular crystal of white diopside, a brown diopside of unusual habit, and a Carlsbad twin of albite were described.—Note on the crystallisation of drops, especially of potash-alum: J. **Chevalier.** The president described observations made by Mr. Chevalier on the crystallisation of drops of solution of potash-alum. These generally yield in succession (*a*) birefringent spherulites; (*b*) octahedra; and (*c*) a fine rectangular network. (*a*) is probably a less hydrated alum, and it becomes isotropic on exposure to moist air by conversion into (*b*). (*c*) is ordinary alum which is in a state of strain, owing to its rapid crystallisation, and becomes white and opaque after a time owing to the development of cracks. Drops observed upon a slide under the microscope behave differently according as they are in the metastable or labile condition. A metastable drop inoculated with (*a*), (*b*), or (*c*) deposits octahedra. A labile drop inoculated with (*a*) deposits spherulites, but inoculated with (*b*) or (*c*) deposits the rectangular network. When a metastable drop containing either octahedra or spherulites, or both, passes into the labile condition (by cooling or by evaporation), they may continue to grow unchanged. If, however, a fragment or germ of octahedral alum be introduced into a labile drop the network (*c*) is immediately produced. An alum crystal growing in a labile solution is surrounded by a zone of metastable liquid which prevents it from starting the network (*c*) characteristic of a labile drop. Experiments were made upon the action of various mineral substances in inducing crystallisation in metastable and labile drops. Among these the holosymmetric cubic crystals, and especially galena, exercise a remarkable effect in producing the network (*c*) in labile drops.—Note on the formation of gypsum crystals in a disused well at chemical works: C. J. **Woodward.** Groups of gypsum crystals were exhibited which were found thirty years ago studding the walls of an old well at Messrs. Chance's chemical works at Oldbury.—Notes on minerals recently found in the Binnenthal: R. H. **Solly.** The minerals described were (1) Ilmenite, in brilliant crystals, displaying marked hemihedrism and showing five new forms. It is associated with quartz, adularia, magnetite and mica, on mica schist. (2) Seligmannite; an exceptionally large and well developed crystal in dolomite. Unlike any previously described, it is untwinned; altogether forty-five forms were observed, of which twenty-one are new. (3) Marrite; two more crystals of this rare mineral were found, one tabular and the other sharply pointed in habit. (4) Proustite; a minute crystal deposited on a crystal of rathite. (5) Trechmannite; a crystal of this rare mineral displaying asymmetric hemihedrism, deposited on a crystal of binnite. (6) Hyalophane; in crystals of an unusual green colour.

Entomological Society, November 15.—Mr. F. Merrifield, president, in the chair.—*Exhibitions.*—A flower-frequenting beetle from the Transvaal, illustrating a remarkable device for the cross-fertilisation of flowers, one of the front feet being tightly clasped by the curiously formed pollinia of an Asclepias: Mr. **Arrow.**—A remarkable specimen of *Agrotis tritici*, taken this year at Oxshott, bearing a close resemblance to *A. agathina*, with which it was flying over heather: W. J. **Kaye.** The specimen was a good example of syncryptic resemblance brought about by the common habit of resting on heather.—A specimen of *Forficula auricularia* taken by Mr. R. A. R. Priske at Deal in September, 1905, having the left cercus normal, while the right was that of var. *forcipata*: W. J. **Lucas.**—Forms of South African Pierine butterflies taken during the dry season of the present year, together with specimens of the same species for comparison taken in the same localities: Dr. F. A. **Dixey.** He said that his exhibit illustrated the fact, now widely recognised, that these forms varied in general correspondence with the meteorological conditions prevailing at the different seasons.—A long series of *Hemerophila abruptaria* bred by the exhibitor illustrating the proportion of light and melanic forms derived from a light male and a light female: E. **Harris.**—A ♂ specimen of *Tortrix pronubana*, Hüb., taken by Mr. Harold Cooper at Eastbourne, either at the end of September or the beginning of October last: S. **Image.** The insect is new to the British list.—*Paper.*—Hymenoptera-Aculeata, collected in Algeria, part iii., Diploptera, by E. Saunders, F.R.S.: Commander J. J. **Walker.**

Linnean Society, November 16.—Mr. C. B. Clarke, F.R.S., vice-president, in the chair.—*Exhibitions.*—Specimens of British water Ranunculi, showing the modifications in the form of the leaves: H. and J. **Groves.** The authors pointed out that the species might be roughly grouped under three headings:—(1) those in which only broadly lobed aërial leaves were produced; (2) those in which submersed multifid leaves with capillary segments were also produced; and (3) those with multifid leaves only.—Photograph showing, of the natural size, the otoliths from thirty-five species of fishes, a collection made by the late Dr. David Robertson: Rev. T. R. R. **Stebbing.**—Leaf and seed of *Macrozamia spiralis* from Queensland, where the plant is stated to cause symptoms of paralysis of the hind-quarters of cattle eating the leaves: E. M. **Holmes.** The chemical nature of the constituents of the plant appears to be unknown.—*Papers.*—Contributions to the embryology of the Amentiferæ, part ii., *Carpinus Betulus*: Dr. Margaret **Benson,** Miss E. **Sanday,** and Miss E. **Berridge.** Material was collected early in July, 1902, and 1904, and more than 600 series of sections were obtained through ovules containing the earlier stages in the development of the embryo-sacs, until the first segmentation of the definitive nucleus had occurred. Former observations (see part i. in *Trans. Linn. Soc.*, ser. ii., bot. iii. (1894), pp. 409–424) were confirmed, and the following new facts obtained. The polar nuclei meet at the neck of the cæcum, descend together, and generally fuse near its base. The pollen-tube enters the sac in their vicinity, and emits one gamete into the cæcum, usually by means of a short spur. The gamete then makes its way to the definitive nucleus. The other gamete is carried up by the tube to the egg, with which it fuses. The egg then becomes clothed with a wall, and segmentation commences.—The membranous labyrinth of five sharks: Prof. C. **Stewart,** F.R.S.

PARIS.

Academy of Sciences, December 4.—M. Troost in the chair.—Contribution to the study of the distribution of the tsetse fly in French West Africa: A. **Laveran.** Since writing the earlier notes on the same subject, the author has accumulated additional material, details of which are now given.—On the deformation of quadrics: C. **Guichard.**—On Bode's law and the inclinations of the planetary equators to the ecliptic: E. **Belot.**—On the intrinsic brightness of the solar corona during the eclipse of August 30, 1905: Charles **Fabry.** The instrument used was a modified Mascart photometer. The intrinsic brightness found was, at a distance of 5′ from the edge of the sun, and in the direction of the equator, about 720 candles per square metre, or about 0·28 the intrinsic brightness of the lunar surface.—The inertia of the electrons: Marcel **Brillouin.**—On certain experiments relating to the ionisation of the atmosphere, executed in Algeria on the occasion of the total eclipse of August 30, 1905: Charles **Nordmann.** A continuous record of the positive ions present in the air was obtained, the instrument destined to measure the amount of negative ions being broken in transit. The curve given by the ionograph showed a marked minimum during the eclipse, thus agreeing with the views of Lenard, Elster and Geitel, who regard the solar radiation as one of the direct or indirect factors in atmospheric ionisation.—On the equilibrium diagram of the iron-carbon alloys: Georges **Charpy.** The influence of the rate of cooling on the composition of the casting has been neglected by the earlier workers on this subject. Details are given of a study of an alloy containing 2·90 per cent. of carbon, for which the Bakhuis-Roozeboom diagram is drawn.—The action of silicon on pure aluminium; its action on impure aluminium; silico-aluminides: Em. **Vigouroux.** Silicon does not form a definite compound with pure aluminium, but in presence of a third metal silicides of aluminium and this metal are formed, well defined crystallised substances, silico-aluminides.—On α-decahydronaphthol and the octahydride of naphthaline: Henri **Leroux.** α-Naphthol, treated with hydrogen by the method of Sabatier and Senderens, gives the decahydride, the details of the preparation and properties of which are given in the present note. Treated with a dehydrating agent it loses a molecule of water and gives an octahydride of naphthalene.—On victorium and the ultra-violet phosphorescence of gadolinium: G. **Urbain.** The phosphorescence spectrum is given by one element when small quantities of a second element, called the excitor, are present. Either of these, in the pure state, gives no phosphorescent spectrum. These considerations have been applied to the examination of gadolinium, and the author regards the spectrum attributed to a new element, victorium, by Sir W. Crookes as due to a complex containing gadolinium.—On the existence of caoutchouc in a genus of Menispermaceæ: Jacques **Maheu.**—On prulaurasine, a crystallised cyanhydric glucoside extracted from the leaves of the cherry laurel: H. **Hérissey.** The method of obtaining this glucoside in a pure crystallised state from the leaves is given. Its formula appears to be $C_{14}H_{17}NO_6$, and under the action of emulsin it is hydrolysed to hydrocyanic acid, glucose, and benzoic aldehyde. It is an isomer of the amygdonitrile-glucoside of Fischer and the sambunigrin of Bourquelot and Danjou.—On the retrocerebral organ of certain rotifers: P. Marais **de Beauchamp.**—On phototropism of the larvæ of the lobster: G. **Bohn.**—On the geological structure of the eastern Pyrenees: Pierre **Termier.**—On the orientation which an elongated body will take when turning in a current of fluid: E. **Noël.**—On the Devonian fossils of the eastern Ahenet collected by M. Noël Villatte: Émile **Haug.** The collection of fossils made in the course of the Laperrine expedition is sufficient to prove the presence of the three principal subdivisions of the Devonian system, but the stratigraphical relations between the different terms cannot be exactly made out.—The influence of the summer rains on the yield of springs in the plains: M. **Houllier.**—The magnetic effects of lightning on volcanic rocks: Gaetano **Platania** and Giovanni **Platania.**

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 14.

ROYAL SOCIETY, at 4.30.—An Investigation into the Structure of the Lumbo-sacral-coccygeal Cord of the Macaque Monkey (*Macacus sinicus*): Miss M. P. Fitzgerald.—On the Distribution of Chlorides in Nerve Cells and Fibres: Prof. A. B. Macallum and Miss M. L. Menten.—The Mammalian Cerebral Cortex, with Special Reference to its Comparative Histology. I. Order Insectivora: Dr. G. A. Watson.—Observations on the Development of Ornithorhynchus: Prof. J. T. Wilson and Dr. J. P. Hill.—Further Work on the Development of the Hepatomonas of Kala-Azar and Cachexial Fever from Leishman-Donovan Bodies: Dr. L. Rogers.—The Action of Anæsthetics on Living Tissues. Part I. The Action on Isolated Nerve: Dr. N. H. Alcock.—Report on the Psychology and Sociology of the Todas and other Indian Tribes: Dr. W. H. R. Rivers.—On the Sexuality and Development of the Ascocarp of *Humaria Granulata*, Quel.: V. H. Blackman and Miss H. C. I. Fraser.—On the Microsporangia of the Pteridospermeæ with Remarks on their Relationship to Existing Groups: R. Kidston, F.R.S.—The Araucarieæ, Recent and Extinct: A. C. Seward, F.R.S., and Miss S. O. Ford.—On the Spectrum of the Spontaneous Luminous Radiation of Radium. Part IV. Extension of the Glow: Sir William Huggins, K.C.B., O.M., F.R.S., and Lady Huggins.

MATHEMATICAL SOCIETY, at 5.30.—On Well-ordered Aggregates: Prof. A. C. Dixon.—Tables of Coefficients for Lagrange's Interpolation Formula: Col. R. L. Hippisley.—On the Representation of certain Asymptotic Series as Convergent Continued Fractions: Prof. L. J. Rogers.—On a New Cubic Connected with the Triangle: H. L. Trachtenberg.—Some Difficulties in the Theory of Transfinite Numbers and Order Types: Hon. B. A. W. Russell.—The Imaginary in Geometry: J. L. S. Hatton.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—*Adjourned Discussion*: The Charing Cross Company's City of London Works: W. H. Patchell.

FRIDAY, DECEMBER 15.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—*Adjourned Discussion*: The Seventh Report to the Alloys Research Committee: On the Properties of a Series of Iron-Nickel-Manganese-Carbon Alloys: Dr. H. C. H. Carpenter, and Messrs. R. A. Hadfield and Percy Longmuir.—*Paper*: Behaviour of Materials of Construction under Pure Shear: E. G. Izod.

PHYSICAL SOCIETY (at Royal College of Science, South Kensington), at 7.—Exhibition of Electrical, Optical and other Physical Apparatus.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Tests of Street Illumination in Westminster: E. E. Mann.

AËRONAUTICAL SOCIETY, at 8.—The Acoustical Experiments carried out in Balloons by the late Rev. J. M. Bacon: Miss Gertrude Bacon.—The Aeromobile: F. Webb.—A New Continuous Impulse Petrol Motor for Dynamic Flying Machines: W. Cochrane.

MONDAY, DECEMBER 18.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Anthropogeographical Investigations in British New Guinea: Dr. C. G. Seligmann and Dr. W. Mersh Strong.

SOCIETY OF ARTS, at 8.—The Measurement of High Frequency Currents and Electric Waves: Prof. J. A. Fleming, F.R.S.

INSTITUTE OF ACTUARIES, at 5.—Canadian Vital Statistics; with Particular Reference to the Province of Ontario: M. D. Grant.

TUESDAY, DECEMBER 19.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Economy in Factories: H. A. Mavor.

ANTHROPOLOGICAL INSTITUTE, at 8.15.—The Origin of Eolithic Flints by Natural Causes: S. H. Warren.

ROYAL STATISTICAL SOCIETY, at 5.—The Decline of Human Fertility in the United Kingdom and other Countries as shown by Corrected Birth-Rates: Dr. Arthur Newsholme and Dr. T. H. C. Stevenson.—Changes in the Marriage- and Birth Rates in England and Wales during the Past Half-century, with an Inquiry as to their Probable Causes: G. Udny Yule.

WEDNESDAY, DECEMBER 20.

GEOLOGICAL SOCIETY, at 8.—(1) The Clunian Series of the Ludlow District.—Miss G. L. Elles and Miss I. L. Slater; (2) The Carboniferous Rocks of Rush (County Dublin): Dr. C. A. Matley, with an Account of the Faunal Succession and Correlation by Dr. A. Vaughan.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Kite Observations from a Trawler in the North Sea: G. C. Simpson.—Investigation of the Upper Air in the West Indies by Means of Kites: C. J. P. Cave and W. H. Dines, F.R.S.—Temperature Observations during the Partial Solar Eclipse, August 30, 1905: W. H. Dines, F.R.S.—Comparison between Glaisher's Factors and Ferrel's Psychrometric Formula: J. R. Sutton.—A Rapid Method of finding the Elastic Force of Aqueous Vapour, &c., from Dry and Wet Bulb Thermometer Readings: Dr. J. Ball.

SOCIETY OF ARTS, at 8.—The Aërograph Method of Distributing Colour: Charles L. Burdick.

ROYAL MICROSCOPICAL SOCIETY, at 8.—A "Fern" Fructification from the Lower Coal-measures of Shore, Lancashire: D. M. S. Watson.—Exhibition of Balsam mounted Slides by the late Andrew Pritchard.

SOCIOLOGICAL SOCIETY, at 8.—The Russian Revolution and its Consequences: Dr. G. de Wesselitsky.

THURSDAY, DECEMBER 21.

LINNEAN SOCIETY, at 8.—Report on the Vienna Botanical Congress: Dr. A. B. Rendle.—*Cyrtandraceae malayanae novae*: Dr. Franz Kränzlin.—On Characeæ from the Cape, collected by Major A. H. Wolley-Dod: H. and J. Groves.—Note on the Distribution of Shortia, Torr and Gray: B. Daydon Jackson.

CHEMICAL SOCIETY, at 8.30.—The Relation of Position Isomerism to Optical Activity. Part V. The Rotation of the Menthyl Esters of the Isomeric Dibromobenzoic Acids: J. B. Cohen and I. H. Zortman.—Azo-derivatives from α-Naphtho-methylcoumarin: J. T. Hewitt and H. V. Mitchell.—The Supposed Identity of Dihydrolaurolene and of Dihydro-*iso*laurolene with 1:1-Dimethylhexahydrobenzene: A. W. Crossley and N. Renouf.—The Slow Combustion of Carbon Disulphide: N. Smith.

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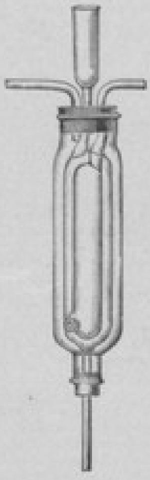

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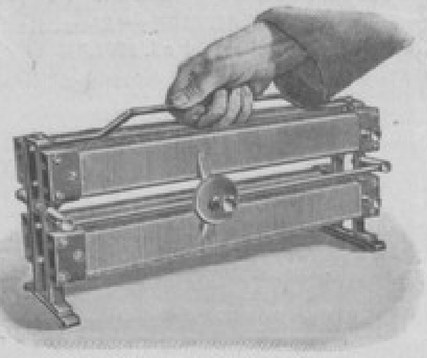

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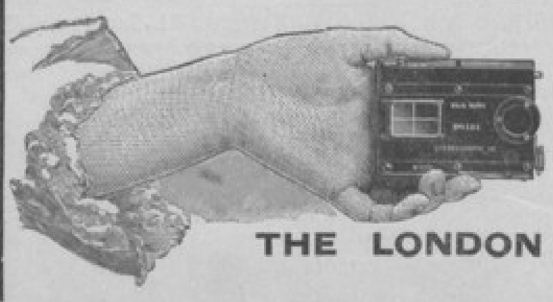

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The Teaching of Scientific Method and other Papers on Education. By Henry E. Armstrong, LL.D., Ph.D., F.R.S. Pp. x+476. (London: Macmillan and Co., Ltd., 1903.) Price 6s.

THIS book reproduces the chief contributions which Prof. Armstrong has made to the literature of education from 1884 to the present time, with the addition of a parody by another hand of that most parodied of music hall lyrics, "The Absent Minded Beggar." I have been so constantly in touch with Prof. Armstrong, and occasionally so closely associated with him, that the book comes to me in no degree as a new work, and I have perforce read it from the point of view of one who regards the mode of presentation of the case rather than the merits of the case itself. Though the work is entitled "The Teaching of Scientific Method," its scope is much wider, for it is an indictment of our educational system from top to bottom, and an indication of how education is to be set right in its relation to all the arts of peace and war.

It appears to me that the weakness of Prof. Armstrong's book lies in the want of system and coordination. The arrangement is probably as good as it could be, provided that nothing were feasible but the mere reprinting of twenty-three occasional addresses, but it is impossible not to suppose that the constant reiteration of doctrine, and the continual reappearance of almost the same words, will deter a reader who sits down to read the book solidly through. It would have been a considerable labour, but it would have given unity and plan to the book, if Prof. Armstrong had mixed the twenty-three outpourings, and had subjected the mixed liquid to a process of fractional distillation.

Coming to the matter of the book, it is unnecessary in the pages of NATURE to say a single word in justification of Prof. Armstrong's assertion of the importance of science as an element in national education, and of the importance of teaching science well. I shall confine myself, therefore, to the question as to whether the method of teaching science which Prof. Armstrong advocates is really a way of teaching it well. On this question there is an apparent diversity of opinion among those who may be supposed to be entitled to express an opinion. I will assume no editorial plural in writing on the subject. I, as one teacher, after twenty years' constant study and observation of science teaching in schools am of opinion that Prof. Armstrong is advocating what is essentially a good method, and though I know that this same method has been spoken of by distinguished people in terms of condemnation and ridicule, I am ready to justify my opinion.

The objects of science teaching in schools have been stated again and again in all degrees of fulness and eloquence. They appear different to different people. Science gained a footing in the schools of this country, I think, in the hope that it would prove a bread-and-butter study, and would provide a body of useful information as clearly available for practical purposes as arithmetic. It was an important ingredient of that "modern side" education which was the outcome of a rebellion against the classical basis on which all education had previously rested. It was accepted reluctantly by schoolmasters, who, too ignorant of science to understand its higher possibilities, regarded the intrusion as essentially Philistine in origin and in aim.

In France science was introduced into the school curriculum with a totally different object. The aim there was to add an element of natural philosophy, to open the mind of the young to an appreciation of the grandeur of natural laws, to use science as an element of culture.

My own independent critical knowledge of science teaching in schools does not go back more than twenty years, but I am prepared to maintain that twenty years ago the science teaching that prevailed in this country was in the main execrable. Good teachers there were, no doubt, for good teachers there always will be, independently of all systems. But whether looked at as giving useful information, culture, or mental training, the teaching of science in my school days and after was in the main worthy of the contempt with which it was regarded by all those who had a humane interest in education.

This state of things has now been altered to a degree which makes the change one of the most remarkable and gratifying educational revolutions with which I am acquainted. The change has been wrought by the efforts of a number of men who were sufficiently interested in science and sufficiently imbued with the spirit of the teacher to set to work and show that science could be made an invaluable mind-training study, and among these men I reckon Prof. Armstrong as a potent leader.

Prof. Armstrong renounces the claim, often imputed to him, of having discovered a new method of teaching. What he has done has been to formulate a scheme of teaching in accordance with principles which are almost as old as civilisation. The aim of this scheme has been to free science teaching from the dogmatic didactic methods by which it has been dominated, and to substitute a system which should yield the benefits of the experimental method. Two things, and two things only, I think, are essential to Prof. Armstrong's plan, first, that the pupils should perform experiments with their own hands, and second, that these experiments should not be the mere confirmation of something previously learned on authority, but the means of eliciting something previously unknown or of elucidating something previously uncertain. In this way only, it is maintained, can pupils gain the knowledge and use of scientific method. Incidentally, it is urged that the experimental studies should be made quantitative, and that a small number of problems should be studied thoroughly.

I cannot imagine that this view of the way in which science should be taught can be seriously disputed, and I think it is a pity that so many of Prof. Armstrong's

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critics should have fastened on quite subsidiary matters and left his main contention unacknowledged.

I feel bound to admit that in some respects Prof. Armstrong has overstated his case. His advocacy has suggested that he desires the pupil to discover everything for himself and by himself, and so is incurred the criticism that it is ridiculous to expect a child to achieve in two or three years that which it has taken grown philosophers centuries of labour to achieve. A beginner cannot discover much for himself by himself, but a judicious teacher may lead him to discover much. I think that Prof. Armstrong has exaggerated the importance of quantitative work, great though that importance be. One has only to think of the achievements of Scheele in order to realise what a splendid thing qualitative work may be when faithfully performed. Again, the element of useful information must not be underestimated; we want to get the pupil along, and there is surely much that may be told, if it is properly presented and punctuated with experiments. In doing this there is no need to throw the pupil into a state of passive acceptance, still less of passive resistance; a good teacher knows how to avoid either.

Another point on which Prof. Armstrong's critics have fastened is his nomenclature. This is really a trifling matter, but such as it is I am on the side of the critics. "Chalk gas" seems unnecessary, even as a temporary name for carbon dioxide. Why not fixed air, which is both descriptive and historical? However, as I have said, such things are mere trifles.

In conclusion, I will express the opinion that it is not the matter of Prof. Armstrong's proposals that has created opposition, but the manner. There is probably no decent member of society more repugnant to the average Englishman than the aggressive educational reformer. If a man quietly records in books the outcome of his mature reflections and experience—well, you can avoid him by not reading his book, but if he appears at all your meetings with his new doctrines, if he invents new terms that dart promiscuously about the atmosphere of the educational world, and if eventually he gets known to the newspapers as a man likely to furnish occasion for the headline "animated debate," it is quite otherwise. If a man is a stylist like Matthew Arnold, deft with epigram, breathing a cultivated irony, he is forgiven everything for his literary excellence. But Prof. Armstrong has not chosen the persuasive method of Matthew Arnold. He is vigorous almost to violence, red-hot, scathing, scornful, uncompromising and incessant. He is no respecter of persons or institutions, however eminent, however ancient. He is absolutely impartial in his iconoclasm.

These peculiarities may have hindered the acceptance of improved methods. In any case, improvement could only have come in slowly, for it is laborious, and taxes the ingenuity as well as the diligence of the teacher. The eagerness of public administrators for speedy results, the false economy which gives the teacher no time to think, and the crowding of elementary classes, not only in the case of science, but all through the school course, are great obstacles to thoroughness. How idle it is to preach improved methods to an overworked teacher who has seventy, eighty or a hundred children to teach at once!

When all reasonable concessions have been made to his critics, it will, I believe, appear that Prof. Armstrong has rendered an inestimable service to the cause of true education. ARTHUR SMITHELLS.

PRACTICAL ZOOLOGY.

First Report on Economic Zoology. By Fred. V. Theobald, M.A. Pp. xxxiv+192; 18 figures. (London: Printed by Order of the Trustees of the British Museum, 1903.) Price 6s.

THIS volume of reports on problems of economic zoology is very welcome. It represents a type of publication familiar in America, which has never been more than very rare in Britain; it is packed with valuable practical advice which must surely justify zoology in the eyes of any unconverted utilitarian; and it illustrates the nature and amount of scientific information on matters of economic importance which the staff of the zoological department of the British Museum "is almost daily called upon, and is prepared to furnish to the public service or to individuals." As is well known, this side of the Museum's work has been brought into particular prominence since Prof. Ray Lankester became director.

The contents are necessarily very heterogeneous, and afford a fine illustration of the multitudinous ways in which man's practical interests come into contact with animal life. We find discussions on cereal pests, root-crop pests, fruit pests, garden pests, forest pests, on poison for moles, on tapeworm in sheep, on the origin and varieties of domesticated geese, on dipterous larvæ in human excreta, on *Anobium tesselatum* in St. Albans Cathedral, on green matter in Lewes Public Baths, on the cigar beetle and the Teredo, on the tsetse fly and the Ceylon pearl fisheries, on the screw worm in St. Lucia, locusts in the Sudan, mosquitoes at Blackheath, and so on through a variety of subjects that is positively astounding. Mr. Theobald deserves warm congratulation on the impressiveness of his "First Report."

The variety of subjects which have had to be discussed in response to inquiries from the Board of Agriculture, the Foreign Office, the Colonial Office, and from private individuals makes the volume very multifarious, and gives a special appositeness to Prof. Ray Lankester's introductory scheme or outline of economic zoology. He gives a classified survey of the various subdivisions which it is found convenient to recognise in the treatment of this subject. This classification of animals in their economic relation to man, which recalls a little book by Dr. Edwin Lankester, proceeds from the simpler relations of primitive man and the animals around him to the more complex relations of civilised man with his endless arts and industries and circumscribed conditions. We give the classification in outline:—

Group A.—Animals *captured* or *slaughtered* by man for food, or for the use by him in other ways, of their skin, bone, fat, or other products. *Examples*:—

animals of the chase; food-fishes; whales; pearl-mussels.

Group B.—Animals *bred* or *cultivated* by man for food or for the use of their products in industry or for their services as living things. *Examples*:—flocks and herds; horses; dogs; poultry; gold-fish; bees; silkworms and leeches.

Group C.—Animals which directly promote man's operations as a civilised being without being killed, captured or trained by him. *Examples*:—scavengers such as vultures; carrion-feeding insects; earthworms and flower-fertilising insects.

Group D.—Animals which concern man as causing bodily injury, sometimes death, to him, and in other cases disease, often of a deadly character. *Examples*:—lions; wolves; snakes; stinging and parasitic insects; disease-germ carriers, as flies and mosquitoes; parasitic worms; parasitic Protozoa.

Group E.—Animals which concern man as causing bodily injury or disease (both possibly of a deadly character) to (*a*) his stock of domesticated animals; or (*b*) to his vegetable plantations; or (*c*) to wild animals in the preservation of which he is interested; or (*d*) to wild plants in the preservation of which he is interested. *Examples*:—Similar to those of Group D, but also insects and worms which destroy crops, fruit and forest trees, and pests such as frugivorous birds, rabbits and voles.

Group F.—Animals which concern man as being destructive to his worked up products of art and industry, such as (*a*) his various works, buildings, larger constructions and habitations; (*b*) furniture, books, drapery and clothing; (*c*) his food and his stores. *Examples*:—White ants; wood-eating larvæ; clothes' moths, weevils, acari and marine borers.

Group G.—Animals which are known as "beneficials" on account of their being destructive to or checking the increase of the injurious animals classed under Groups D, E, and F. *Examples*:—Certain carnivorous and insectivorous birds, reptiles and Amphibia; parasitic and predaceous insects, acari, myriapods, &c.

We have, then, in this "First Report on Economic Zoology" a large number of expert discussions of particular points—all of practical importance and some of theoretical interest as well; and we have also a luminous orientation of the whole subject. No one can help being impressed by the fact that zoology does not lose either in interest or in thoroughness as it becomes more social.

J. A. T.

IRRIGATION WORKS.

Irrigation Engineering. By Herbert M. Wilson, C.E. Fourth edition. Pp. xxiii+573. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 17*s*. net.

AN annual grant of about 500,000*l*. having been recently allotted by the Congress of the United States for the construction of irrigation works in arid regions, under the supervision of the director of the Geological Survey, various projects have been prepared with a view to their execution in the near future, which have already given employment to a number of engineers. This development has enhanced the importance of a sound knowledge of the principles of irrigation engineering, and has, accordingly, led the author to revise thoroughly and enlarge his book on the subject.

The area of land irrigated in the United States, reaching more than $7\frac{1}{2}$ million acres, is second only to India with 33 million acres, being larger than the irrigated area in Egypt of 6 million acres, in Italy of $4\frac{7}{16}$ million acres, and in Spain of $2\frac{4}{5}$ million acres. The States in which irrigation has been most resorted to are Colorado, California, Montana, Utah, and Idaho, with irrigated lands ranging from $1\frac{1}{3}$ million to half a million acres. After a very short introductory chapter on irrigation, the book is divided into three parts, dealing with hydrography, irrigation canals and canal works, and storage reservoirs respectively, in nineteen chapters altogether.

The subjects treated of in the first and third parts are, for the most part, similar to those contained in books on water-supply, the chief exceptions being chapter iv., on alkali, drainage, and sedimentation; chapter v., on the quantity of water required; and the end portion of the last chapter in part i., relating to sewage irrigation, which belongs strictly to sewage disposal. When the drainage of irrigated lands is not efficiently provided for, and an excess of water is carelessly distributed, any alkali in solution in the water accumulates by the evaporation which occurs as soon as the water rises to the surface, sodium carbonate being the most injurious to the soil; and the land also becomes water-logged and swampy, which, besides being bad for agriculture, is liable to occasion malarial fevers. Silt, which is brought down in large quantities in flood-time by many rivers, the waters of which are used for irrigation, is very valuable as a manure if it can be spread over the land, but it is very liable to deposit in the storage reservoirs and canals provided for irrigation, before the water reaches its destination; and the aim of the engineer is to convey the lighter and more fertile silt on to the land with the water, and to arrest the heavier silt before it reaches the reservoir, or to scour it out through sluices in the dam; and in the case of a diversion canal from a river, to arrange its entrance so as to keep out most of the heavier silt, and to make the remainder deposit in a part of the canal from whence it can be readily removed. The amount of water required to irrigate a given area depends upon the conditions of the locality and the crops raised, and forms the basis of all irrigation schemes.

The second part deals with works relating exclusively to irrigation in seven chapters, in which inundation and perennial canals, their alignment, slope, and cross section, headworks and diversion weirs, scouring sluices, regulators and escapes, falls and drainage works, distributaries and the application of water and pipe irrigation, are successively considered; and this constitutes the most important part of the book as regards irrigation. The book, however, as a whole, deals with the principles and practice of irrigation in a very complete manner, and is profusely illus-

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trated by forty-one full-page views and plans, and one hundred and forty-two figures in the text; it is written in a simple style and printed in large type; and within a moderate compass the volume furnishes a large amount of information, combined with the results of experience, especially in the United States, which should prove of considerable value to engineers engaged in irrigating arid regions.

OUR BOOK SHELF.

Graphic Statics, with Applications to Trusses, Beams, and Arches. By Jerome Sondericker, B.S., C.E. Pp. viii + 137. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 8*s.* 6*d.* net.

THIS is a very practical treatise on the determination of the forces in braced structures, beams, masonry arches, and abutments. It is based on a course of instruction given at the Massachusetts Institute of Technology. The author presupposes a knowledge of the strengths of materials, of the principles of statics, and of ordinary beam formula for stresses and deflections, and is thus able to present his methods in a very concise form without any lengthy preliminary explanation, and he pays special attention to the precautions which should be taken in drawing the diagrams in order to secure the best results.

The graphical processes are accompanied by analytical calculations, and the student is wisely encouraged to make himself familiar with both methods of computation, and not to follow either slavishly. Building construction is mainly drawn upon in providing examples, which include such cases as steel framed buildings under the action of gravitation loads and wind pressures. The author does not employ the strain energy method or its equivalent for structures with redundant elements, but proceeds by arbitrary assumption as to what seems probable in each particular case. This is often the only feasible plan, but too much reliance should not be placed on the results obtained. For instance, there is probably considerable error on p. 79 in the tacit assumption that the reactions in the trussed beam are the same as if the middle support did not yield. Considerable attention is given to frames where the members are subject to binding stresses as well as to direct stresses.

The three-hinged arch is dealt with, and some of the methods which have been proposed for determining the line of resistance in a masonry arch are briefly discussed; the author works out one example in full detail, showing how to find the linear arch which lies within a specified region (such as the middle third), and has the least horizontal thrust.

Memories of the Months. Third series. By Sir Herbert Maxwell, Bart. Pp. xi + 290; illustrated. (London: Edward Arnold, 1903.) Price 7*s.* 6*d.*

THE author has no occasion to offer apologies for converting the "Memories" into a trilogy, and it is with sincere pleasure that we welcome this latest addition to a charming series, of which we hope we have not yet seen the end. Whether his subject be forestry, the habits and activity of squirrels, local place-names, salmon-disease, or "vole-plagues," Sir Herbert writes with a charm peculiarly his own, and, while imparting information, does so in a style which many of our best novelists might envy. Perhaps the highest praise we can bestow is to say that whenever one of the author's books comes into our hands for review, we invariably read it from beginning to end—and that with pleasure and satisfaction.

As Sir Herbert is not, we believe, a professed naturalist, a few slight errors, mainly due to lack of acquaintance with current zoological literature, could scarcely fail to occur in a work of this nature.

For instance, his arguments and conclusions drawn from the remarkable distribution of the fresh-water fishes of the genus Galaxias (p. 50) are rendered practically nugatory by the recent discovery of a marine representative of that group. Again, he does not appear to be aware that the Thessalian vole (p. 39) has been assigned to a new species by Captain Barrett-Hamilton, under the name of *Microtus hartingi*. We may also direct attention to the practical repetition, on pp. 46 and 47, of the account of the damage inflicted on Scottish pine forests by crossbills given on pp. 1 and 2, the repetition extending even to the fading of the crimson of the head and neck of the bird to dull greenish-olive after death. Another repetition will be found by comparing pp. 73 and 115, in connection with the origin of the name Winchester; with the discrepancy that "Gwent" is stated to mean "white" in the latter, and "downs" in the former passage. Finally, the misprint *Odicnemus* on p. 102 is scarcely consonant with the author's predilection for etymology.

Where all is interesting, it is difficult to select passages for special notice. Attention may, however, be directed to the calculation of the muscular activity of the goldcrest as contrasted with that of man (p. 40). It may also be noted that the author defends his contention as to the limited height to which holly is prickly by the remark that when this has been called in question it is owing to artificial strains, and not the natural wild stock, having been the subject of observations.

With this we must take leave of a volume as charming and full of interest as its predecessors. R. L.

Educational Woodwork. By A. C. Horth. Pp. 159. (London: Percival Marshall and Co., n.d.) Price 3*s.* 6*d.* net.

THE author has attempted to provide, within the restricted limits of a hundred and sixty pages, a three years' course of woodwork, drawing, and object lessons; chapters on discipline, organisation and method; particulars as to the fittings and furniture required for the exercises, as well as hints on the instruction of deaf, blind, and special children. At the same time he has found space for nearly two hundred illustrations. The consequence is that the instructions are meagre, and in many cases quite inadequate. The illustrations in the earlier pages are good, but some of the drawings intended to help the object lessons outlined in chapter viii. will fail to convey much meaning to pupils. The courses of woodwork are also published separately in pamphlet form at fourpence net for each year.

Die Proportion des goldnen Schnitts. By J. Kübler. Pp. 36. (Leipzig: B. G. Teubner, 1903.)

THIS is an attempt to discuss the properties of quantities in continued proportion, and in particular the series of proportionals derived from the problem of medial section, in connection with a large number of mathematical, physical, and even physiological problems.

If books of this kind are written and read as a recreation by people who enjoy thinking about semi-mathematical and semi-philosophical considerations, and who merely take the conclusions arrived at for what they are worth, without attaching special scientific value to them, then the present volume completely fulfils its object.

LETTERS TO THE EDITOR.

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

The Royal Society.

AT the special meeting of the Royal Society held on January 21, when the constitution and functions of the sectional committees were under consideration, the opinion was expressed by more than one speaker that the usefulness of the society in encouraging and advancing scientific work is not what it might be; but no very definite suggestions were made with a view to its improvement.

It seemed to me that the functions of these sectional committees had a good deal to do with the lack of scientific enterprise which we observe in the Royal Society, and that they might with advantage be done away with.

As many of the fellows had left the meeting before I spoke, and as everything that affects the efficiency of the Royal Society concerns the public, I crave the hospitality of the columns of NATURE to develop as shortly as possible my views on this matter.

The main function of the sectional committees is to *refer* papers received by the society from fellows, to some other fellow or fellows of the society to be certified that they are or are not fit to be accepted and published by the society.

It is well known that the fellows of the society are *de facto* chosen by the council after rigid scrutiny and the most careful inquiry, and the only object of this scrutiny and inquiry is to satisfy the council that the candidate whom it recommends is a man of eminence in his own science, and that the work which he is likely to do will be a credit to the society. So convinced is the society of the thoroughness and impartiality with which the council discharges this duty that the confirmation of its selection by election has come to be a pure formality. This being so, it cannot fail to surprise the newly elected fellow, when he proceeds to justify his election by doing work and communicating the results of it to the society, to find that he is now in no better position than he was before he was elected. His work is *referred* in the same way as that of any outsider. His recent selection by the council is ignored by that body or is regarded as having no weight, and it treats him, scientifically, as a perfect stranger.

Furthermore, this *reference*, which amounts to neither more nor less than a secret revision of the title of the fellow to the privileges of the society, is repeated on every occasion when he comes under the notice of the society by offering it work. So long as he is content to be a passive fellow, or at least an inactive one, he is spared this injustice and indignity. It is no wonder then that the fellowship of the Royal Society has come to be looked on as an invitation to repose rather than as an incentive to work.

How different is the state of things which we observe in the parallel society in France, the Academy of Sciences. Its constitution is thoroughly democratic, and all its proceedings are inspired by enlightened self-respect. But we need only contemplate the work which it puts through in the year and compare it with what is turned out by the Royal Society to see that there is something for us to learn by its study.

First and foremost the academy meets fifty-two times in the year, namely, on every Monday, with the exception of Easter Monday and Whit Monday, and then it meets on the following Tuesdays. By the time-table of the current year the Royal Society is to meet twenty times.

Papers by members, or communicated by members of the academy, are not obliged to be sent in before the meeting. The *agenda* of the meeting is compiled at the meeting, each member who has a paper to communicate giving notice of it to the secretary on his arrival in the room, and the papers are taken strictly in the order of their intimation. If the paper communicated by the member is to be published in the *Comptes rendus* of the sitting, it has to be handed in to the secretary at the sitting; the corrected proof has to be returned to the printer on the Wednesday evening, and it is then published without fail on the Sunday. The communication, reading, and publication of a paper presented to the academy is therefore an affair of the inside of a week, and it is a certainty. This promptitude in the putting through of work is due to the fundamental fact that when a man is elected a member of the academy he enters at once into the full enjoyment of all its privileges, and one of the chief of these is the complete confidence of all his fellow-members. When he communicates a paper, whether it be by himself or by someone not a member of the academy, it is accepted without question. The only limitation in the privileges of members is with regard to the space that they are entitled to claim in the *Comptes rendus*. A paper by a member or foreign associate of the academy may fill six pages per number, and his communications in the year may fill fifty pages in all, and this as a matter of right.

It is unnecessary to occupy more space in order to show what a powerful engine the Academy of Sciences is in the production and encouragement of work, or to indicate how easily the Royal Society may successfully rival it. Let every fellow of the society, whether he be on the council or not, have complete confidence in his fellow-fellows and give practical effect to it, and the thing is done. The rest will follow of itself.

J. Y. BUCHANAN.

January 23.

The Radiation from an Electron describing a Circular Orbit.

THE complete formula for the radiation may be useful to some of those who are now indulging in atomic speculations. It is derived from the general formula I gave a year ago in NATURE (October 30, 1902), expressing the electromagnetic field everywhere due to an electron moving anyhow. Put in the special value of R required, which is a matter of elementary geometry, and the result is the complete finite formula. But only the part depending on R^{-1} is required for the radiation; and, in fact, we only want the r^{-1} term (if r=distance from the centre of the orbit), if the ratio of the radius of the orbit to the distance is insensible, and that, of course, is quite easy, on account of the extreme smallness of electronic orbits. The magnetic force is given by

$$H_\phi = \frac{Qun}{4\pi rv}\alpha^3 \cos\theta \cos\phi_1, \qquad (1)$$

$$H_\theta = \frac{Qun}{4\pi rv}\alpha^3(\sin\phi_1 - \beta), \qquad (2)$$

subject to

$$\alpha = \frac{1}{1-\beta\sin\phi_1}, \quad \beta = \frac{u}{v}\sin\theta, \qquad (3)$$

$$\phi_0 = \phi_1 + \beta\cos\phi_1 = \phi - nt + nr/v. \qquad (4)$$

There is no limitation upon the size of u/v, save that it must be less than 1. But there is a limitation regarding the acceleration. If the change in the acceleration is sensible in the time taken by light to traverse the diameter of the electron, it will sensibly alter the results. The size of the electron itself will then have to be considered. But this is very extreme. To explain the symbols: the (surface) charge is Q moving at speed u and angular speed n in a circle in the plane perpendicular to the axis from which θ is measured. It revolves positively round this axis, and its position when $t=0$ is $\phi=0$. Also, r, θ, ϕ are the usual spherical coordinates of the point of observation, and H_ϕ, H_θ are the ϕ and θ components of the magnetic force at that point at the moment t. The coefficient α^3 shows the Doppler effect on **H**. The difference between ϕ_0 and ϕ_1 must be noted.

It will be readily seen what an important part the Doppler effect plays if, as has been sometimes assumed, subatomic motions of electrons involve values of u which are not insensible fractions of v. For instance, in the plane of the orbit, $H\phi=0$, and

$$H_\theta = \frac{Qun}{4\pi rv}\frac{\sin\phi_1 - u/v}{[1-(u/v)\sin\phi_1]^3} \qquad (5)$$

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The effect is to compress H in one half and expand it in the other half of a period, with corresponding strengthening and weakening of intensity, and also with a shifting of the nodes towards the compressed part. When u/v is made large, there is a great concentration at $\phi_1=\phi_0=\frac{1}{2}\pi$, $2\frac{1}{2}\pi$, $4\frac{1}{2}\pi$, &c., with only a weak disturbance of opposite sign between them. That is, there is a tendency to turn the original simply periodic vibration into periodic pulses, which become very marked as u increases towards v. The radiation of energy is very rapid. It involves (*l.c.*) the factor $(1-u^2/v^2)^{-2}$. This becomes so great as seemingly to shut out the possibility of anything more than momentary persistence of revolution. But there might be a solitary partial revolution, or nearly complete, in cometary fashion, which would generate a single pulse, if there cannot be a sequence of several at speeds nearly equal to that of light.

Three suggestions have been made about the X-rays. Röntgen suggested a longitudinal ether disturbance. This has not found favour, because it requires a new theory of electricity. Schuster suggested very rapid vibrations. This is tenable, because in the inside of an atom rudimentary calculations show that vibrations much more frequent than light are easily possible with revolving electrons. Stokes suggested collisional pulses. This is tenable too, for the collisions must produce electromagnetic pulses. I think X-rays are mixed Stokes pulses and Schuster vibrations, the latter arising from the atoms of the body struck. Now a pulse is not the same as a continued vibration, though it may be analysed into the sum of various sorts of continued vibrations, just as the distorted simply periodic vibration in (5) above may be. There ought, then, to be a physical difference between the effects of collisional pulses and continued very rapid vibrations. Apart from the emission of electrons and matter, there might be six sorts of radiation at least, say, light vibrations, below light, above light, collisional pulses, cometary pulses, and possibly periodic pulses. The last may have to be excluded for the reason mentioned. The cometary pulses would resemble the collisional pulses, though less dense. The above light vibrations need not require u/v to be more than a small fraction, though even then their maintenance is a difficulty. They require renewal again and again, perhaps in a collisional manner. There is a good deal to be found out yet in the relations of electricity to matter. There is also sometimes a good deal of misconception as to the relations of theory to fact. A purely dynamical theory of electricity, like Maxwell's, can give no information about the connection between electricity and matter. For example, Zeeman's experiment, as interpreted by Lorentz, brought out the striking fact that it was the negative electricity that revolved, not seemingly the positive, and the fact harmonises with J. J. Thomson's negative corpuscles. Theory could never predict such a fact, because it is not in the theory. It could not be there, because it has no dependence upon the dynamics of electricity in the theory. The same may be said of various other new facts much discussed of late. Now, though the theory cannot predict such facts, it is useful, of course, as a guide in framing hypotheses to account for the new facts, for it is no use flying in the face of solid theory. Whether the solid theory itself (not meaning that the ether is solid) will need to be altered remains to be seen. There is no sign of it yet, though I cannot believe the ethereal theory is complete.

To analyse the dopplerised vibrations expressed by (1), (2) into simply periodic vibrations seemed to involve very complicated work at first, save just for two or three terms. But there is a trick in it, which, when found, allows the complete expansions to be developed in a few lines. First show that (this is the trick)

$$a^2\cos\phi_1=-\frac{d^2}{d\phi_0^2}\cos\phi_1,\quad a^2(\sin\phi_1-\beta)=-\frac{d^2}{d\phi_0^2}\sin\phi_1. \quad (6)$$

Next, by the theorem known as Lagrange's, $\sin\phi_1$ can be at once put in the form of a series involving the derivatives of various powers of $\cos\phi_0$. Do not find the derivatives from them, but put $\cos^n\phi_0$ in terms of the sum of first powers of cosines by the well known circular formula. The full differentiations, not forgetting those in (6), may then be done at sight in one operation. The result is

$$a^2(\sin\phi_1-\beta)=\sin\phi_0-\beta\,.\,2\cos 2\phi_0-\frac{3}{8}\beta^2(9\sin 3\phi_0+\sin\phi_0)$$
$$+\frac{4}{3}\beta^3(4\cos 4\phi_0+\cos 2\phi_0)+\frac{\beta^4}{\underline{|4}}\frac{1}{2^4}\Big(5^3\sin 5\phi_0+5\cdot 3^4\sin 3\phi_0$$
$$+10\sin\phi_0\Big)-\frac{\beta^5}{\underline{|5}}\frac{1}{2^5}\Big(6^4\cos 6\phi_0+6.4^4\cos 4\phi_0+15\cdot 2^4\cos 2\phi_0\Big)$$
$$-\ldots \quad (7)$$

and so on to any extent. Then, to find the other one, differentiate the series in (7) with respect to ϕ_0 and divide the nth term by n. Thus

$$a^2\cos\phi_1=\cos\phi_0+2\beta\sin 2\phi_0-\frac{\beta^2}{8}\Big(27\cos 3\phi_0+\cos\phi_0\Big)-\ldots \quad (8)$$

and so on. This analysis of the vibrations is useful in some special developments, but of course the original distorted simple vibration is the most significant. In fact, the result of the analysis exhibits the common failing of most series developments that the resultant meaning is not evident.

Another way. Use Bessel's series for the sine and cosine of ϕ_1, and then carry out (6). It is remarkable that the relation between the eccentric and mean anomaly in a planetary orbit should be imitated, for the dynamics is quite different.

When I was a young child I conceived the idea of an infinite series of universes, the solar system being an atom in a larger universe on the one hand, and the mundane atom a universe to a smaller atom, and so on. I do not go so far as that now, but only observe that there is a tendency to make the electrons indivisible, and all exactly alike. But they must have size and shape, and be therefore divisible. Unless, indeed, they are infinitely rigid. Or they may vary in shape without dividing. There are infinite possibilities in the unknown. Kaufmann's measurements go to show that the mass of an electron, if there is any, is only a small fraction of its effective electromagnetic mass, although that is not a definite quantity subject to the Newtonian second law. But it is too soon to say that the electron has no mass at all, that is, to be quite sure that negative electricity is absolutely separable from matter, though it seems likely. It would be well to have, if possible, similar measurements made on positive electricity. If permanently attached to matter, it should not exhibit the increased inertia with increased speed in a sensible manner.

January 11. OLIVER HEAVISIDE.

Atmospheric Electricity.

YOUR correspondent Mr. George Simpson truly points out that the sun's α rays would be stopped by the upper atmosphere, whereas his β rays would penetrate much further; and perhaps he may have also noticed that an energetic separation of these oppositely charged rays would be effected by the earth's magnetic field, the negative being conveyed toward the poles, and the positive remaining near the tropics along with the maximum sunshine.

Consequently quadrantal earth-currents would be generated, and likewise a Leyden jar action would be set up in the tropical region of the lower atmosphere, sufficient to account for prevalent tropical thunderstorms. Some magnetic perturbations could also be accounted for.

OLIVER LODGE.

Nomenclature and Tables of Kinship.

A CIRCULAR letter, arranged like the following, is about to be issued for carrying out certain inquiries into heredity, and I am anxious, before taking a more definite step, to have it criticised and to receive suggestions. I send it to NATURE not only for my own advantage, but because I think it will interest those readers who occupy themselves in analysing experiences in breeding animals of any kind, although this table has been specially designed to receive hereditary facts concerning man.

The processes that it is desired to facilitate are, in outline, as follows:—Some marked peculiarity is determined on to be made the subject of study. It may be an excess or deficiency of some normal character, or it may be a trait, a feature, a disease, or a monstrosity, the process being the same in all these cases. The inquirer then endeavours to trace its hereditary distribution. He fixes upon some individual who possesses the peculiarity in a highly marked degree, and traces the frequency and intensity with which it occurs among his kinsmen. He tries to do so exhaustively by compiling the facts relative to those kinsmen in each and every degree to as great a distance of kinship as he is able, or cares, to go. He follows a similar course in respect to many other individuals belonging to as many different families, and finally he obtains average results by well-known methods. I am speaking solely of inquiries

Distribution of the Peculiarity X *in the Family of* A. B.

fa=Father or father's, according to its place; similarly, *me*=Mother; *bro*=Brother; *si*=Sister; *so* (or *son* where more euphonious)=Son. The links in the chain of kinship are to be read as leading outwards from A.B. Thus, *me da* signifies "A.B.'s mother's daughter is." *fa bro son* means "A.B.'s father's brother's son is."

Ordinary names for generalised kinships	Titles showing the precise chain of kinships	Adults alone: Total No. of sons and daus	Adults alone: Initials of those whose X deserves record	Titles showing the precise chain of kinships	Adults alone: Total No. of sons and daus	Adults alone: Initials of those whose X deserves record	Names in full of those whose initials appear in the preceding column
Grandfather Grandmother	*fa fa* *fa me*	1 1		*me fa* *me me*	1 1		
Uncles ... ... Aunts	*fa bro* *fa si*			*me bro* *me si*			
Father ... ... Mother... ...	*father* *mother*	1 1		— —	— —	— —	
Brothers ... Sisters	*brother* *sister*			— —	— —	— —	
Half-brothers Half-sisters	*fa son* *fa da*			*me son* *me da*			
Nephews ... Nieces	*bro son* *bro da*			*si son* *si da*			
First cousins Male ...	*fa bro son* *fa si son*			*me bro son* *me si son*			
First cousins Female...	*fa bro da* *fa si da*			*me bro da* *me si da*			

Maiden name of the wife	Year of marriage	Number who survived infancy: sons	Number who survived infancy: daus	Initials of those whose X deserves record

directed to what I would call the *actuarial* side of heredity, because they are analogous to those made by actuaries with medical experiences to determine the just rates of insurance in respect to expectation of life and other vital phenomena.

The ambiguity and cumbrousness of the ordinary terms of kinship are serious obstacles in carrying out these researches; it is also very difficult to present the results in a compact form by any established method. I have endeavoured to overcome both difficulties, the latter by the arrangement of the present table, and the former by the use of syllables, which give a perfectly distinctive description, and which, in addition to the advantage of brevity, have those of being easily intelligible, euphonious, even though they may be a trifle absurd, and capable of the most extended application. The details of the peculiarity X, as they appear in the several persons named in the last column of the table, are supposed to be entered in a corresponding number of paragraphs on a separate sheet. After more trials and failures than would be easily credited, I think I have at last succeeded fairly well. Still, as I began by saying, I should be very grateful for useful suggestions. The table admits of indefinite extension, with no alteration of method. It will, of course, be understood that each successive step in the line of descent introduces a new element that may seriously affect the previous influences. Much might be added, but I think that with the aid of a little reflection the arrangement of the table will explain and justify itself.

FRANCIS GALTON.

The Source of the Energy of Radium Compounds.

IF I understand Prof. Rutherford's communication aright (NATURE, January 7, p. 222), he concludes from the constancy of radio-active results with a solid radium salt and the same diluted that the energy of radium compounds cannot be derived from external sources. The matter is of such wide scientific interest that I ask your permission to present concisely the contra argument.

(1) When a coloured solid is dissolved the amount of absorption of light effected by the solid is equal to the amount of light absorbed by its solution. Thus I have shown that a plate of solid bichromate of potash 0·71 millimetre in thickness effects the same absorption of light as 6 centimetres of solution containing 0·0309 gram of the salt per cubic centimetre, as in each case the same number of bichromate molecules or molecular aggregates is acting on the light. To be perfectly clear, taking the specific gravity of bichromate of potash as 2·617, we have in the former case a rectangular bundle of rays 1 square centimetre in section passing through $0{\cdot}71 \times 0{\cdot}2617 = 0{\cdot}1858$ gram of solid, while the bundle of rays in the latter case passes through $6 \times 0{\cdot}0309 = 0{\cdot}1854$ gram of dissolved bichromate (see *Chem. News*, October 5, 1877).

(2) It has been amply demonstrated that the absorption of X-rays follows the same general laws as the absorption of light; thus the amount of both kinds of radiation absorbed increases (1) with the thickness of the body passed through, and (2) with the molecular weight in a comparable series of bodies ("The Old Light and the New," 1896, pp. 73–80).

Therefore if it be postulated that the energy of radium is due to the absorption of "an unknown external radiation" "similar in character to the radiations which are emitted," viz. the γ rays, then the mere act of dilution of a milligram of radium bromide will not affect its constancy of absorption, and therefore also will not materially influence its radio-activity.

WILLIAM ACKROYD.

Borough Laboratory, Halifax, Yorks.

γ-Rays from Radium.

FROM the letter of Prof. Rutherford in NATURE of January 7 it is improbable that γ rays from radium are Röntgen rays generated by self-bombardment. The γ rays must therefore arise from radium directly, and not as a secondary effect of bombardment.

It may be useful here to recall a remark made by Sir George Stokes at a meeting of the physical colloquium of the Owens College, Manchester, shortly before his death. Commenting on Becquerel rays, he likened the discharge of kathode rays to the discharge of a gun, the impact of kathode projectiles on a target creating an ethereal disturbance recognised as Röntgen rays. But, he said, in the same way as there is an explosive disturbance in the gun where the bullets issue, so there must also be a violent ethereal disturbance, not only where kathode rays strike, but also where they issue.

Is it not just this disturbance where β rays issue which is now being detected in γ rays, and is it not quite consistent with this view that the explosive disturbance of the atom which produces α and β rays should at the same time generate something akin to Röntgen rays?

J. R. ASHWORTH.

105 Freehold Street, Rochdale, January 16.

F.6v

Phosphorescence of Photographic Plates.

I HAVE frequently observed the phenomenon described in your correspondent's letter published in NATURE of January 14 on treating plates which had been exposed to the action of Röntgen rays, with a solution of alum.

I first noticed it in June, 1898, and the temperature of the dark room was 23°. The film being "hardened" was that on an "Ilford Special Rapid Plate," which had been subjected to a somewhat protracted development with pyrogallol; on pouring a $7\frac{1}{2}$ per cent. solution of common alum over the plate, the liquid lit up with a pale phosphorescence, not unlike that seen on stick phosphorus on a warm night, which continued for about ten seconds and then faded away.

Plates developed with ferrous oxalate also glow occasionally under similar conditions, and phosphorescence seems to take place only when the film has not been exposed to ordinary light, and when the surrounding air is exceptionally warm. JAMES F. RONCA.

Clapham, S.W., January 23.

WITH reference to the letter from Mr. T. A. Vaughton in your issue of January 14 regarding the phosphorescence of silver bromide, it is worth noticing that this is not a function of the silver haloid salt.

Whilst working here for Dr. W. J. Russell, F.R.S., I chanced to empty some spent pyro developer and a dilute solution of alum into the sink of the dark room at the same time, when the whole liquid at once glowed with a brilliant phosphorescence.

This takes place whenever a dilute aqueous solution containing pyro, a soluble sulphite, and an excess of alkali is made acid. It occurs even when the amount of pyro is very small, but it is essential that the solution be alkaline. If the pyro be mixed with sodium sulphite alone, although the latter be in sufficient quantity to ensure faint alkalinity, the solution remains colourless and does not phosphoresce; an oxidation of the pyro seems to be necessary.

Either a dilute solution of a mineral acid, of an organic acid, or of an acid salt can be used to acidify the pyro.

This phenomenon is not a new one, but so far as I am aware has never been studied. O. F. BLOCH.

The Davy Faraday Research Laboratory,
Albemarle Street, W., January 20.

M. Blondlot's *n*-Ray Experiments.

ABOUT three months ago I independently discovered that a feebly luminous phosphorescent zinc sulphide screen when brought near the body increased in brightness.

I mentioned this fact to Mr. H. A. Taylor, remarking that I believed it to be the effect of an undiscovered ray given off by the flesh; he suggested, however, that heat was the cause of the phenomenon.

Further trials showed this to be the case; by laying the back of the screen against a fluted jar filled with warm water the zinc sulphide would brighten up along the edges of the fluting and clearly indicate the pattern; on removing the screen the light would fade, showing the pattern now as dark lines against a lighter background.

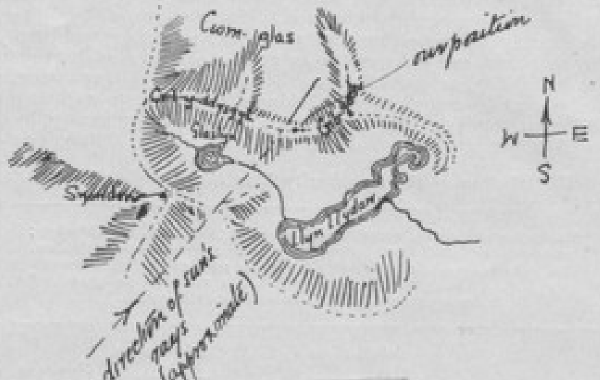
With care screens of sulphide of zinc or of calcium may be made highly sensitive to warmth, and by this means it might be possible to photograph many dark bodies simply by means of the heat rays given off, provided a suitable lens was employed. S. G. BROWN.

4 Great Winchester Street, London, E.C., January 23.

Curious Shadow Effect.

I SHOULD feel obliged, if not troubling you, if you could tell me where I could obtain information with regard to the following:—

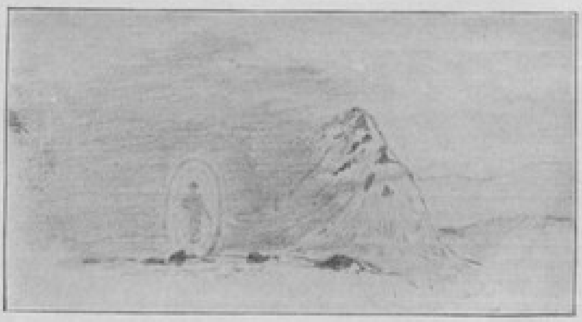
During the Christmas holiday my brother and I were in North Wales, and happened to be on the ridge that lies north of Llyn Llydaw; the sun was about 1h. from time of setting, and was low enough to clear the lower edge of the thin clouds which came from a northerly direction. The hollow (Cwm Glas) to the north of the ridge was, every now and then, filled up with thin mist on which our shadows were projected; surrounding the shadow was a faint oval-shaped rainbow, which, as the sunlight strengthened, became brighter, and a second bow outside the one nearest to the figures appeared, though very faintly. Although my companion was within a few feet of me, we each saw our *own* shadows only. We also saw, when the mist was



further from us, a shadow of the ridge itself with our two figures on it, in this case the figures appearing much smaller than in the other effect, and without any bow.

These phenomena are, I believe, not rare on this ridge, certain conditions, such as a bright low-down sun behind one, and a fairly opaque mist in front, being, of course, necessary.

The point on which I desire information is why the bows



should be of this oval form, and why they should appear at all?

The *shadow* of one's figure I can more readily understand.

The little pencil sketch enclosed may perhaps explain my description. H. M. WARNER.

44 Highbury Park, N., January 14.

Destructive Action of Rain upon Animal Life.

THE protracted and heavy rains during periods of the past year must have imposed a severe strain upon the smaller and more fragile forms of animals, such as, for instance, plant lice, mites, many of the smaller species of insects, spiders, &c. Even if adults are able to withstand the destructive effects of torrents of rain, it is difficult to understand how very immature examples, or individuals that have recently undergone ecdysis, can survive. During prolonged and heavy rain over a mixed tract of country the available shelter is relatively very small. Practically the whole surface soil becomes sodden, and, in the open at any rate, almost the whole vegetation is drenched. In some plants, as is well known, the flowers and certain areas of the leaves and other parts afford shelter, but even taking this into account, it would seem that the injury must be very great. In the county of Sussex during ordinary June or July weather the number of small creatures harbouring in such a position as, say, a patch of rank herbage near water is truly astonishing. During the last ten years I have often visited such positions in heavy rain, and I am convinced that great mortality is caused, but I have not been able to satisfy myself whether this is due to drowning, burial in the soil, the impact of falling drops, or to some other cause or combination of causes.

Over an area not subject to violent meteorological fluctuations, the fauna will assume a condition of equilibrium. Any sudden and wide departure from the mean conditions for the particular season of the year will have an immediate and profound effect. I venture to write, therefore, in the hope that someone will pay special attention to the effects of such periods of abnormal rainfall as we have had during the last few months. The subject does not appear to have received the attention it merits, and the inquiry might profitably be extended so as to cover other meteorological effects. W. RUSKIN BUTTERFIELD.

4 Stanhope Place, St. Leonards-on-Sea, January 17.

Subjective Images.

THE letter on the above subject (p. 271) reminds me of one that I sent to NATURE in 1871 (vol. iv. p. 122) describing a phenomenon complementary to that observed by Mgr. Molloy. I was induced to write it in consequence of a communication by Mr. T. Ward (NATURE, vol. iv. p. 68), who observed that the white chalk lines on a blackboard appeared to be blue when the sun was shining on his eyes; I noticed that the printing in a book looked bright red when I was walking on a chalk road, the book being shaded by an umbrella.

There appears to be a connection between the three phenomena, but I will not venture to suggest an explanation; possibly the persistence of colours may be different in different eyes. HERBERT McLEOD.

January 23.

IN response to Dr. Molloy's appeal, I may mention that a correspondent of *Work* having asked the reason for the colours in Benham's artificial spectrum top, I made, in the number for April 6, 1895, a suggestion which is practically the same as his explanation. This was that the optic nerves which according to the Young-Helmholtz theory produce the sensation of violet, are the most easily excited of the three sets, and that those producing the sensation of green, having the greatest inertia, are least easily excited and retain the impression for a longer time than the other two. In the number of the same journal for January 11, 1896, other phenomena were cited which might be explained by the same hypothesis. ALEX. THURBURN.

Keith.

IT seems probable that the effect mentioned by Dr. Gerald Molloy in your issue of January 21 is the same effect—produced in a different way—as that I spoke of in my letter published in NATURE of January 14.

In the instance he mentions we have black letters on a white marble slab, viewed by eyes in a partially dazzled state from the effect of strong sunlight. In the case to which I directed attention, these conditions are almost reproduced, viz. the blackened silver bromide on a white porcelain dish under a dazzling red light. Before the developing solution is added, the bromide under the red light appears as a grey powder in a white dish, but on adding the developing solution it is blackened, and when the liquid is poured off the change from black to bright green may be conveniently observed. The angle at which the dish is viewed seems not to be without influence on the brightness of the colour. Under the best conditions the bromide has the appearance of masses of uncut emeralds. T. A. VAUGHTON.

Ley Hill House, Sutton Coldfield, January 23.

Abysmal Deposits.

I BELIEVE there is some difficulty in accounting for the difference in the distribution of living Foraminifera at the surface of the sea and of deposits of their skeletons at the bottom. As is well known, the abysmal deposits contain no Foraminifera, while the much vaster pelagic deposits consist chiefly of them. The difference in depth has suggested that in the case of the pelagic deposits the free carbonic acid in the water has not had time to dissolve the sinking skeleton, while it has had time before a skeleton can reach the greater depths occupied by the abysmal deposits. But surely if this were the whole truth some effect would have been produced by the time the skeleton had sunk 2000 or 2500 fathoms or even less, so that it ought to be impossible to find, as we do, perfect skeletons in the globigerina ooze.

I wish to suggest a theory which is new, so far as I know, viz. that solution does occur, but does not begin until the organic matter protecting the carbonate of lime has all putrefied away. Hence the solution may be begun and ended in the excess of depth which the abysmal parts of the ocean-bed have over the pelagic parts.

H. ROBSON.

29 Hurlbutt Street, Newington Butts, S.E.

Spelling Reform.

IN your review of Dr. Joseph Bowden's "Elements of the Theory of Integers," there is included a severe condemnation of the very moderate instalment of spelling reform which the author appears to have introduced into his work. A discussion on the general question of spelling reform would, of course, not be suitable to your pages, and I therefore confine myself to making a respectful remonstrance against your reviewer's sweeping condemnation of what I conjecture to be an attempt to remedy a few of the glaring inconsistencies and anomalies of the current English spelling. Other languages have, from time to time, reformed their spelling so as to bring it more into harmony with the pronunciation, and this has been the case in our own time with German. It can scarcely be doubted that, sooner or later, the same will be the case with English. In that event the spellings you quote will certainly be adopted, with the exception of "*fixd*," which will, of course, be spelt *fixt*. T. B. S.

Edinburgh, January 15.

MAY I point out that Dr. Bowden's book purports to deal with the "Elements of the Theory of Integers," and not with questions of spelling reform? Neither on the title-page nor in the preface does the author make any claim to address his work to those members of the community who prefer to have their thoughts expressed in a written language differing from that of their fellow beings. Failing any such indication, it must be assumed that the work is intended to be read and criticised by English speaking and English writing readers of the present day, to whom the author's spelling of the words in question must appear to be grossly incorrect. I quite agree with T. B. S. that "a discussion of the general question of spelling reform," as exemplified by the modern German equivalent of *red*, would "not be suitable to your pages."

THE REVIEWER.

RESEARCHES RELATING TO RADIUM.

THE year just passed has witnessed a widespread interest among all classes of people in Mme. Curie's discovery of radium, and attention has been generally directed to the nature of the new property of matter which it exhibits to such a surprising degree. The far-reaching consequences of M. Becquerel's discovery of radio-activity for the element uranium on our ideas with regard to the relations between energy and matter, although they have been long recognised by those immediately connected with the development of the subject, are now universally admitted. The million-fold more powerful radium appeals to the practical as well as to the academic imagination, and the problems raised by the new property have been brought into universal prominence. Owing to the excellent work of Giesel in improving the methods of extracting the new element from its

f.7v

ores, and to the enterprise of the Chinin-Fabrik, of Brunswick, many during the past year have had the opportunity of satisfying themselves by experiment that the marvellous properties attributed to radium have not been exaggerated.

Considering the short time that has elapsed since the discovery, and the difficulty experienced in the past in obtaining the element, our knowledge of its properties at the present time is surprisingly complete. Attention will here be mainly directed to outstanding features which need further inquiry. In the first place, in spite of the many years of painstaking labour devoted to the determination by Mme. Curie, doubt still lingers as to the atomic weight of the new element. The case is a remarkable one, and has never arisen before in the determination of an atomic weight. On the one hand we have Mme. Curie's experimental value 225, and on the other an indirect value, 257·8, arrived at by Runge and Precht from spectroscopic data. Each of these determinations rests upon evidence which cannot be lightly set aside, and the discrepancy still remains to be explained. We have the authority of M. Demarçay for the purity of the preparations employed by Mme. Curie, for the former states that the spectroscopic trace of barium present could have had no effect on the atomic weight determination.

In ordinary circumstances the value 225 would probably be accepted as trustworthy to a unit in either direction. Runge and Precht's result, on the other hand, cannot be ascribed to chance relationships between the lines in the spectrum, possessing no real physical significance. For they succeeded in sorting the lines into related series, the lines in each series being resolved in the same way in a magnetic field. The series for radium are strictly analogous to those previously recognised in the spectra of the other alkaline-earth elements, and the connection between the atomic weight of the element and the distance apart of the lines in the series, which is the same for the different series of the same elements, holds very exactly for the cases of magnesium, calcium, barium and strontium. For radium, however, the number 257·8 is indicated. The evidence drawn from the chemical nature of radium and from the character of its spectrum agrees, however, in making the new element a member of the alkaline-earth family, and the experimental number is the only one which admits of this classification in the periodic table. The higher value, if it allows of the element being placed in the group of divalent metals at all, would make radium analogous to mercury and cadmium, so that it seems as if the experimental number should be accepted and the spectroscopic value regarded as abnormal for some unknown reason. The question is of considerable importance, and it is to be hoped that new experimental determinations will soon be available.

An explanation of the property of radio-activity was put forward by Prof. Rutherford and the writer about a year and a half ago as a result of the discovery of thorium X and of the behaviour which the thorium from which it is separated exhibits. This has since been developed and extended to afford a working hypothesis applicable to every detail of the phenomenon. The radio-elements are regarded as slowly disintegrating, a definite proportion of the total changing in the case of each element in the unit of time, the change being marked by the expulsion of rays. On account of the fact that the disintegration proceeds *per saltum* through several stages, and once started proceeds from stage to stage comparatively rapidly, the infinitesimal amounts of the transition-forms of matter can be detected and studied on account of the rays they emit in passage to the next succeeding stage. On this view thorium X, the uranium X of Crookes, the emanations of radium and thorium, and the active matter resulting from the further change of the latter, which gives rise to the phenomenon of "induced" or "excited" activity, are all transition-forms in the *per saltum* disintegration of the parent elements into more stable systems. The emanations are perhaps the most remarkable of these forms, as they are gaseous, and in consequence have been the most narrowly studied since the original discovery of the thorium emanation by Rutherford in 1899. The energy given out is, on this view, derived from the store of internal energy of the changing atom, and is, for any given mass of matter changing, enormous compared with that involved in any previously known change. It is in consequence of this fact that the excessively minute changes which produce radio-activity can be detected and investigated.

With regard to the nature of the radiations, the advances made by Rutherford in our knowledge of the nature of the α rays are among the most important. The β rays are known from the work of J. J. Thomson and Becquerel to consist of high velocity kathode rays, or negatively charged particles of mass about one-thousandth of the hydrogen atom projected with a velocity approaching that of light. The γ rays are in all probability X rays of high penetrating power which accompany the production of the β rays. Rutherford was the first to recognise that these two types are relatively unimportant, and that the α rays represent at least 99 per cent. of the total energy radiated. The analysis of the rays from a radio-element into its several parts, the greater part usually coming from the various transition-forms, which can be removed by chemical means, and only a small part from the parent element itself, has borne out this conclusion. For in the majority of cases known α rays are alone expelled in the disintegration. The discovery of the magnetic and electric deviability of the α ray of radium to an extent about one thousand times less, and in the direction opposite to that suffered by the β ray in similar circumstances, enabled Rutherford to settle the question as to their nature by showing them to consist of projected particles carrying a positive charge, about one thousand times the mass of the kathode ray particle and therefore comparable in size to the hydrogen atom, travelling with a velocity about one-tenth that of light.

This discovery has two bearings. On the one hand it confirms in a remarkable manner the view of the nature of electricity adopted by J. J. Thomson as the result of his investigations of the conduction of electricity through gases, that the negative charge can be dissociated from the atom, whereas the positive charge is always associated with a particle of atomic dimensions. On the other, it provided at once a mental picture of the precise change suffered by the atom of a radio-element, which the discovery of thorium X and the investigation of its behaviour had established. To take the case of radium as an example. The α particle expelled is an integral part of the heavy radium atom, which after disintegration forms a new and lighter atom, viz. that of the emanation. This suffers a second disintegration, expelling more α particles and changing into the matter which causes the "excited activity." Owing to the average life of the emanation atom being short—only 5·79 days—its energy is liberated so rapidly that a correspondingly small quantity can be detected. The energy manifestations from the emanation are very surprising, although it is not present in sufficient quantity to be detected by ordinary means.

An interesting feature at the present time arises from the fact that since the α rays given out by a radium compound are derived from several distinct atoms, the parent radium atom, and the successive products of its disintegration, it is to be expected, as Rutherford has pointed out, that the velocity of the α particles will vary within certain limits. Becquerel, however, states that the α radium rays in his experiments were deflected as a homogeneous pencil. Moreover, according to the same authority, they possess the remarkable property of being the more difficult to deviate for any given strength of field the greater the distance of air traversed. Both these observations seem contrary to what we should expect, and the latter especially is difficult to account for.

With regard to the "spinthariscope" effect of the α ray when it impinges on a zinc-blende screen, discovered by Crookes, it appears probable from the work of Becquerel, Tommasina and others that the scintillations are not caused, as was at first thought, by the direct impact of the individual α particle, but are due to cleavages provoked in the crystals of the blende by the bombardment, each cleavage, rather than each impact, giving rise to a flash of light.

The spontaneous heat evolution of radium to the extent of 100 gram-calories per gram of radium per hour, which was established some months ago by Curie and Laborde by direct calorimetric experiments, although it is the fact about radium which has appealed most strongly to the general imagination, hardly came as a surprise to those who were aware of the other properties of the element. Rutherford and McClung in 1901 estimated the energy radiated from a gram of uranium oxide as at least 0·03 calorie per gram per year, and it was known that this must be increased at least a million times for the case of radium. In addition, the well known chemical actions of the radium rays—the conversion of oxygen into ozone, and the decomposition of water into its elements—showed that their energy must be very considerable. The recent discovery of Rutherford and Barnes that more than 70 per cent. of the energy evolved from radium is due to the insignificant amount of emanation and the products of its further change, less than 30 per cent. being due to the element itself, follows as a direct consequence of the disintegration theory. It furnishes, it would seem, an almost unanswerable argument against the view that the energy evolved from radium is derived from an external source of unknown nature.

The view that radio-activity proceeds independently of temperature, which was originally arrived at by Becquerel by his study of the radiations of uranium, and is now generally recognised, was confirmed by M. Curie last year by some careful measurements of the rate of decay of the penetrating radiation from a sealed glass tube containing the radium emanation. He showed that the rate of the decay was not affected by variations of temperature between 450° C. and −180° C. Since it is the universal experience, not only for variations in temperature, but also for all other agents, that the rate of disintegration is constant and unaffected by molecular forces, it follows that the causes at work which produce disintegration are at present entirely unknown. It appears certain that it cannot be brought about by any agencies with which we are familiar. Sir Oliver Lodge has suggested that the unstable condition results from the incessant radiation of the internal energy of the atom, the latter being a necessary consequence of the electronic theory of atomic structure.

The discovery by Sir William Ramsay and the writer that radium is continuously producing helium in sufficient quantities to be spectroscopically recognised marks a new phase in the development of radio-activity by bringing the problem within the range of the ordinary methods of chemical investigation. From the disintegration theory it followed that the accumulation, during past ages, of the final products of the change of the radio-elements must exist in the natural minerals in which these elements are found. The existence of helium in the radio-active minerals, and its absence from those which do not contain the radio-elements, coupled with the fact that this gas forms no compounds but exists in the minerals "occluded" in a curious and unexplained way, pointed strongly to the view that it had been formed as one of the products of the change of one of the radio-elements during past ages, and mechanically imprisoned within the mineral. This led to the experiments being undertaken. The gradual growth of the helium spectrum in a sealed tube in which the radium emanation was originally condensed by liquid air and all other gases removed by the pump, excludes the view that radium may form a slowly decomposing compound with helium. The amount produced, as theory requires, is excessively minute, and its detection with the small quantity of radium available was due to the extreme delicacy of its spectrum reaction, and to the refined methods of gas manipulation developed by Ramsay in his investigation of the rare gases of the atmosphere. The suggestion that has been made that the α particle is an atom of helium has not yet been experimentally proved.

These direct confirmations of the theoretical predictions show that our knowledge of radio-activity has passed from a purely descriptive basis. The numerous unrelated and inexplicable experimental facts which have accumulated during the seven years the property has been known have during the past year been co-ordinated harmoniously as the effect of a definite and consistent cause. Radio-activity, in consequence, claims to-day to rank as an independent science. It is a property which may be best described as added on. It manifests itself without affecting or being affected by the ordinary chemical and physical nature of the matter in question, and therefore belongs to the domain neither of physics nor of chemistry. There is in consequence reason for considerable satisfaction that the theory of atomic disintegration to which radio-activity has directly led is also in the nature of an addition to, rather than a controversion of, accepted scientific doctrines. Nothing could be further from the truth than the idea that it upsets in any way the atomic theory of chemistry. On the contrary, as the bearing of the conception comes to be more clearly seen, it will probably be recognised that it provides the atomic theory with a measure of confirmation and new evidence which advances it a little further in the direction of that direct experimental proof which we are so frequently being reminded it is impossible for any theory to attain.

FREDERICK SODDY.

OBSERVATIONS OF GLACIERS AND AVALANCHES.[1]

BOTH the pamphlets mentioned below are issued by the Commission Française des Glaciers. The former mainly consists of a study of the glaciers about the head-waters of the Arc, a region which, forty years ago, had been visited only by a few Alpine climbers, who found the official maps far from accurate above the snow line; following this are notes about glaciers of the Grandes Rousses, a snowy ridge

1 "Rapport sur les Observations Glaciaires en Haute-Maurienne, dans les Grandes-Rousses et l'Oisans, dans l'été de 1902." Par M. Paul Girardin. Revue de Glaciologie. No. 2. Année 1902. Par M. Charles Rabot. Pp. 121; illustrated. (Paris: Typographie Philippe Renouard, 1903.)

"Observations sur l'Enneigement et sur les Chutes d'Avalanches, exécutées par l'Administration des Forêts dans les Departements de la Savoie. Pp. 15. (Paris: Au siège du Club Alpin Français, 1903.

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between the Maurienne and Dauphiné. In the former region the glaciers are not large, though fairly continuous along the western side of the watershed between France and Italy; the highest peaks just exceeding 12,000 feet, and the passes between them being about 10,000 feet. M. Girardin in his remarks directs attention to a point not always sufficiently remembered, that the size of a glacier depends even more upon the form of its birthplace than the altitude. Of this, Dauphiné, rather to the south of the region noticed by him, affords an excellent example. The western end of the horseshoe of its higher peaks is formed by the Mont de Lans, a tabular mountain mass, which, though mostly well under 11,000 feet high, is clothed with a sheet of névé, terminating in glaciers, more extensive than those of the adjoining Râteau and Meije, which rise some 2000 feet higher. It is incidentally mentioned, and this fact is important, that the climate of Lanslebourg is much wetter than that of Modane, the dominant wind at the latter being W. or N.W., at the former E. or S.E., bringing vapour from the plain of the Po. As the district is so little known, we content ourselves with giving M. Girardin's general conclusions. They are:—(1) the glaciers of this region, after a rapid retreat (since 1860 approximately), have during the last few years either moved back very slowly or even halted; (2) this retreat has changed many of them from valley glaciers to plateau glaciers; (3) sometimes the glacier has gone back as a whole, sometimes it has melted away from the sunny side of a valley, thus changing the form of its terminal boundary, a matter to be remembered in speaking of the "retreat" of a glacier.

This report is followed by the *Revue de Glaciologie*, No. 2, giving a summary of observations about the increase or decrease of glaciers in many parts of the world, made or published in 1902, with occasional mention of earlier changes, and some interesting notes on the level of the snow-line. Evidently, though locally the retreat has been arrested or even changed into an advance, a period of growth has not yet really begun.

The second pamphlet largely consists of tables giving the snowfall and avalanches in parts of the French Alps during the winter of 1899–1900 and the two following years. These will ultimately be very valuable, but at present hardly suffice for drawing inferences. We may, however, mention that in the first period the snowfall in Savoy ranged from 85 mm. at Thonon to 1600 mm. at Sixt. The largest amount recorded is on the Col de Fréjus, in the Maurienne (almost above the great tunnel), the differences probably depending mostly on altitude but to some extent on geographical position. In that year the largest downfall in an hour was 68.6 mm., on this pass and its neighbourhood. The statistics of avalanches are for 1900–1, and for the following season. March is the worst month, then February and April. The falls were much more numerous and mischievous in the second year, during which fifty-six persons were overwhelmed by them, of whom eight perished, as against three in the former year.

JOHN SAMUEL BUDGETT.

BRITISH zoology in general, and the Cambridge School of Zoology in particular, has received a heavy blow in the tragic and untimely death of Mr. J. S. Budgett. It is only a few weeks since the readers of NATURE were informed of the brilliant success attending Mr. Budgett's researches during his last expedition, and zoologists—not of this country alone—were looking forward with the greatest interest to the publication of his full results. It was not to be. On Saturday, January 9, after his usual day's work in the laboratory at Cambridge, he fell ill with blackwater fever, and after a few days' illness he passed away on the morning of January 19, the very day on which he was to have read to the Zoological Society his account of the general results of his last expedition.

Mr. Budgett was born near Bristol thirty-one years ago, and here, at his home, Stoke Bishop, the earlier years of his life were passed. In his father's house Budgett had the great advantage of meeting as friends such men as Dr. W. H. Dallinger and the late Prof. W. K. Parker, and from them he received much inspiration and encouragement. He was particularly influenced by Parker. He possessed copies of Parker's monographs, and he set himself a task which few indeed would have attempted without an elaborate university training, the task of working over the development of the skull in a series of vertebrate types. By the exercise of limitless patience and admirable technical skill—he even designed a perfectly original and remarkably successful mechanical microtome for the cutting of serial sections—he produced a series of beautiful models of developing crania.

Mr. Budgett commenced his academic studies at University College, Bristol, under Lloyd Morgan and Reynolds, and thence passed on to Cambridge and entered Trinity College in 1894. There he went through the routine course of study for the natural sciences tripos—interfered with to some extent, from the point of view of mere academic success, by his accompanying Prof. Graham Kerr on an expedition to South America during 1896–7. On this expedition Budgett devoted himself to gaining a general acquaintance with the neotropical fauna, and also to broadening his knowledge of general morphology by carrying out dissections and making microscopic preparations of many of the more important animals. In addition to this he applied himself especially to the study of the Amphibia, amassing a large amount of information as well as valuable collections of developmental and other material. This material received preliminary treatment in a paper in the *Quarterly Journal of Microscopical Science*, but Budgett intended to work it up later in a comparative paper along with the material collected under similar physical conditions in West Africa.

On this first expedition Budgett's splendid qualities shone out conspicuously—his personal courage, his fortitude and cheerfulness under physical discomfort and suffering, and his absolute loyalty.

Already during his stay in South America Budgett had practically decided to take up the problem of the development of Polypterus, and immediately after graduating at Cambridge he set out with this object in view to the Gambia. Here he spent the greater part of a year in the first instance, returning again for a few months during 1900. During these expeditions Mr. Budgett did not manage to obtain the main object of his quest, but he did succeed in obtaining and preserving with the faultless technique so characteristic of him a mass of most valuable material. The hand of Death has intervened before time had been given for more than preliminary work on this material, but even this preliminary work contains results of much importance to vertebrate zoology—in particular a complete and accurate account of the genito-urinary organs of Polypterus, the demonstration that the crossopterygian fin is really a uniserial archipterygium, and finally a most valuable series of observations on the breeding habits and developmental features of Protopterus and of several interesting teleostean fishes.

Budgett still stuck pertinaciously to the main problem. Having been elected Balfour student, he

R. CLAY AND SONS, LTD., BREAD ST. HILL, E.C., AND BUNGAY, SUFFOLK.

started off again in June, 1902, this time to East Africa in the hope of there finding a locality with physical conditions more favourable to the prosecution of his research. Finding, however, that conditions were less rather than more favourable, Mr. Budgett returned down the Nile to England. In June, 1903, he started again for West Africa, and took up his quarters at a point in the Niger delta where he knew Polypterus to be abundant. Here at last he succeeded, by means of artificial fertilisation, in obtaining a fine series of the long wished for eggs and larvæ. He returned to England and settled down to work out his material in the laboratory of his friend and teacher, Mr. Adam Sedgwick, and there he was at work on that fateful Saturday when there came to him the first premonition of impending illness.

Budgett's personality had a peculiar charm. Unassuming, modest to a fault, his diffidence at times brought him moods of severe depression. Latterly, however, he had been cheered and encouraged by the appreciation of his work by those to whom he most looked up.

He was a zoologist of the best type. He was a keen and accomplished observer in the field, and always recognised to the full that the first and main interest in an animal lies in the fact that it is an organism which *lives*. But in addition he was a most accomplished laboratory investigator. With great interest in laboratory technique he combined tireless patience in research and almost fastidious accuracy. His artistic powers were shown in the charming sketches which he brought back from his various expeditions, and they are again apparent in the beautiful preparations with which he enriched the museum at Cambridge.

He has gone, but he has left behind an enduring memorial in the work he has done and in the affectionate memories which will be treasured by his many friends.

NOTES.

LORD RAYLEIGH has been created a foreign Knight of the Prussian Order Pour le Mérite for sciences and arts by the German Emperor.

THE remains of James Smithson, the Englishman who founded the Smithsonian Institution in Washington, reached New York on January 20, having been conveyed from Genoa in the *Prinzessin Irene*. The United States despatch-boat *Dolphin* awaited the arrival of the vessel in order to act as an escort of honour from the lower bay to the city. Smithson's remains were taken to Washington in the *Dolphin*; and on January 25 the transfer of the coffin, draped with the American and British flags, was witnessed by Sir Mortimer Durand, the British Ambassador, Mr. Loomis, Acting Secretary of State, and a number of members of the Senate and House of Representatives. Escorted by a troop of cavalry and a marine band, the remains were conveyed to the Smithsonian Institution, where a suitable tomb will be erected.

PROF. WEISMANN's seventieth birthday was celebrated in Freiburg on January 17, when a large and representative gathering assembled to do him honour. A bust by Kowazik, of Frankfort, had been subscribed for by biologists in various parts of the world, and was presented in the name of the subscribers by Prof. H. E. Ziegler, of Jena; it is to be placed in the zoological institute of the university. A special number of the *Zoologische Jahrbücher*, containing papers by various naturalists, was presented by Prof. Spengel, of Giessen, and from the Grand Duke of Baden Prof. Weismann received the highest order conferable, that of the Cross and Star of Bertold I. To all interested in the advance of biological science, and more especially to those who know him also as a man of wide culture and high ideals, it will be a satisfaction to learn that Weismann retains unabated his freshness, vigour, and untiring energy.

THE President of the Board of Trade has appointed a committee to inquire and report as to the statutory requirements relating to the illuminating power and purity of gas supplied by the metropolitan gas companies, and as to the methods now adopted for testing the same, and whether any alteration is desirable in such requirements or methods, and, if so, whether any consequential alteration should be made in the standard price of gas. The members of the committee are:—Lord Rayleigh, F.R.S. (chairman), Sir William de W. Abney, K.C.B., F.R.S., Dr. Robert Farquharson, M.P., Mr. William King, and Mr. J. Fletcher Moulton, M.P. Mr. Herbert C. Honey, of the Board of Trade, has been appointed secretary to the committee.

WE regret to announce that the Rev. Dr. Salmon, F.R.S., Provost of Trinity College, Dublin, since 1888, died on Friday last at eighty-four years of age.

MR. F. E. BEDDARD, F.R.S., has been elected a corresponding member of the Königliche Böhmische Gesellschaft de. Wissenschaften.

A REUTER message from New York on January 22 states that the University of California has been informed of the discovery of remarkably fine remains of an ichthyosaurus in Chile.

A DESPATCH from Buenos Ayres announces that the *Français*, with Dr. Charcot's Antarctic Expedition on board, reached Ushuaia, Patagonia, on January 15, and left for the south after coaling.

DR. LORENZO CAMERANO, of the Royal Zoological Museum, Turin, Dr. Fritz Sarasin, and Dr. Paul B. Sarasin, of Basel, have been elected foreign members of the Zoological Society of London.

A PREHISTORIC Society of France has just been founded at Paris with the object of studying questions of palæoethnology. The president for 1904 is M. Émile Rivière, and the monthly meetings are held at 93 Boulevard Saint-Germain.

MR. W. SAVILLE-KENT has been engaged to investigate and advise towards the further development of the pearl, shell and other fisheries pertaining to certain Polynesian Island properties, and will leave England in a few weeks' time to take up his new appointment.

THE death is announced of Prof. Georg Wagner, professor of chemistry in the polytechnic at Warsaw, aged fifty-four.

THE Guy medal of the Royal Statistical Society has been presented to M. Yves Guyot for his paper on "The Sugar Industry on the Continent."

THE St. Petersburg Physico-Chemical Society has projected a new Arctic expedition to be undertaken for the following objects:—observations of solar radiation and atmospheric refraction, of cloud movements, and of atmospheric electricity in connection with the extinction of ultraviolet light; determination of the phenomena of terrestrial magnetism and of electric currents in the ocean; chemical analyses of the composition of the air and water; and examinations of the polar ice.

WE regret to see the announcement of the death of Dr. William Francis, which occurred early last week. Dr. Francis was in his eighty-seventh year, and had been in failing health but a short time. He was almost the oldest, if not the oldest, fellow of the Chemical Society, and was joint editor of the *Annals and Magazine of Natural History* and of the *Philosophical Magazine*. In the latter capacities he came in contact with most of the eminent scientific men of the nineteenth century.

To commemorate the twenty-fifth anniversary of the introduction and commercial development of the incandescent lamp, the friends and associates of Mr. Thomas A. Edison have taken steps to found a medal which will be entrusted to the American Institute of Electrical Engineers. It is proposed to present the medal fund at the annual dinner of the institute on February 11, which is Mr. Edison's birthday.

IT is reported from St. Petersburg that on January 16 Dr. Turtchinowitch, director of the laboratory for the preparation of plague remedies at the Imperial Institute of Experimental Medicine, was taken ill after having been engaged in experimenting with bubonic plague cultures, and died of plague on January 20. It has been established that two assistant physicians who were working with Dr. Turtchinowitch have also acquired the disease.

ON Thursday next, February 4, Mr. A. D. Hall will deliver the first of three lectures at the Royal Institution on "Recent Research in Agriculture." On Saturday, February 6, Mr. C. Waldstein will lecture on "The Study of Style in Greek Sculpture," and on February 13 his subject will be "Culture and Sculpture." On Saturday, February 20, Lord Rayleigh will begin his course of six lectures on "The Life and Work of Stokes." The Friday evening discourse on February 19 will be delivered by Mr. C. T. R. Wilson on "Condensation Nuclei."

THE Tanganyika Committee (Prof. Ray Lankester, Sir John Kirk, Sir W. Thiselton-Dyer, Mr. Boulenger, and Dr. Sclater) has determined to send out another naturalist for the further investigation of the "Tanganyika problem," and has selected Mr. W. A. Cunnington, of Christ's College, Cambridge, for this purpose. Mr. Cunnington will leave for Tanganyika (*viâ* Chinde and Zomba) in March, and will pay special attention to the lacustrine flora of the lake, of which, as yet, little is known, but will not neglect other subjects relating to the lake-basin.

A SCIENTIFIC expedition for the exploration of northern Nigeria, conducted by Lieut. Boyd Alexander and Captain G. B. Gosling, of the Rifle Brigade, is in preparation, and will shortly leave England. Lieut. Claud Alexander, who holds the diploma of the Royal Geographical Society, will act as surveyor and map-maker. The party will proceed up the Niger and Benué, and establish a station somewhere in the central hill-country of northern Nigeria, where collections of natural history will be made, and the surrounding country explored and mapped. Lieut. Boyd Alexander, who has already had much experience in African travel on the Zambezi, in the Gold Coast Colony, and in Fernando Po, is a thoroughly competent man, and has obtained the sanction of the War Office to his expedition.

WE regret to see announced the death of Mr. Walter G. Doggett, the naturalist of the Anglo-German Boundary Commission under Major Delmé Radcliffe, who has lost his life while crossing the Kagera River in Uganda. Mr. Doggett, who was the son of a well-known taxidermist at Cambridge, served on Sir Harry Johnston's staff as naturalist and photographer both in Nyasaland and in Uganda, and will be found frequently mentioned in Sir Harry's work on the latter country. Doggett made the ascent of Ruwenzori in the Special Commissioner's company, and amongst many other objects, obtained there specimens of a remarkable new bramble which has been named after him *Rubus Doggetti*. He was the first person to discover the existence of the shoebill (*Balaeniceps rex*) on the shores of Lake Victoria.

IT appears from a telegram dated Yakutsk, January 15, and communicated to the Russian Press, that on that date the boatswain Byegacheff, one of the members of Lieut. Kolchak's Expedition which was sent out in search of Baron Toll, returned to Yakutsk. The expedition did not find the Arctic traveller either in the New Siberia Islands or in Bennett Land. It only found in the latter place some papers left by Baron Toll stating that he was leaving Bennett Land on November 8, 1902, and going southwards. He consequently expected to reach the mainland of Siberia somewhere near Nizhne-Kolymsk, but as nothing was heard of Baron Toll during last summer, one cannot but entertain the gravest apprehensions as to his position. Lieut. Kolchak is expected soon to reach Yakutsk, as well as the other search party under Brusneff, so that we shall probably have more detailed news in a few days.

THE Royal Society catalogue of scientific papers from 1884 to 1900, completing the century, is making progress. It appears that 111,000 titles have already been prepared by the referees in the various subjects, while 68 serials containing more than 91,000 titles have been completely dealt with for both the authors' catalogue and the subject index. It is part of the scheme to make a single subject index for the whole of the nineteenth century; nearly 82,000 of the 400,000 papers dealt with in the existing catalogue have now been classified for this index. The index will be in seventeen sections, published separately, each section containing, in one or more octavo volumes, a single science indexed according to the schedules of the international catalogue; when published, these volumes cannot fail to be of great use to workers in science. The committee of the Royal Society is making strenuous efforts to expedite the work. Its chief difficulty has been in obtaining a sufficient staff of experts, and attention is invited to its advertisement asking for additional helpers.

THE annual general meeting of the Iron and Steel Institute will be held on Thursday and Friday, May 5 and 6. The council will shortly proceed to award Carnegie research scholarships, and candidates must apply before February 29. The awards will be announced at the general meeting. In accordance with previous announcements, the autumn meeting will take place in New York on October 24–26. After the meeting there will be an excursion to Philadelphia, Washington, Pittsburg, Cleveland, Niagara Falls, and Buffalo, returning to New York on November 10. An influential committee has been formed in the United States for the reception of the institute, Mr. Charles Kirchhoff being the president and Mr. Theodore Dwight the hon. secretary.

As the result of a meeting held in London several months ago, a society has been formed for the promotion of scientific studies in sociology. It is hoped that when the Sociological Society becomes adequately organised it will materially help to fill a serious gap in the cultural apparatus for national education and research. One of the founders of the society has given 1000*l*. towards the endowment of sociological teaching in London University. With that exception there is at present no provision in British universities for studies specifically sociological. This country is also alone among leading nations in having neither a journal of sociological studies nor a special library of sociological literature. In addition to directing attention to these national deficiencies, the Sociological Society is making particular efforts to organise a reference library of sociology and to establish a journal of sociology. Particulars referring to the society's origin, purpose and programme may be obtained by application to the secretary, 5 Old Queen Street, Westminster, S.W.

EARLY in September, 1900, Galveston was devastated by a storm and a great wave which overwhelmed the bank on which the city is built. To prevent the recurrence of this disaster, the whole city—buildings, streets, boulevards, parks, theatres, residences and quays—in fact, everything now resting on the present ground level, are, says *Transport*, to be lifted up 17 feet in the air, and the space between the old and the new levels will be filled in, so that the city will be actually that number of feet higher than it is at present. The cost of this undertaking is estimated to be some three and a half million dollars, and the contract for lifting the city has been awarded to Messrs. Goedhart Brothers, of New York City, in cooperation with Mr. Lindon W. Bates, the engineer who devised the scheme for making Galveston flood-proof.

THE Autocopyist Company has sent us one of its "Black Boxes." This is really a form of small portable changing bag, and should be found useful to every photographer, whether amateur or professional, whilst travelling. The term "box" is rather a misnomer, for it is really not a box at all. The black cloth, forming the dark space, is very ingeniously made to fold up or out by means of two sets of wire frames after the principle of an umbrella, the lower portion having a larger circumference than the upper; when expanded the whole arrangement is placed on a bench or table and is ready for use. There are two sleeves for the insertion of the arms and one for the head, all of which have elastic extremities to fit tight to keep out the light. There is also a small window covered with red cloth, and a separate celluloid red sheet to place over this window. Altogether this portable dark room looks as if it would prove very serviceable, for it is well made, light, and closes up into a small compass.

THE Deutsche Seewarte (Hamburg) has recently made an addition to its useful contributions to maritime meteorology by the publication of a quarterly pilot chart for the North Sea and Baltic. The first issue is for the present winter, and every available space is occupied by valuable information for navigators and others. The mean frequency of wind direction for various parts of the different coasts is shown by wind-stars giving percentages of the observations by lines radiating from a central circle in which is shown the number of calms; the percentage of wind direction for any point of the compass can be easily measured from a given scale. The mean tracks of storms are laid down in the usual way, together with the average minima of barometric pressure. Three subsidiary charts show (1) the mean isobars and prevalent wind direction; (2) the average air temperature; (3) the mean temperature of the sea surface and average prevalence of fog. The reverse side of the chart is occupied by a series of maps showing the tidal currents on the coasts of the British Islands and north-west Europe for each hour following the flood and ebb tides at Dover. In addition to the data exhibited by the charts, the text contains much useful information relating to the prevalence of storms, ice and other matters.

THE Meteorological Office Atlantic pilot chart for February contains an interesting article by Dr. Shaw on "Buys Ballot's Law and Trajectories of Air." Several diagrams are given representing the air movements during the passage across our islands of two cyclonic systems, that of November 12–13, 1901, moving at the rate of 15 miles an hour, attended by hard gales and heavy rain, and that of March 24–25, 1902, moving at the rate of 25 miles an hour, attended by strong winds and gales and but little rain. The circumstances in the two cases differ also in the general disposition of atmospheric pressure and the behaviour of the barometer in the surrounding regions. There is, consequently, a wide divergence in the air trajectories of the two systems. From a consideration of the facts presented we are "led to associate changes of surface velocity with exchange of air between the surface and the upper regions, unless they can be accounted for by alterations of area. Exchanges between the surface and the upper air are connected with temperature change and generally also with rainfall, and thus the vicissitudes of the air along its trajectories may have a very close connection with the special character of the weather changes associated with the passage of depressions." To the mariner the questions raised are of more than passing interest, for the article touches upon the question of ascending and descending air currents, which can be established or verified by the effects produced upon meteorological instruments or upon the surface of the sea. Every sailor has observed how the wind in some storms beats down the sea, while in others it raises a tumultuous sea. There is reason to suppose that in the former case the wind is a descending current, in the latter an ascending current. It is to be hoped that officers will supply careful notes on these different characteristics of wind and sea, as the subject is one of great importance from a meteorological point of view, and up to the present has not been investigated.

AN interesting paper on a familiar subject, the relation of temperature to the keeping property of milk, has reached us from Storrs, Connecticut. The view of the writer, Mr. H. W. Conn, the well-known dairy bacteriologist, is that the keeping of milk is more a matter of temperature than of cleanliness. He points out that at 50° F. milk may not curdle for two weeks, whereas at 70° F. it may keep but forty-eight hours, and at 95° F. but eighteen hours. This curdling is due to the action of bacteria, and the effect of temperature on their multiplication is surprising. Thus at 50° the ordinary milk organisms increase about 5-fold in twenty-four hours, but at 70° they may multiply 750-fold in the same time. The optimum temperature for different species varies considerably. At 70° the ordinary *B. lactis acidi* develops rapidly, while at 95° the undesirable lactic ferment *B. lactis aerogenes* develops quickly and the ordinary form does not. At 50° neither of the lactic ferments makes much growth, but putrefactive bacteria develop, and though these may not make the milk sour, they make it unwholesome. Milk which has been kept sweet by exposure to low temperatures should be viewed with suspicion.

THE fourth report of the Royal Commission on Sewage Disposal, which has just been published, deals with the pollution of tidal waters, with special reference to contamination of shell-fish. The Commissioners state that they are satisfied that a considerable number of cases of enteric fever and other illness are caused by the consumption of shell-fish which have been exposed to sewage contamination. Of the remedies suggested, the opinion is expressed that no general enactment as to the treatment of sewage before its discharge into tidal waters or as to the seizure of unwholesome food would meet the necessities of the case, but that the remedy must be sought in connection with the waters, foreshores, pits, ponds, and layings themselves. It is considered that the only way in which the evil can be effectively dealt with is by placing tidal waters under the jurisdiction of some competent authority, and conferring on that authority power to prevent the taking of shell-fish for human consumption from any position in which they are liable to risk of dangerous contamination, and to enforce restrictions as regards pollution and as regards the waters, beds, &c., in which shell-fish are fattened or stored. At the end of the report several pages are devoted to a consideration of the bacteriological methods employed in the examination of shell-fish. It is stated that Dr. Houston, the bacteriologist to the Commission, has examined more than 1000 oysters, some taken from the purest waters in the country, and has found that nearly all, from whatever laying, contain the *Bacillus coli*. Doubt is therefore raised as to the value that may attach to the *B. coli* test, and it is considered that further research is necessary in order to establish a bacteriological standard of purity.

IN the December issue of the *Proceedings* of the American Academy (vol. xxxix., No. 10) Mr. F. C. Carlton records the results of experiments with regard to the cause and nature of the periodical colour-change in the skin of the Florida chamæleon-iguana (*Anolis carolinensis*). The extreme variations in the colour of this lizard are dark brown and pea-green, the former (in captive specimens at any rate) assumed in daylight and the latter at night. The brown condition is produced by the migration of pigment-granules from the centre to the terminal branches and processes of the "melanophores," the green stage, which is one of rest, being the result of the withdrawal of the same granules to the centre of the latter bodies. In three fundamental points the colour-change differs from that of the true chamæleons.

THE November (1903) issue of the *American Naturalist* contains the second of the series of articles on the adaptations of mammals to particular modes of life, the present section, by Mr. L. I. Dublin, dealing with arboreal types. With the exception of the Monotremata, all the terrestrial orders have arboreal representatives, the number of such forms being greatest in the Chiroptera (where all adopt this mode of life) and Primates, and least in the Ungulata, where there are only the tree-hyraces. Arboreal mammals may be divided into two main groups, in the first of which terrestrial progression is retained in a greater or less degree, while in the second it is wholly lost. Among the modifications for this kind of life, in addition to those of the feet and tail, the author specially notices the frequent increase of the number of the vertebræ, and the development of dermal spines and scales, as in the Anomaluridæ and Gymnura, which aid in climbing. The inclusion of the latter genus among arboreal mammals appears to indicate some new information in the possession of the author.

THE *Journal* of the Royal Statistical Society for December 31, 1903, contains an important paper on the metric system by Mr. Alexander Siemens, together with a report of the discussion. It is illustrated by tables showing the trade of metrical and non-metrical countries for the year 1900, that year marking a culminating point in most countries. Mr. Siemens puts forward powerful arguments in favour of adopting the metric system, and concludes by saying that "it is quite certain that the action of Great Britain in this matter would immediately be followed by Greater Britain, the United States, and Russia, so that international unity of weights and measures would become an accomplished fact for which James Watt started his agitation 120 years ago."

WE have received the "Naturalist's Directory" for 1904–5 from Mr. L. Upcott Gill, by whom the annual is published. It gives the names and addresses of naturalists, natural history agents, societies, field clubs and museums of the British Isles, and the information has been corrected to the present date.

DR. A. LAWRENCE ROTCH writes to correct the following mistakes made by him in his letter on "The Unusual Sky Colours and the Atmospheric Circulation," published in NATURE of December 24, 1903 (p. 173). In the first paragraph, line twenty-four, for "southern" read "northern," and in the second paragraph, line eight, for "unlike" read "like."

THE new edition of Hazell's "Annual"—that for 1904—is the nineteenth issue of this valuable book of reference. As usual, the alphabetical arrangement is adopted, but this year many of the separate entries of former years have been collected in the form of more complete articles. Thus the information given respecting scientific societies and the advances made in various branches of scientific knowledge during 1903 is brought together in a convenient manner in some thirteen successive pages. A complete index much assists reference to the large amount of statistical and other information given in the volume.

THE Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne, held a conversazione on January 19 at the Hancock Museum, Newcastle-upon-Tyne. Experimental and lantern demonstrations in a variety of subjects were given during the evening. These and the exhibitions included:—the inactive atmospheric gases; their spectra and some of the apparatus used in determining their physical properties, by Sir William Ramsay; objects illustrating certain properties of the emanations of radium, by Sir William Crookes; the bactericidal emanations from radium, by Mr. Henry Crookes; models of turbine machinery from the Parsons' Marine Steam Turbine Co., Ltd., and many others. The meeting was an excellent indication of the interest in scientific research which exists in this northern district.

IN the *Sitzungsberichte* of the Vienna Academy of Sciences Dr. Langstein gives an account of his researches on the carbohydrates of serum-globulin. The experiments establish the fact that *d*-glucose is one of the primary decomposition products of blood-globulin, and the existence of a close relationship between albumen and glycogen is shown. Reference is made to the possible connection between the observed facts and the abnormal physiological processes taking place in cases of diabetes.

IN a paper entitled "An Enquiry into the Working of Various Water-softeners," read before the Institution of Mechanical Engineers on December 18, 1903, Messrs. Stromeyer and Baron describe and illustrate by means of diagrams seventeen continuous water-softeners. Analyses of the unsoftened and softened waters are given which permit of a fair comparison being made as to the suitability of the various types for special purposes. Of the seventeen softeners, fourteen are fitted with filters, two of them having sand filters, and the others woodwool, or sponge filters.

WE have received vol. ii. of the *Transactions* of the North Staffordshire Ceramic Society. The Society has a membership of thirty, and seven papers have been read before the members during the session. Of special interest is a paper by Messrs. Hopwood and Jackson on the nature and origin of the abnormal red, blue and black colorations of fire-clay ware. The red colorations are found to be due to the conversion of the iron in the clay substance into free ferric oxide, the black principally to free carbon, whilst the external vitreous blue films of blue-fired clay-wares are found to consist of a basic ferrous silicate.

THE much debated question regarding the dual nature of chromium solutions as manifested in the green and violet colour is again discussed by Messrs. Richards and Bonnet in a recent number of the *Proceedings* of the American Academy. The authors' experiments and previous observations seem to be most easily explainable on the assumption that the violet solutions of, say, chromium sulphate contain the salt in a state comparable to that of other normal salts, whilst the green solutions are due to hydrolysis resulting in the production of free acid and one or more complex basic salts.

IN the quarterly statement of the Palestine Exploration Fund Mr. W. Ackroyd discusses the cause of the saltness of the Dead Sea. Facts are brought forward which seem to indicate that the saltness cannot be entirely due to accumulation of chlorides derived from the Palestine rocks by solvent denudation or the cutting off of an arm of the Red Sea by the rising of Palestine in past ages followed by evaporation of the solution. The author brings evidence forward in favour of a third cause, which is perhaps more important than either, viz. the atmospheric transportation of salt from the Mediterranean.

A THIRD revised edition of part ii. of "Machine Design," by Prof. Forrest R. Jones, of Cornell University, has been published in this country by Messrs. Chapman and Hall. This part of the work deals with the form, strength, and proportions of parts, and the new issue has been increased by about eighty pages of new matter.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mrs. Hughes; a White-collared Mangabey (*Cercocebus collaris*) from West Africa, presented by Mr. H. Ion; a Chacma Baboon (*Papio porcarius*) from South Africa, presented by Mr. James Adams; a Levaillant's Cynictis (*Cynictis penicillata*) from South Africa, presented by Lady Constance Ryder; a Spotted Ichneumon (*Herpestes nigropunctatus*) from Nepal, presented by Mr. S. D. Pritchard; two Herring Gulls (*Larus argentatus*), European, presented by Mr. F. H. Haines; a Barn Owl (*Strix flammea*), British, presented by Master C. Fox; a — Sheep (*Ovis* sp. inc) from Baluchistan, two Waxwings (*Ampelis garrulus*), European; a Grey Squirrel (*Sciurus cinereus*) from North America, a Brazilian Tortoise (*Testudo tabulata*) from South America, two Ceylonese Terrapins (*Nicoria trijuga*) from India, two Derbian Sternotheres (*Sternothoerus derbianus*) from West Africa, deposited; a Humboldt's Lagothrix (*Lagothrix humboldti*), a Red-faced Ouakari (*Ouacaria rubicunda*) from the Upper Amazons, purchased.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN FEBRUARY:—

Feb. 1. 12h. Saturn in conjunction with the sun.
4. 8h. 41m. Minimum of Algol (β Persei).
7. 5h. 30m. ,, ,, ,,
8. 6h. 17m. Transit (ingress) of Jupiter's Sat. IV. (Callisto).
9. 15h. Ceres in conjunction with moon. Ceres 0° 8′ N.
,, 21h. Mercury at greatest elongation. 25° 52′ W.
12. 16h. Venus in conjunction with moon. ♀ 4° 8′ S.
14. Venus. Illuminated portion of disc = 0·797.
24. 5h. 57m. to 7h. 15m. Moon occults α Tauri (Aldebaran, Mag. 1·1).
25. 17h. Mercury in conjunction with Saturn. Mercury 0° 49′ S.
,, 17h. Mars in conjunction with Jupiter. Mars 0° 30′ N.
27. 7h. 13m. Minimum of Algol (β Persei).
29. 8h. 53m. to 9h. 46m. Moon occults o Leonis (mag. 3·8).

VARIABILITY OF THE MINOR PLANET IRIS.—A telegram from Prof. Pickering, through the Kiel Centralstelle, announces that Prof. Wendell has discovered a periodic variability in the brightness of the minor planet (7) Iris. The period of the changes is six hours, and the range of variability about one-quarter of a magnitude.

HARVARD MERIDIAN PHOTOMETER OBSERVATIONS.—Part i. vol. xlvi. of the Harvard College Observatory *Annals* contains the tabulated results of the meridian photometer observations made by Prof. Solon. I. Bailey at Arequipa and Cambridge (Mass.) during the years 1899–1902. Chapter i. contains the reduced observations of some 4500 stars situated south of −30° declination made at the southern station during 1899, the stars observed being generally selected from the Argentine General and Cordoba Zone Catalogues.

One of the chapters contains the results of a series of observations made at Cambridge (1900–1902) in order to produce a catalogue of standard stellar magnitudes for regions regularly distributed throughout the sky. To this end the sky was divided into 432 regions, each approximately 10° square, and one star of about the fifth magnitude was photometrically observed in each region, care being taken to select, wherever possible, a star having a first-type spectrum. All the stars were compared with λ Ursæ Minoris and other standard comparison stars, and on reducing the observations it was soon apparent that the results obtained from λ were systematically different from those obtained from the other stars. This difference indicates an increase of two-tenths of a magnitude in the brightness of λ Ursæ Minoris, which may either be due to a personal equation depending on the colour or to a real variation in the star.

LIGHT CHANGES OF ϵ AURIGÆ.—In Nos. 3918, 3919 and 3920 of the *Astronomische Nachrichten* Herr H. Ludendorff publishes the results of an exhaustive research as to the most probable data for the light variation of ϵ Aurigæ.

He first gives and discusses the observational results of Argelander, Heis, Schwab, Plassman, and thirteen other observers, and then, applying suitable weights to the various results, obtains a mean result by the method of least squares. The resulting elements obtained from this analysis are

$$T = 2415476 \text{ days} = \text{April } 1, 1901,$$
$$t = 207\text{d}. \quad t_m = 313\text{d}.,$$
$$T = 2415840 = \text{March } 31, 1902,$$

where T = the epoch at which the light commences to decrease from its normal magnitude, t = the time taken for the complete decrease to minimum or the corresponding increase to maximum, t_s = the duration of the constant minimum, and T_s = the epoch of the mean minimum.

Summarising the results the author finds that the star has a normal magnitude of 3·35, decreases 0·73 mag. in 207 days, remains at constant minimum for 313 days, and then returns to the normal magnitude again in 207 days. After these changes it remains constant for 25·13 years. Thus the complete period for this star becomes 27·12 years, or 9905 days, of which only 1·99 years are occupied by the actual variation.

f. 13r

f. 13v

SCIENTIFIC INVESTIGATION AND PROGRESS.[1]

AT the weekly services of many of our churches it is customary to begin with the reading of a verse or two from the Scriptures for the purpose, I suppose, of putting the congregations in the proper state of mind for the exercises which are to follow. It seems to me we may profit by this example, and accordingly I ask your attention to Article i. of the Constitution of the American Association for the Advancement of Science, which reads thus:—"The objects of the association are, by periodical and migratory meetings, to promote intercourse between those who are cultivating science in different parts of America, to give stronger and more general impulse and more systematic direction to scientific research, and to procure for the labours of scientific men increased facilities and a wider usefulness."

The first object mentioned, you will observe, is "to promote intercourse between those who are cultivating science in different parts of America"; the second is "to give a stronger and more general impulse and more systematic direction to scientific research"; and the third is "to procure for the labours of scientific men increased facilities and a wider usefulness." Those who are familiar with the history of the association are well aware that it has served its purposes admirably, and I am inclined to think that those who have been in the habit of attending the meetings will agree that the object which appeals to them most strongly is the promotion of intercourse between those who are cultivating science. Given this intercourse and the other objects will be reached as a necessary consequence, for the intercourse stimulates thought, and thought leads to work, and work leads to wider usefulness.

While in 1848, when the association was organised and the constitution was adopted, there was a fair number of good scientific investigators in this country, it is certain that in the half century that has passed since then the number of investigators has increased very largely, and naturally the amount of scientific work done at present is very much greater than it was at that time. So great has been the increase in scientific activity during recent years that we are apt to think that by comparison scientific research is a new acquisition. In fact there appears to be an impression abroad that in the world at large scientific research is a relatively new thing, for which we of this generation and our immediate predecessors are largely responsible. Only a superficial knowledge of the history of science is necessary, however, to show that the sciences have been developed slowly, and that their beginnings are to be looked for in the very earliest times. Everything seems to point to the conclusion that men have always been engaged in efforts to learn more and more in regard to the world in which they find themselves. Sometimes they have been guided by one motive and sometimes by another, but the one great underlying motive has been the desire to get a clearer and clearer understanding of the universe. But besides this there has been the desire to find means of increasing the comfort and happiness of the human race.

A reference to the history of chemistry will serve to show how these motives have operated side by side. One of the first great incentives for working with chemical things was the thought that it was possible to convert base metals, like lead and copper, into the so-called noble metals, silver and gold. Probably no idea has ever operated as strongly as this upon the minds of men to lead them to undertake chemical experiments. It held control of intellectual men for centuries, and it was not until about a hundred years ago that it lost its hold. It is very doubtful if the purely scientific question whether one form of matter can be transformed into another would have had the power to control the activities of investigators for so long a time, and it is idle to speculate upon this subject. It should, however, be borne in mind that many of those who were engaged in this work were actuated by a desire to put money in their purses—a desire that is by no means to be condemned without reserve, and I mention it not for the purpose of condemning it, but to show that a motive that we sometimes think of as peculiarly modern is among the oldest known to man.

[1] Address by Prof. Ira Remsen, retiring president of the American Association for the Advancement of Science, delivered at St. Louis, December 28, 1903.

When the alchemists were at work upon their problems, another class of chemists was engaged upon problems of an entirely different nature. The fact that substances obtained from various natural sources and others made in the laboratory produce effects of various kinds when taken into the system led to the thought that these substances might be useful in the treatment of disease. Then, further, it was thought that disease itself is a chemical phenomenon. These thoughts, as is evident, furnish strong motives for the investigation of chemical substances, and the science of chemistry owes much to the work of those who were guided by these motives.

And so in each period as a new thought has served as the guide we find that men have been actuated by different motives, and often one and the same worker has been under the influence of mixed motives. Only in a few cases does it appear that the highest motives alone operate. We must take men as we find them, and we may be thankful that on the whole there are so many who are impelled by one motive or another, or by a mixture of motives, to take up the work of investigating the world in which we live. Great progress is being made in consequence, and almost daily we are called upon to wonder at some new and marvellous result of scientific investigation. It is quite impossible to make predictions of value in regard to what is likely to be revealed to us by continued work, but it is safe to believe that in our efforts to discover the secrets of the universe only a beginning has been made. No matter in what direction we may look we are aware of great unexplored territories, and even in those regions in which the greatest advances have been made it is evident that the knowledge gained is almost insignificant as compared with that which remains to be learned. But this line of thought may lead to a condition bordering on hopelessness and despondency, and surely we should avoid this condition, for there is much greater cause for rejoicing than for despair. Our successors will see more and see more clearly than we do, just as we see more and see more clearly than our predecessors. It is our duty to keep the work going without being too anxious to weigh the results on an absolute scale. It must be remembered that the absolute scale is not a very sensitive instrument, and that it requires the results of generations to affect it markedly.

On an occasion of this kind it seems fair to ask the question: What does the world gain by scientific investigation? This question has often been asked and often answered, but each answer differs in some respects from the others, and each may be suggestive and worth giving. The question is a profound one, and no answer that can be given would be satisfactory. In general it may be said that the results of scientific investigation fall under three heads—the material, the intellectual and the ethical.

The material results are the most obvious, and they naturally receive the most attention. The material wants of man are the first to receive consideration. They cannot be neglected. He must have food and clothing, the means of combating disease, the means of transportation, the means of producing heat and a great variety of things that contribute to his bodily comfort and gratify his æsthetic desires. It is not my purpose to attempt to deal with all of these and to show how science is helping to work out the problems suggested. I shall have to content myself by pointing out a few of the more important problems the solution of which depends upon the prosecution of scientific research.

First, the food problem. Whatever views one may hold in regard to that which has come to be called "race suicide," it is certain that the population of the world is increasing rapidly. The desirable places have been occupied. In some parts of the earth there is such a surplus of population that famines occur from time to time, and in other parts epidemics and floods relieve the embarrassment. We may fairly look forward to the time when the whole earth will be overpopulated unless the production of food becomes more scientific than it is now. Here is the field for the work of the agricultural chemist who is showing us how to increase the yield from a given area, and, in case of poor and worn-out soils, how to preserve and increase their fertility. It appears that the methods of cultivating the soil are still comparatively crude, and more and more thorough investigation of the processes involved in the growth of plants is called for. Much has been learned since Liebig founded the science of agricultural chemistry. It was he who pointed out some of the ways by which it is possible to increase the fertility of a soil. Since the results of his investigations were given to the world the use of artificial fertilisers has become more and more general.

But it is one thing to know that artificial fertilisers are useful and it is quite another thing to get them. At first bone dust and guano were chiefly used. Then as these became dearer, phosphates and potassium salts from the mineral kingdom came into use.

At the Fifth International Congress for Applied Chemistry, held at Berlin, Germany, last June, Dr. Adolph Frank, of Charlottenburg, gave an extremely interesting address on the subject of the use of the nitrogen of the atmosphere for agriculture and the industries, which bears upon the problem that we are dealing with. Plants must have nitrogen. At present this is obtained from the great beds of saltpetre found on the west coast of South America—the so-called Chili saltpetre—and also from the ammonia obtained as a by-product in the distillation of coal, especially in the manufacture of coke. The use of Chili saltpetre for agricultural purposes began about 1860. In 1900 the quantity exported was 1,453,000 tons, and its value was about 60,000,000 dollars. In the same year the world's production of ammonium sulphate was about 500,000 tons, of a value of somewhat more than 20,000,000 dollars. Of these enormous quantities about three-quarters find application in agriculture. The use of these substances, especially of saltpetre, is increasing rapidly. At present it seems that the successful cultivation of the soil is dependent upon the use of nitrates, and the supply of nitrates is limited. Unless something is done we may look forward to the time when the earth, for lack of proper fertilisers, will not be able to produce as much as it now does, and meanwhile the demand for food is increasing. According to the most trustworthy estimations indeed, the saltpetre beds will be exhausted in thirty or forty years. Is there a way out? Dr. Frank shows that there is. In the air there is nitrogen enough for all. The plants can make only a limited use of this directly. For the most part it must be in some form of chemical combination, as, for example, a nitrate or ammonia. The conversion of atmospheric nitrogen into nitric acid would solve the problem, and this is now carried out. But Dr. Frank shows that there is another, perhaps more economical, way of getting the nitrogen into a form suitable for plant food. Calcium carbide can now be made without difficulty, and is made in enormous quantities by the action of a powerful electric current upon a mixture of coal and lime. This substance has the power of absorbing nitrogen from the air, and the product thus formed appears to be capable of giving up its nitrogen to plants, or, in other words, to be a good fertiliser. It is true that this subject requires further investigation, but the results thus far obtained are full of promise. If the outcome should be what we have reason to hope, we may regard the approaching exhaustion of the saltpetre beds with equanimity. But, even without this to pin our faith to, we have the preparation of nitric acid from the nitrogen and oxygen of the air to fall back upon.

While speaking of the food problem, a few words in regard to the artificial preparation of foodstuffs. I am sorry to say that there is not much of promise to report upon in this connection. In spite of the brilliant achievements of chemists in the field of synthesis it remains true that thus far they have not been able to make, except in very small quantities, substances that are useful as foods, and there is absolutely no prospect of this result being reached within a reasonable time. A few years ago Berthelot told us of a dream he had had. This has to do with the results that, according to Berthelot, are to be brought about by the advance of chemistry. The results of investigations already accomplished indicate that, in the future, methods will perhaps be devised for the artificial preparation of food from the water and carbonic acid so abundantly supplied by nature. Agriculture will then become unnecessary, and the landscape will not be disfigured by crops growing in geometrical figures. Water will be obtained from holes three or four miles deep in the earth, and this water will be above the boiling temperature, so that it can be used as a source of energy. It will be obtained in liquid form after it has undergone a process of natural distillation, which will free it from all impurities, including, of course, disease germs. The foods prepared by artificial methods will also be free from microbes, and there will consequently be less disease than at present. Further, the necessity for killing animals for food will no longer exist, and mankind will become gentler and more amenable to higher influences. There is, no doubt, much that is fascinating in this line of thought, but whether it is worth following depends upon the fundamental assumption. Is it at all probable that chemists will ever be able to devise methods for the artificial preparation of foodstuffs? I can only say that to me it does not appear probable in the light of the results thus far obtained. I do not mean to question the probability of the ultimate synthesis of some of those substances that are of value as foods. This has already been accomplished on the small scale, but for the most part the synthetical processes employed have involved the use of substances which themselves are the products of natural processes. Thus, the fats can be made, but the substances from which they are made are generally obtained from nature and are not themselves synthetical products. Emil Fischer has, to be sure, made very small quantities of sugars of different kinds, but the task of building up a sugar from the raw material furnished by nature—that is to say, from carbonic acid and water—presents such difficulties that it may be said to be practically impossible.

When it comes to starch, and the proteids which are the other chief constituents of foodstuffs, the difficulties are still greater. There is not a suggestion of the possibility of making starch artificially, and the same is true of the proteids. In this connection it is, however, interesting to note that Emil Fischer, after his remarkable successes in the sugar group and the uric acid group, is now advancing upon the proteids. I have heard it said that at the beginning of his career he made out a programme for his life work. This included the solution of three great problems. These are the determination of the constitution of uric acid, of the sugars and of the proteids. Two of these problems have been solved. May he be equally successful with the third! Even if he should be able to make a proteid, and show what it is, the problem of the artificial preparation of foodstuffs will not be solved. Indeed, it will hardly be affected.

Although science is not likely, within periods that we may venture to think of, to do away with the necessity of cultivating the soil, it is likely to teach us how to get more out of the soil than we now do, and thus put us in a position to provide for the generations that are to follow us. And this carries with it the thought that, unless scientific investigation is kept up, these coming generations will be unprovided for.

Another way by which the food supply of the world can be increased is by relieving tracts of land that are now used for other purposes than the cultivation of foodstuffs. The most interesting example of this kind is that presented by the cultivation of indigo. There is a large demand for this substance, which is plainly founded upon æsthetic desires of a somewhat rudimentary kind. Whatever the cause may be, the demand exists, and immense tracts of land have been and are still devoted to the cultivation of the indigo plant. Within the past few years scientific investigation has shown that indigo can be made in the factory from substances the production of which does not for the most part involve the cultivation of the soil. In 1900, according to the report of Dr. Brunck, managing director of the Badische Anilin- und Soda-Fabrik, the quantity of indigo produced annually in the factory "would require the cultivation of an area of more than a quarter of a million acres of land (390 square miles) in the home of the indigo plant." Dr. Brunck adds:—"The first impression which this fact may be likely to produce is that the manufacture of indigo will cause a terrible calamity to arise in that country; but, perhaps not. If one recalls to mind that India is periodically afflicted with famine, one ought not, without further consideration, to cast aside the hope that it might be good fortune for that country if the immense areas now devoted to a crop which is subject to many vicissitudes and to violent market changes were at last to be given over to the raising of breadstuffs and other food products." "For myself," says Dr. Brunck, "I do not assume to be an impartial adviser in this matter, but, nevertheless, I venture to express my conviction that the Government of India will be rendering a very great service if it should support and aid the progress, which will in any case be irresistible, of this impending change in the cultivation of that country, and would support and direct its methodical and rational execution."

The connection between scientific investigation and health is so frequently the subject of discussion that I need not dwell upon it here. The discovery that many diseases are due primarily to the action of microscopic organisms that find their way into the body and produce the changes that reveal themselves in definite symptoms is a direct consequence of the study of the phenomenon of alcoholic fermentation by Pasteur. Everything that throws light upon the nature of the action of these microscopic organisms is of value in dealing with the great problem of combating disease. It has been established in a number of cases that they cause the formation of products that act as poisons, and that the diseases are due to the action of these poisons. So also, as is well known, investigation has shown that antidotes to some of these poisons can be produced, and that by means of these antidotes the diseases can be controlled. But more important than this is the discovery of the way in which diseases are transmitted. With this knowledge it is possible to prevent the diseases. The great fact that the death rate is decreasing stands out prominently and proclaims to humanity the importance of scientific investigation. It is, however, to be noted in this connection that the decrease in the death rate compensates to some extent for the decrease in the birth rate, and that, if an increase in population is a thing to be desired, the investigations in the field of sanitary science are contributing to this result.

The development of the human race is dependent not alone upon a supply of food, but upon a supply of energy in available forms. Heat and mechanical energy are absolutely essential to man. The chief source of the energy that comes into play is fuel. We are primarily dependent upon the coal supply for the continuation of the activities of man. Without this, unless something is to take its place, man is doomed. Statistics in regard to the coal supply and the rate at which it is being used up have so frequently been presented by those who have special knowledge of this subject that I need not trouble you with them now. The only object in referring to it is to show that, unless by means of scientific investigation man is taught new methods of rendering the world's store of energy available for the production of heat and of motion, the age of the human race is measured by the extent of the supply of coal and other forms of fuel. By other forms of fuel I mean, of course, wood and oil. Plainly, as the demand for land for the production of foodstuffs increases, the amount available for the production of wood must decrease, so that wood need not be taken into account for the future. In regard to oil, our knowledge is not sufficient to enable us to make predictions of any value. If one of the theories now held in regard to the source of petroleum should prove to be correct, the world would find much consolation in it. According to this theory petroleum is not likely to be exhausted, for it is constantly being formed by the action of water upon carbides that in all probability exist in practically unlimited quantity in the interior of the earth. If this be true, then the problem of supplying energy may be reduced to one of transportation of oil. But given a supply of oil and, of course, the problem of transportation is solved.

What are the other practical sources of energy? The most important is the fall of water. This is being utilised more and more year by year since the methods of producing electric currents by means of the dynamo have been worked out. There is plainly much to be learned before the energy made available in the immediate neighbourhood of the waterfall can be transported long distances economically, but advances are being made in this line, and already factories that have hitherto been dependent upon coal are making use of the energy derived from waterfalls. The more rapidly these advances take place the less will be the demand for coal, and if there were only enough waterfalls conveniently situated, there would be no difficulty in furnishing all the energy needed by man for heat or for motion.

It is a fortunate thing that, as the population of the earth increases, man's tastes become more complex. If only the simplest tastes prevailed, only the simplest occupations would be called for. But let us not lose time in idle speculations as to the way this primitive condition of things would affect man's progress. As a matter of fact, his tastes are becoming more complex. Things that are not dreamed of in one generation become the necessities of the next generation. Many of these things are the direct results of scientific investigation. No end of examples will suggest themselves. Let me content myself by reference to one that has of late been the subject of much discussion. The development of the artificial dye-stuff industries is extremely instructive in many ways. The development has been the direct result of the scientific investigation of things that seemed to have little, if anything, to do with this world. Many thousands of workmen are now employed, and many millions of dollars are invested, in the manufacture of dye-stuffs that were unknown a few years ago. Here plainly the fundamental fact is the æsthetic desire of man for colours. A colourless world would be unbearable to him. Nature accustoms him to colour in a great variety of combinations, and it becomes a necessity to him. And his desires increase as they are gratified. There seems to be no end to development in this line. At all events, the data at our disposal justify the conclusion that there will be a demand for every dye that combines the qualities of beauty and durability. Thousands of scientifically trained men are engaged in work in the effort to discover new dyes to meet the increasing demands. New industries are springing up and many find employment in them. As a rule the increased demand for labour caused by the establishment of these industries is not offset by the closing up of other industries. Certainly it is true that scientific investigation has created large demands for labour that could hardly find employment without these demands.

The welfare of a nation depends to a large extent upon the success of its industries. In his address as president of the British Association for the Advancement of Science given last summer, Sir Norman Lockyer quotes Mr. Chamberlain thus:—"I do not think it is necessary for me to say anything as to the urgency and necessity of scientific training. . . . It is not too much to say that the existence of this country, as the great commercial nation, depends upon it. . . . It depends very much upon what we are doing now, at the beginning of the twentieth century, whether at its end we shall continue to maintain our supremacy or even equality with our great commercial and manufacturing rivals." In another part of his address Sir Norman Lockyer says:—"Further, I am told that the sum of 24,000,000*l*. is less than half the amount by which Germany is yearly enriched by having improved upon our chemical industries, owing to our lack of scientific training. Many other industries have been attacked in the same way since, but taking this one instance alone, if we had spent this money fifty years ago, when the Prince Consort first called attention to our backwardness, the nation would now be much richer than it is, and would have much less to fear from competition."

But enough on the purely material side. Let us turn to the intellectual results of scientific investigation. This part of our subject might be summed up in a few words. It is so obvious that the intellectual condition of mankind is a direct result of scientific investigation that one hesitates to make the statement. The mind of man cannot carry him much in advance of his knowledge of the facts. Intellectual gains can be made only by discoveries, and discoveries can be made only by investigation. One generation differs from another in the way it looks at the world. A generation that thinks the earth is the centre of the universe differs intellectually from one that has learned the true position of the earth in the solar system, and the general relations of the solar system to other similar systems that make up the universe. A generation that sees in every species of animal and plant evidence of a special creative act differs from one that has recognised the general truth of the conception of evolution. And so in every department of knowledge the great generalisations that have been reached through the persistent efforts of scientific investigators are the intellectual gains that have resulted. These great generalisations measure the intellectual wealth of mankind. They are the foundations of all profitable thought. While the generalisations of science belong to the world, not all the world takes advantage of its opportunities. Nation differs from nation intellectually as individual differs from individual. It is not, however, the possession of knowledge that makes the efficient individual and the efficient nation. It is well known that an individual may be very learned and at the same time very inefficient. The question is, what use does he make of his knowledge? When we speak of intellectual results of scientific investigation, we mean not only accumulated knowledge, but the way in which this knowledge is invested. A man who simply accumulates money and does not see to it that this money is carefully invested is a miser, and no large results can come from his efforts. While, then, the intellectual state of a nation is measured partly by the extent to which it has taken possession of the generalisations that belong to the world, it is also measured by the extent to which the methods by which knowledge is accumulated have been brought into requisition and have become a part of the equipment of the people of that nation. The intellectual progress of a nation depends upon the adoption of scientific methods in dealing with intellectual problems. The scientific method is applicable to all kinds of intellectual problems. We need it in every department of activity. I have sometimes wondered what the result would be if the scientific method could be employed in all the manifold problems connected with the management of a Government. Questions of tariff, of finance, of international relations would be dealt with much more satisfactorily than at present if the spirit of the scientific method were breathed into those who are called upon to deal with these questions. It is plain, I think, that the higher the intellectual state of a nation the better will it deal with all the problems that present themselves. As the intellectual state is a direct result of scientific investigation, it is clear that the nation that adopts the scientific method will in the end outrank both intellectually and industrially the nation that does not.

What are the ethical results of scientific investigation? No one can tell. There is one thought that in this connection I should like to impress upon you. The fundamental characteristic of the scientific method is honesty. In dealing with any question science asks no favours. The sole object is to learn the truth, and to be guided by the truth. Absolute accuracy, absolute fidelity, absolute honesty are the prime conditions of scientific progress. I believe that the constant use of the scientific method must in the end leave its impress upon him who uses it. The results will not be satisfactory in all cases, but the tendency will be in the right direction. A life spent in accordance with scientific teachings would be of a high order. It would practically conform to the teachings of the highest types of religion. The motives would be different, but so far as conduct is concerned the results would be practically identical. I need not enlarge upon this subject. Unfortunately, abstract truth and knowledge of facts and of the conclusions to be drawn from them do not at present furnish a sufficient basis for right living in the case of the great majority of mankind, and science cannot now, and I do not believe it ever can, take the place of religion in some form. When the feeling that the two are antagonistic wears away, as it is wearing away, it will no doubt be seen that one supplements the other, in so far as they have to do with the conduct of man.

What are we doing in this country to encourage scientific investigation? Not until about a quarter of a century ago can it be said that it met with any encouragement. Since then there has been a great change. Up to that time research was sporadic. Soon after it became almost epidemic. The direct cause of the change was the establishing of courses in our universities for the training of investigators somewhat upon the lines followed in the German universities. In these courses the carrying out of an investigation plays an important part. This is, in fact, the culmination of the course. At first there were not many following these courses, but it was not long before there was a demand for the products. Those who could present evidence that they had followed such courses were generally given the preference. This was especially true in the case of appointments in the colleges, some colleges even going so far as to decline to appoint anyone who had not taken the degree of doctor of philosophy, which is the badge of the course that involves investigation. As the demand for those who had received this training increased, the number of those seeking it increased at least in the same proportion. New universities were established and old ones caught the spirit of the new movement until from one end of the country to the other centres of scientific activity are now found, and the amount of research work that is done is enormous compared with what was done twenty-five or thirty years ago. Many of those who get a taste of the work of investigation become fascinated by it and are anxious to devote their lives to it. At present, with the facilities for such work available, it seems probable that most of those who have a strong desire and the necessary industry and ability to follow it find their opportunity somewhere. There is little danger of our losing a genius or even one with fair talent. The world is on the lookout for them. The demand for those who can do good research work is greater than the supply. To be sure the rewards are not as a rule so great as those that are likely to be won by the ablest members of some other professions and occupations, and so long as this condition of affairs continues to exist there will not be so many men of the highest intellectual order engaged in this work as we should like to see. On the other hand, when we consider the great progress that has been made during the last twenty-five years or so, we have every reason to take a cheerful view of the future. If as much progress should be made in the next quarter century, we shall, to say the least, be able to compete with the foremost nations of the world in scientific investigation. In my opinion this progress is largely dependent upon the development of our universities. Without the opportunities for training in the methods of scientific investigation there will be but few investigators. It is necessary to have a large number in order that the principle of selection may operate. In this line of work as in others, many are called, but few are chosen.

Another fact that is working advantageously to increase the amount of scientific research done in this country is the support given by the Government in its different scientific bureaus. The Geological Survey, the Department of Agriculture, the Coast and Geodetic Survey, the National Bureau of Standards and other departments are carrying on a large amount of excellent scientific work, and thus helping most efficiently to spread the scientific spirit throughout the land.

Finally, two exceedingly interesting experiments in the way of encouraging scientific investigation are now attracting the attention of the world. I mean, of course, the Carnegie Institution, with its endowment of 10,000,000 dollars, and the Rockefeller Institute, devoted to investigations in the field of medicine, which will no doubt be adequately endowed. It is too early to express an opinion in regard to the influence of these great foundations upon the progress of scientific investigation. As both will make possible the carrying out of many investigations that would otherwise probably not be carried out, the chances of achieving valuable results will be increased. The danger is that those who are responsible for the management of the funds will be disappointed that the results are not at once of a striking character, and that they will be tempted to change the method of applying the money before those who are using it have had a fair chance. But we who are on the outside know little of the plans of those who are inside. All signs indicate that they are making an earnest effort to solve an exceedingly difficult problem, and all who have the opportunity should do everything in their power to aid them.

In the changes which have been brought about in the condition of science in this country since 1848, it is safe to say that this association has either directly or indirectly played a leading part. It is certain that for the labours of scientific men increased facilities and a wider usefulness have been procured.

FIREBALLS IN JANUARY.

APART from the rich shower directed from the region of Bode's asterism Quadrans, or northern limits of Boötes, on the opening nights of January, the meteors visible in this month have usually attracted little attention. Observers who have watched the cold winter sky have, indeed, generally remarked a scarcity of meteors amongst the beautiful constellations displayed at this season of the year. Zezioli, it is true, was more successful in the clear atmosphere of Italy, for on the closing nights of January, 1868, he saw a plentiful swarm of shooting stars falling from Corona and Ursa Major, and one or two other observers have occasionally recorded meteoric activity of somewhat special character, but, with the exception of its New Year's shower, the month commonly furnishes us neither with any plentiful displays nor with an abundance of meteors giving evidence of a multitude of attenuated streams.

But in recent years January has certainly shown itself rather noteworthy on account of the brilliant fireballs which have appeared. This month in 1901, 1903 and 1904 proved rich in these startling visitors. About ten were seen in 1901, five were well observed and their real paths computed in 1903, and seven appeared between January 8–22, 1904. We must also remember the great fireballs of 1894 January 25, 1898 January 21, and the pair which were quite conspicuous in bright sunshine on the early afternoons of 1900 January 9 and 1901 January 6 respectively.

A comparison of the various dates shows that the apparitions have marked two periods of the month, viz.

January 6 to 15, and
January 23 to 29.

In future years it will be desirable to watch for fireballs at these special epochs. No particular shower appears to have been responsible for their production in past years. The radiant points seem to have been widely separated, and prove that our brilliant January meteors have little if any community of origin, but may rather be regarded as isolated cosmic rovers. If they individually represent meteoric showers, such showers must form the relicts of rich, old-time systems now thinned out beyond visible recognition by frequent *rencontres* with the planets.

It is characteristic of many vividly luminous fireballs that they have very slow, long and nearly horizontal flights. Their average heights are about 67 miles at first, and they disappear either at about 46 or 29 miles. Their radiant-points are usually not far from the horizon, and placed in unusual westerly positions where no ordinary radiants of shooting stars are ever detected. In 1903 very brilliant meteors were seen on January 10, 13, 14, 25 and 28, and in 1904 on January 8, 9, 10, 13, 15, 18 and 22. The one alluded to in NATURE for January 14 as seen by Mr. W. E. Rolston at Fulham on January 9, 8h. 27m., was also observed by Mr. G. F. Oldham at Tunbridge Wells, moving from $110°+36°$ to $128°+37°$ in four seconds. The real height of the object during its luminous career was from 60 to 41 miles over the east coast of Kent (Folkestone to Ramsgate), radiant point at $41°+5°$, and velocity certainly not more, and very probably less, than 6 miles per second. There was another fireball on the following night, Sunday, January 10, at 8h. 32m., observed at Oxford and Llanelly. It descended from a radiant in the east region of Aries over Monmouthshire from a height of 67 to 31 miles. Yet another fireball was recorded on January 15 at Bridgwater and Banbury. It fell from a height of 63 to 27 miles from a radiant near the zenith in the region bordering Perseus and Auriga.

It is fortunate to have secured duplicate observations of these fine objects, and more of them may be expected to appear before the close of the month.

In February fireballs have often been seen on the 3rd, 7th and 10th. These dates will nearly correspond with February 5, 9 and 12 in 1904. There is also a pretty rich shower of meteors from near Capella sometimes observed between February 7 and 23.

W. F. DENNING.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

PROF. EDUARD STUDY, of Greifswald, has been appointed to the chair of mathematics at Bonn in succession to the late Prof. Lipschütz.

ON Thursday, February 11, Prof. Armstrong will give an address at the Battersea Polytechnic on "The Placing of 'Domestics' on a Scientific Practical Basis."

CORNELL University will, says *Science*, receive more than 40,000*l*. from the estate of the late Mr. F. W. Guiteau, of Irvington-on-the-Hudson, which is nearly 10,000*l*. more than was announced at the time of Mr. Guiteau's death last year. The money will be used as a fund for the assistance of needy students, and will be lent them without interest.

DR. GEORG SCHROETER has been appointed professor of organic chemistry in the University of Bonn; Mr. F. Kreutzberg, of Düsseldorf, has been appointed professor of applied mathematics at the new Academy of Posen; Dr. Leo Marchlewski, professor of chemistry at Cracow; Mr. L. Farny, professor in the Zürich Polytechnic; Dr. W. Kötz, professor of chemistry at Göttingen; and Dr. Erich Müller, professor in the chemical department of the Dresden High School.

A PETITION, which it is intended to present to the central educational authorities of the United Kingdom, is being circulated for signature among the registered medical men of the British Isles. The petition directs attention to the serious physical and moral conditions of degeneracy and disease resulting from the neglect and infraction of the elementary laws of hygiene, and urges the central authorities for education to consider whether it would not be possible to include in primary and secondary schools such teaching as may lead all children duly to appreciate healthful bodily conditions. The petition then reviews the steps taken in this direction by English-speaking nations, and shows that great prominence is given in many British colonies to instruction in the laws of health, and concludes by urging the necessity of ensuring that the training of all teachers shall include adequate instruction in these subjects.

AT the annual meeting of the Mathematical Association held on January 23, Prof. A. R. Forsyth, the president, who occupied the chair, in referring to the report of the Committee on the Teaching of Elementary Mathematics, said that in the various stages of the consideration of changes in the regulations at Cambridge University the report of the association proved to be of substantial value. The most interesting event outside the association was the production of the report of the syndicate at Cambridge and the discussion of that report. Some slight modifications were introduced into it, and then it was adopted by the University of Cambridge without a single dissentient. Therefore there had come a change not indeed in teaching, but in the conditions under which teaching could be carried on. If the first working of the regulations was carried out in the spirit in which they were proposed, if the teachers would take the advantage that was offered by the greater ease of the regulations, he thought a substantial improvement would come in the mathematical teaching of the country. Mr. E. M. Langley exhibited models of regular and semi-regular solids, including the four *polyèdres étoiles* of Poinsot. Mr. C. S. Jackson read an account of a recent discussion on the possibility of fusion of the teaching of mathematics and science. Mr. J. C. Palmer dealt with a geometrical note, and Mr. C. A. Rumsey read a paper on advanced school courses of mathematics.

IN the course of an address at the Mansion House on Monday, at the distribution of prizes to the successful students of the City and Guilds Institute, Sir William White remarked that as regards higher technical education we were as a nation in a critical condition. What was wanted was coordination of educational agencies on a carefully considered plan. There must be conference between teachers and the representatives of the professions, businesses, and manufactures if the best results were to be obtained. He was extremely hopeful of the results which would follow the work of an advisory committee at the Institution of Civil Engineers containing representatives of all the great engineering associations in this country, the duty of which it would be to report as to the best mode of training British engineers in the future. We had at present no proper system of secondary education preparing students for entering technical institutes. In this respect the Germans had certainly stolen a march upon us. We should cease arguing for ever whether the classical side or the modern side of education was the best. The simple solution was that they should go on side by side. There should be a more generous recognition by employers of the necessity and value of the services of trained men. It was a sad thing to know that some of the researches originally made in this country had been first turned to practical account abroad. He knew one case where British manufacturers were to this day paying large royalties in connection with a process of steel manufacture which was actually initiated in England. He looked forward to a system of technical education in London and throughout the country which would show the world that England was still the leader in industry and in resource.

SOCIETIES AND ACADEMIES.

LONDON.

Mathematical Society, January 14.—Dr. E. W. Hobson, vice-president, in the chair.—The following papers were communicated:—Various systems of piling: Prof. J. D. **Everett.** The method of "steps" for dealing with the structure of piles of equal spheres is applied to various arrangements which are of especial interest in crystallography.—The notion of lines of curvature in the theory of surfaces: Dr. G. **Prasad.** The object of the paper is to investigate conditions under which certain known theorems in the theory of surfaces can be extended to the case in which the coordinates of points on the surface are defined by non-analytical functions. The theorems in question are:—(1) The only surface of constant positive curvature is a sphere; (2) no surface of constant negative curvature with continuously varying tangent plane can extend to infinite distances.—Electric radiation from conductors: H. M. **Macdonald.** It is shown that in general, when electrical oscillations on a conductor are taking place, no surface can be drawn to cut the lines of electric force at right angles and to be everywhere close to the surface of the conductor. If such a surface could be drawn there would be no decay of the oscillations by radiation. It is shown that surfaces can be drawn to have the property in question everywhere except near the nodal points of the oscillation, and it is concluded that the radiation takes place mainly in the neighbourhood of the nodes. It is pointed out further that the ordinary theory of electrical waves along wires involves an invalid limiting operation, by which the wires are treated as indefinitely thin and the electric force is taken, nevertheless, to be everywhere at right angles to the wires; and the correction of the ordinary theory required to avoid this operation is discussed.—Groups of the order $p^a q^\beta$: Prof. W. **Eurnside.** By a consideration of certain properties of the group-characteristics of groups of the orders in question, it is shown that all these groups are soluble.—The solution of partial differential equations by means of definite integrals: H. **Bateman.** The paper deals with various generalisations of the known solutions of Laplace's equation by means of definite integrals.—Open sets and the theory of content: Dr. W. H. **Young.** Two definitions of the content of an open set are given, and are shown to be in agreement for that class of open sets which has the property that the content of the set, obtained by adding to any member of the class any set of non-overlapping intervals, is equal to the sum of the contents of the component sets. This class contains all known open sets, and all those obtainable from them by any of the ordinary processes.—Upper and lower integration: Dr. W. H. **Young.** All functions, whether integrable or not, possess upper integrals and lower integrals. The problem of determining them is reduced in the paper to that of ordinary integration. It is shown that an upper n-ple integral of a discontinuous function can be expressed in terms of $\int I dk$, where I is the content of the set of points at which the maximum of the function is not less than k, and the integral is taken between suitable limits.—List of primes of the form $4n+1$ between 10^8 and 10^8+10^5: Dr. T. B. **Sprague.**

PARIS.

Academy of Sciences, January 18.—M. Mascart in the chair.—The application of the general theory of the flow of sheets of water infiltrated in the soil to large springs of permeable strata, and, in particular, to several of those supplying Paris: J. **Boussinesq.** The mathematical theory previously worked out by the author has been applied to the three sources of Dhuis, Cérilly, and Armentières. It is found that for important springs in permeable ground the basin of supply is considerably extended downwards below its edge.—On the first numbers of the photographic catalogue of the sky published by M. Trépied: M. **Lœwy.**—On the dispersion of the n-rays and on their wave-length: R. **Blondlot.** The dispersion was studied by means of aluminium prisms and lenses, and it was recognised that the radiation was separated into eight bundles, the refractive indices of which varied from 1·04 to 1·85. The wave-lengths were determined by two methods: by a diffraction grating and by the formation of Newton's rings. The results of the two methods were concordant within the limits of experimental error, the wave-lengths determined proving to be much shorter than those of light. These radiations would appear to be different from the rays of very short wave-length discovered by M. Schumann, inasmuch as the latter are strongly absorbed by air and the n-rays are not.—On the peroxides of zinc: M. **de Forcrand.** A discussion of the results of M. Kuriloff with regard to the formula of peroxide of zinc.—On a characteristic property of the families of Lamy: Alphonse **Demoulin.**—On the *genre* of the derivative of an entire function and on the exceptional case of M. Picard: A. **Wiman.**—The action of radium bromide on the electrical resistance of bismuth: R. **Paillot.** The radiations emitted by radium bromide diminish the electrical resistance of bismuth. The action is practically instantaneous, rapidly falling off with the distance of the radium tube from the bismuth and vanishing when this distance amounts to 1 cm.—On a self-recording differential speed measurer: J. **Richard.**—The influence of the physical nature of the anode on the constitution of electrolytic peroxide of lead: A. **Hollard.** If the lead were deposited as the dioxide, the analytical factor would be 0·866 to convert the dioxide into lead. Experiments with an anode of roughened platinum gave a factor of 0·853, this being independent of the amount of lead in solution.—The chemical nature of colloidal solutions: Jacques **Duclaux.**—A method of separating alumina and iron by the use of formic acid: A. **Leclère.** A modification of the hyposulphite of sodium method, in which the aluminium is separated as the basic formate.—The estimation of chlorates, bromates, and iodates: Léon **Débourdeaux.**—The preparation of primary alcohols by means of the corresponding amides: L. **Bouveault** and G. **Blanc.** The higher fatty amides, reduced by sodium in boiling ethyl alcoholic solution, give yields of from 25 to 30 per cent. of the theoretical. Normal hexyl, normal nonyl, and phenylethyl alcohols were prepared in this way.—The synthesis of sugars, starting from trioxymethylene and sulphite of soda: A. **Seyewetz** and M. **Gibello.**—A new method of synthesis of tertiary alcohols by means of organomagnesium compounds: V. **Grignard.** The magnesium compound R.MgX is converted into $R.CO_2.MgX$ by the action of carbon dioxide, and this is then treated with an additional molecule of R′.MgX, the object being to prepare the ketone R.CO.R′. The reaction was found, however, to result in the production of the tertiary alcohol $R.R'_2.OH$. The new alcohols prepared by this method include diethylisoamyl carbinol, isobutyldiisoamyl carbinol, and phenyldiethyl carbinol.—The influence of radium rays on the development and growth of the lower fungi: J. **Dauphin.** The radium rays arrest the growth of the mycelium of Mortierella, but the spores and mycelium are not killed, but are in a latent state, and, replaced under normal conditions, can germinate and continue to grow.—Researches on the transpiration of the leaves of Eucalyptus: Ed. **Griffon.** In opposition to the views generally expressed, it is found that the leaves of Eucalyptus have not an unusually large transpiratory capacity compared with other leaves. The effects of the growth of this tree in marshy soil are more probably due to its power of rapidly producing a large mass of foliage than to any specially large transpiratory effects.—The utilisation of entomophytic fungi for the destruction of larvæ: C. **Vaney** and A. **Conte.**—On the excrescences of the leaves of the vine: P. **Viala** and P. **Pacottet.** These abnormalities are not observed in vineyards, but are produced by forced culture under glass.—On a trachyte in the French Soudan: H. **Arsandaux.** The case described is the first example of volcanic rock in the western French Soudan. Two types of alkaline trachyte and one basalt were found.—The increase of useful work in traction by the use of elastic apparatus: MM. **Ferrus** and **Machart.**—Remarks by M. **Marey** on the preceding paper.—The relation between the appearance of secondary sexual characters and the interstitial testicular gland: P. **Ancel** and P. **Bouin.**—The action of various substances on the glycogeny of the liver: MM. **Doyon** and **Kareff.**—The determination of the value of intraorganic combustion in the parotid gland of the ox in a state of activity and repose: G. **Moussu** and J. **Tissot.**—On the stimulation of nerves by discharges of condensers: M. **Cluzet.**—On certain congenital anomalies of the head, determining a symmetrical transformation of the four extremities (acrometagenesis): V. **Babès.**—On the destruction of the winter egg of Phylloxera: G. **Cantin.**

DIARY OF SOCIETIES.

THURSDAY, JANUARY 28.

ROYAL SOCIETY, at 4.30.—Observations on the Sex of Mice—Preliminary Paper: Dr. S. M. Copeman, F.R.S., and F. G. Parsons.—Observations upon the Acquirement of Secondary Sexual Characters indicating the Formation of an Internal Secretion by the Testicle: S. G. Shattock and C. G. Seligmann.—On the Part played by Benzene in Poisoning by Coal Gas: Dr. R. Stachelin.—On the Islets of Langerhaus in the Pancreas: H. H. Dale.—The Morphology of the Retrocalcarine Region of the Cortex Cerebri: Prof. G. Elliot Smith.

ROYAL INSTITUTION, at 5.—The Flora of the Ocean: G. R. M. Murray, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Edison Accumulator for Automobiles: W. Hibbert. (Adjourned discussion.) To be opened by Dr. J. A. Fleming, F.R.S.—On the Magnetic Dispersion in Induction Motors, and its Influence on the Design of these Machines: Dr. H. Behn-Eschenburg. (Adjourned discussion.)

FRIDAY, JANUARY 29.

ROYAL INSTITUTION, at 9.—The Marshes of the Nile Delta: D. G. Hogarth.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Metallurgy as Applied in Engineering: Archibald B. Head.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Extra Meeting. Sixth Report to the Alloys Research Committee on the Heat Treatment of Steel: the late Sir William C. Roberts-Austen, K.C.B., F.R.S.. Completed by Prof. W. Gowland. (Continued discussion.)

SATURDAY, JANUARY 30.

ROYAL INSTITUTION, at 3.—British Folk Song: J. A. Fuller-Maitland.

ESSEX FIELD CLUB, at 6.30 (Essex Museum of Natural History, Stratford).—Evidences of Prehistoric Man in West Kent: J. Russell Larkby.—Recent Observations concerning London City Walls, the Walbrooke and Moorfields: F. W. Reader.

MONDAY, FEBRUARY 1.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—A Résumé of the Report, Minutes of Evidence, and Appendices of the Royal Commission on Arsenical Poisoning: Julian L. Baker.

SOCIETY OF ARTS, at 8.—Oils and Fats—their Uses and Applications: Dr. J. Lewkowitsch (Cantor Lectures II.).

ARISTOTELIAN SOCIETY, at 8.—Reality: Shadworth H. Hodgson.

TUESDAY, FEBRUARY 2.

ROYAL INSTITUTION, at 5.—The Development of Animals: Prof. L. C. Miall, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Sanding-up of Tidal Harbours: A. E. Carey. (Discussion).—Tonnage Laws and the Assessment of Harbour Dues and Charges: H. H. West.

MINERALOGICAL SOCIETY, at 8.—On a New Sulphostannite of Lead from Bolivia, and its Relations with Franckeite and Cylindrite: G. T. Prior.—On the Gnomonic Net: Harold Hilton.

ZOOLOGICAL SOCIETY, at 8.30.—On the Subspecies of *Giraffa camelopardalis*: R. Lydekker, F.R.S.—On a Collection of Mammals from Namaqualand: Oldfield Thomas, F.R.S.—On the Arteries of the Base of the Brain in Certain Mammals: F. E. Beddard, F.R.S.

FARADAY SOCIETY, at 8.—Notes on Aluminium Welding: Sherard Cowper-Coles.—Some Applications of the Theory of Electrolysis to the Seporation of Metals from One Another: A. Hollard.

WEDNESDAY, FEBRUARY 3.

SOCIETY OF ARTS, at 8.—Steam Cars for Public Service: Thomas Clarkson.

GEOLOGICAL SOCIETY, at 8.—The Rhætic Beds of the South Wales Direct Line: Prof. S. H. Reynolds and A. Vaughan. On a Deep-Sea Deposit from an Artesian Boring at Kilacheri, near Madras: Prof. H. Narayana Rau.

ENTOMOLOGICAL SOCIETY, at 8.—On the Habits of some Mantidæ: Captain C. E. Williams.—Systematic Observations upon the Dermatoptera: Malcolm Burr.—Descriptions of New Species of Crypinæ, from the Khasia Hills, Assam; and a New Species of Bembex: Peter Cameron.—On a New Species of Heterogynis: Dr. T. A. Chapman.—On some New or Imperfectly Known Forms of South African Butterflies: Roland Trimen, F.R.S.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Annual Meeting, followed by Note on the Quantitative Estimation of Mechanical Wood Pulp in Paper: C. F. Cross and E. J. Bevan.—Note on Chinese Tallow Seed Oil: L. Myddelton Nash.—Note on the Analysis of Jam: Raymond Ross.

THURSDAY, FEBRUARY 4.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Reduction Division in Ferns: R. Gregory.—Cultural Experiments with "Biologic Forms" of the Erysiphaceæ: E. S. Salmon.—On the Origin of Parasitism in Fungi: George Massee.—On Mechanical and Electrical Response in Plants: Prof. J. C. Bose.—On the Effects of Joining the Cervical Sympathetic Nerve with the Chorda Tympani: Prof. J. N. Langley, F.R.S., and Dr. H. K. Anderson.

ROYAL INSTITUTION, at 5.—Recent Research in Agriculture: A. D. Hall.

CHEMICAL SOCIETY, at 8.—The Tautomeric Character of the Acidic Thiocyanates—Preliminary Note: R. E. Doran.—The Resolution of αβ-Dihydroxybutyric Acid into its Optically Active Constituents: R. S. Morrell and E. K. Hanson.

LINNEAN SOCIETY, at 8.—Account of Researches in the Physiology of Yeast: Prof. Sydney H. Vines, F.R.S.—Further Researches on the Specialisation of Parasitism in the Erysiphaceæ: E. S. Salmon.

RÖNTGEN SOCIETY, at 8.30.—Discussion on the Production of Photographic Reversal through the Action of Various Radiations.

SATURDAY, FEBRUARY 6.

ROYAL INSTITUTION, at 3.—Study of Style in Greek Sculpture: Dr. C. Waldstein.

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NOTICE.—Advertisements and business letters for NATURE *should be addressed to the Publishers; Editorial Communications to the Editor. The telegraphic address of* NATURE *is* "PHUSIS," LONDON.

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fa_1 fa + br : si. Data wanting

=

fa_1 + br : si. (fa bros, fa sis) (3 ; 3) Frederick, George, Valdemar ; Dagmar, Thyra, Alexandra.

me + br : si. Data wanting

=

Self + br : si (bros + sis) (5 ; 3) Christian, Charles, Harald, Ingeborg, Gustav ; Louise, Thyra, Dagmar

=

Sons and daus (1 ; 0) Alexander b. 1903

=

fa_1 bro_2 his sons & das (sons + fa bro daus) ~~+ [illegible]~~ (5 ; 1) Constantine, George, Nicholas, Andrew, Christopher ; Marie

fa_1 si_1 her sons and daus ~~+ [illegible]~~ (2 ; 2) Nicholas, Michael ; Xenia, Olga

fa_1 si_3 her sons & daus (1 ; 3) George ; Louise, Victoria, Maud.

=

fa, si_1 son_1 her sons and daus ~~+ [illegible]~~. (1 ; 4) Alexis ; Olga, Tatiana, Marie, Anastasia

Add to list in Graphic Nov 25 1905

fa si_1 son_1 son_1 Alexis Tsarevitch b. 1904

son_1 Alexander Crown Prince of Norway b 1903 f.2r

KING HAAKON'S ROYAL FAMILY.

King Christian of Denmark has with some reason been called the "father of Europe," for it is astonishing to find how many crowned heads belong to his family. His eldest daughter is our beloved Queen Alexandra, and his second son, William, became in 1863 King of the Hellenes, taking the name George I. The second daughter, Dagmar, became Marie Feodorovna when she married the late Tsar Alexander III. in 1866, and is mother of the present Tsar, Nicholas II. The list of crowned heads in King Christian's family will shortly be increased by the names of his grandchildren, Charles and Maud—the former being the second son of the Danish Crown Prince, and the latter the daughter of Queen Alexandra—who are to be crowned as King Haakon and Queen Maud of Norway. It is curious to note how each crowned head has an heir. The youngest Crown Prince in the family is, of course, the little Tsarevitch, who was only born in July last year, being nearly a year older than the Crown Prince Olaf of Norway. In some cases the descent is so far secured that the Crown Princes have sons, as in the case of our Prince of Wales and the Crown Prince of Greece, and, of course, in that of the Crown Prince of Denmark. An examination of the accompanying genealogical tree will show that besides providing rulers or consorts for rulers for Great Britain, Greece, Russia, and Norway, the Danish Royal House is allied by marriage with the Prussian Royal Family, the Swedish Royal House, and the Orleans family.

F.2v

DALY'S THEATRE.—Produced by Mr. George Edwardes.—EVENINGS, at 8.30, MATINEE, EVERY SATURDAY, and on WEDNESDAY NEXT, at 2.30, THE LITTLE MICHUS. Mlle. Adeline Genee, Messrs. Robert Evett, Louis Bradfield, James Blakeley, Willie Warde, and George Graves. Misses Adrienne Augarde, Amy Augarde, and Denise Orme. Matinées and Evenings.

IMPERIAL THEATRE. Mr. LEWIS WALLER. NIGHTLY, at 8.45. MAT., WEDS. and SATS., at 2.30. THE PERFECT LOVER, by Alfred Sutro. 8.15, a Farce, by W. W. Jacobs and Frederick Fenn, THE TEMPTATION OF SAMUEL BURGE.

GAIETY THEATRE.—Manager, Mr. George Edwardes.—TO-NIGHT, and EVERY EVENING, at 8 (doors open 7.40), a new Musical Play, entitled, "THE SPRING CHICKEN." Box Office open from 10 till 10. Matinée, To-day (Saturday), at 2.0. Doors open 1.40.

ADELPHI.—Lessee and Manager, Otho Stuart.—TO-NIGHT (SATURDAY), and Every Evening, at 8 precisely, Matinées, Every Wednesday and Saturday, at 2. A MIDSUMMER NIGHT'S DREAM.

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LYRIC THEATRE. (Lessee, Mr. William Greet.)
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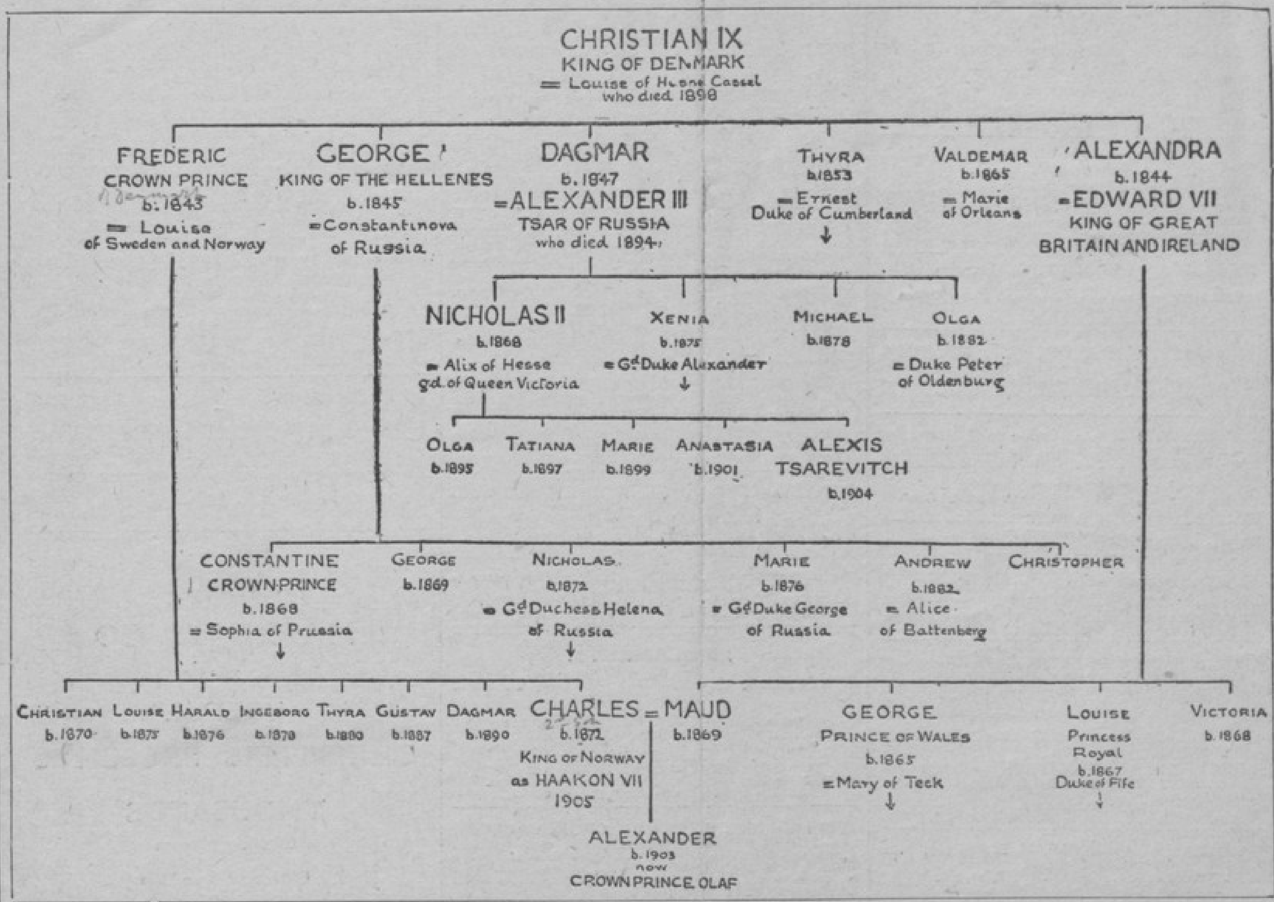

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F. 3v

THEATRES.

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8.15, Mr. HENRI DE VRIES in "The Factory Fire."
LAST MATINEE, TO-DAY, at 2.15.

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CLARICE. Last Special Matinée, Thursday Next, at 2.30.

PRINCE OF WALES'S THEATRE.—Lessee and Manager, Mr. Frank Curzon.—Mr. George Edwardes' Season.
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"PUBLIC OPINION."
By R. C. CARTON.
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THEATRES.

HAYMARKET. LUCKY MISS DEAN.
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GARRICK.—MR. ARTHUR BOURCHIER as "Shylock," and Miss VIOLET VANBRUGH as "Portia," TO-DAY, at 2 and 8, in Shakespeare's play,
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