THURSDAY, FEBRUARY 12, 1903.

THE SCIENTIFIC WORK OF SIR GEORGE STOKES.

STOKES ranged over the whole domain of natural philosophy in his work and thought; just one field—electricity—he looked upon from outside, scarcely entering it. Hydrodynamics, elasticity of solids and fluids, wave-motion in elastic solids and fluids, were all exhaustively treated by his powerful and unerring mathematics.

Even pure mathematics of a highly transcendental kind has been enriched by his penetrating genius; witness his paper "On the Numerical Calculation of a Class of Definite Integrals and Infinite Series,"[1] called forth by Airy's admirable paper on the intensity of light in the neighbourhood of a caustic, practically the theory of the rainbow. Prof. Miller had succeeded in observing thirty out of an endless series of dark bands in a series of spurious rainbows for the determination of which Airy had given a transcendental equation, and had calculated, of necessity most laboriously, by aid of ten-figure logarithms, results giving only two of those black bands. Stokes, by mathematical supersubtlety, transformed Airy's integral into a form by which the light at any point of any of those thirty bands, and any desired greater number of them, could be calculated with but little labour and with greater and greater ease for the more and more distant places where Airy's direct formula became more and more impracticably laborious. He actually calculated fifty of the roots, giving the positions of twenty black bands beyond the thirty seen by Miller.

With Stokes, mathematics was the servant and assistant, not the master. His guiding star in science, was natural philosophy. Sound, light, radiant heat, chemistry, were his fields of labour, which he cultivated by studying properties of matter, with the aid of experimental and mathematical investigation.

His earliest published papers [Cambridge Philosophical Society, April 25, 1842, and May 29, 1843, followed (November 3, 1846) by a Supplement] were on fluid motion; the second of these and its supplement contained a beautiful mathematical solution of the problem of finding the motion of an incompressible fluid in the interior of a rectangular box to which is given any motion whatever, starting from rest with the contained liquid at rest. This solution, as shown in Thomson and Tait's "Natural Philosophy," §§ 704 and 707, is also applicable to the very practical problem of finding the torsional rigidity of a rectangular bar of metal or glass. For every oblong rectangular section, the solution may be put in one or other of two interestingly different forms, which are identical when the cross-section is square and are always both convergent. One of them converges much more rapidly than the other when one of the diameters of cross-section is more than two or three times the other. Regarding these two solutions, Thomson and Tait (§ 707) say:—

"The comparison of the results gives astonishing theorems of pure mathematics, such as rarely fall to the lot of those mathematicians who confine themselves to pure analysis or geometry, instead of allowing themselves to be led into the rich and beautiful fields of mathematical truth which lie in the way of physical research."

The 1843 paper contained his theory of the viscosity of fluids; and his definite mathematical equations for its influence in fluid motion, which constitute the complete foundation of the hydrokinetics of the present day. In the same paper, by reference to known facts, relating to natural and artificial solids, glass, iron, india-rubber, jelly, and results of experimental investigations, he relieved the theory of elastic solids from what is now known as the Navier-Poisson doctrine of a constant proportion between the moduluses of resistance to compression and of rigidity (resistance to change of shape); and, following Green, gave us the equations of equilibrium and motion of isotropic elastic solids, with their two distinct moduluses, which constitute the whole theory of equilibrium and motion of elastic solids as we have it at this day.

Seven years later, building on the foundation he had laid, he communicated another great paper to the Cambridge Philosophical Society,[1] "On the Effect of the Internal Friction of Fluids on the Motion of Pendulums." In this paper he solved the following very difficult problems, taxing severely the mathematical power of anyone trying to attack them.

(1) The oscillations of a rigid globe in a mass of viscous fluid contained in a spherical envelope having for its centre the mean position of the globe.

(2) The oscillations of an infinite circular cylinder in an unlimited mass of viscous fluid.

(3) Determination of the motion of a viscous fluid about a globe moving uniformly with small velocity through it.

(4) The effect of fluid friction in causing the rapid subsidence of ripples in a puddle and the slow subsidence from day to day of ocean waves when the storm which produced them is followed by a calm.

Of solution (3) he makes a most interesting application to explain the suspension of clouds by determining from the known viscosity of air, the terminal velocity of an exceedingly minute rigid globule of water falling through air. His formula for this has been used with excellent effect in the Cavendish Laboratory by Prof. J. J. Thomson and his research corps; first, I believe, by Townsend in determining approximately the diameter of the globules in a mist produced by electrolysis, by observing its rate of subsidence when left to itself in a glass bell.

In the interval between the two great papers of 1843 and 1850, Stokes gave another magnificent hydrokinetic paper,[2] "Theory of Oscillatory Waves," containing a thoroughly original and masterly investigation of a most difficult problem, the determination of the motion of *steep* deep-sea waves. As an illustration of his results, he gives a diagram (M. and P.P., vol. ii., p. 212) showing the shape of a deep-sea wave in which the difference of level between crest and hollow is seven-fortieths of the

[1] "Collected Mathematical and Physical Papers," vol. i., pp. 329-357. From Cambridge Philosophical Society, March 11, 1850.

[1] December 9, 1850, M. and P. P., vol. ii., pp. 1-144.

[2] Camb. Phil. Soc., March, 1847, M. and P. P., vol. i., pp. 197-229, with supplement first published in the reprint M. and P. P., pp. 316-326.

wave-length—an admirable triumph of mathematical power.

He proved (vol. i. p. 227) that the steepest possible wave has a crest of 120°, with slope of 30° down from it before and behind. He *hoped* to work out fully its shape, and would no doubt have succeeded had time permitted.

Four short papers of July, 1845, February, 1846, May, 1846, and July, 1846,[1] show that in those early times Stokes had taken to heart the wave theory of light. His later splendid work on light has given such great results that even in the scientific world Stokes is often thought of only as a worker in optics and the wave theory of light. Truly his work in this province is more than enough for the whole life-time of a hard-working searcher in science.

A short paper of great value,[2] "On the Formation of the Central Spot of Newton's Rays beyond the Critical Angle," touches in its title a physical question of fundamental importance—*What motion takes place in the ether close behind the perfect mirror presented by total internal reflection?* And the answer to it given in the paper is admirably clear and satisfactory.

A little later, we find one of the most important of all of Stokes's papers on light,[3] "The Dynamical Theory of Diffraction." This paper contains the full mathematical theory of the propagation of motion in a homogeneous elastic medium. It contains, also, application of the theory to the disturbance produced in ether by a Fraunhofer grating for the two cases of incident light, (1) with its vibrations *in* the plane of incidence, and (2) with its vibrations *perpendicular to that plane* (therefore parallel to the lines of the grating). Lastly, it contains a description of an elaborate experimental investigation by himself, and a comparison of the results with theory, from which he concluded that the plane of polarisation is the plane perpendicular to the direction of vibrations in plane polarised light. This conclusion, notwithstanding adverse criticism by Holtzmann,[4] was confirmed by Lorenz, of Copenhagen.[5] The same conclusion was arrived at from the dynamics of the blue sky by Stokes and Rayleigh, and from the dynamics of reflection at the surface of a transparent substance by Lorenz and Rayleigh. We may now consider it one of the surest truths of physical science.

The greatest and most important of all the optical papers of Stokes was communicated to the Royal Society on May 27, 1852, under the title "On the Change of the Refrangibility of Light."[6] In this paper, his now well-known discovery of fluorescence is described; according to which a fluorescent substance emits in all directions from the course through it, of a beam of homogeneous light. The periods of analysed constituents of this fluorescent light, in all Stokes's experiments, were found to be longer than the period of the exciting incident light. But I believe fluorescent light of shorter periods than the exciting light has been discovered in later times.

Stokes found that the fluorescence vanished very quickly after cessation of the incident light. A beautiful supplement to his investigation was made by Edmond Becquerel showing a persistence of the fluorescent light for short times, to be measured in thousandths of a second, after the cessation of the exciting light.

Stokes's fundamental discovery of fluorescence is manifestly of the deepest significance in respect to the dynamics of waves, and of intermolecular vibrations of ether excited by waves, and causing fresh trains of waves to travel through the fluorescent substance. The prismatic analysis of the fluorescent light for any given period of incident light was investigated by Stokes for a large number of substances in his first great paper on the subject, and was followed up by further investigations by Stokes himself in later years, of which some of the results are given in his paper "On the Long Spectrum of the Electric Light" (*Phil. Trans.*, June 19, 1862).

Stokes's great paper on the refrangibility of light is the last paper of the last volume (vol. iii.) hitherto published of his mathematical and physical papers. It is to be hoped that with the least possible delay we shall have a complete collected republication of *all* his other papers. Every one of them, however small, will in all probability be found to be a valuable contribution to science; witness, for example, his paper of twenty-one lines in the *Phil. Mag.* for October, 1872. Let us hope that manuscript may be found for the communication to the Royal Society promised at the end of that paper.

Stokes's scientific work and scientific thought is but partially represented by his published writings. He gave generously and freely of his treasures to all who were fortunate enough to have opportunity of receiving from him. His teaching me the principles of solar and stellar chemistry when we were walking about among the colleges some time prior to 1852 (when I vacated my Peterhouse fellowship to be no more in Cambridge for many years) is but one example. Many authors of communications to the Royal Society during the thirty years of his secretaryship remember, I am sure gratefully, the helpful and inspiring influence of his conversations with them. I wish some of the students who have followed his Lucasian lectures could publish to the world his *Opticae Lectiones*; it would be a fitting sequel to the "Opticæ Lectiones" of his predecessor in the Lucasian chair, Newton.

The world is poorer through his death, and we who knew him feel the sorrow of bereavement. KELVIN.

[1] M. and P. P., vol. i., pp. 141–157.
[2] Camb. Phil. Soc., December 11, 1848, M. and P. P., pp. 56–81.
[3] Camb. Phil. Soc., November 26, 1849, M. and P.P., pp. 243–328.
[4] *Poggendorff's Annalen*, vol. xcix., 1856, or *Phil. Mag.*, vol. xiii. p. 135.
[5] *Poggendorff's Annalen*, vol. iii., 1860, or *Phil. Mag.*, vol. xxi. p. 321.
[6] *Phil. Trans.* and M. and P.P., pp. 259–407.

RECENT METHOD IN PRACTICAL MATHEMATICS.

Höhere Analysis für Ingenieure. Von Dr. John Perry. Autorisierte deutsche Bearbeitung von Dr. Robert Fricke und Fritz Süchting. Pp. viii+423. (Leipzig und Berlin: Teubner, 1902).

CONSIDERING the poor opinion the Germans express for the school of mathematics in this country, it is a great honour for Prof. Perry that his "Calculus for Engineers" should be considered suitable for translation as conveying a message of new method worthy of imitation and adoption.

The improvement of the mathematical instruction

required for practical engineers and electricians has been exciting considerable attention in Germany, as shown by a series of addresses by Prof. Klein, Dr. Erwin Papperitz ("Die Mathematik an der deutschen technischen Hochschulen") and others on this subject, thereby attention has been directed to the stimulating method of Perry, who has utilised the idea due originally to Squeers and worked it to a practical result.

The book, as a series of events connected by a slight thread of continuous theory, suggests a mathematical Pickwick; the subject is inculcated by a succession of practical problems, chiefly of electrical and engineering interest, always completed very usefully by an arithmetical application to a real case. As in Pickwick, these applications have a personal flavour, which must not be lost by research delayed too late even where they are malicious, as in the story of the theorist who proposed an electrical condenser which would have cost a million, or perhaps even a billion, pounds to build.

The state of mathematics in England, as indeed of most learning, is in a very depressed condition. The school at Cambridge is going down hill; the numbers in the mathematical tripos are diminishing so rapidly that it has sunk from its former proud position to third on the list in size. The decay started when the examination was divided into two parts, and the first half was advanced into the summer time, on the simple innocent plea that it would force the men not to waste their time with gaieties. These gaieties flourish more unrestrictedly than ever, and so the examination is held earlier still so as not to clash with boat races and other frivolous fixtures, and the three years' course, as it is called, is reduced to about two years and a half, to suit the convenience of the college tutors, who are allowed to run the University in their own interest. As showing the danger of ill-considered reform, it is ruled now that a return is impossible to the old system, which worked quite well; and to remedy matters a new scheme was nearly adopted of reducing the time still further, ostensibly to two years, really to one-and-a-half. At this rate, the Cambridge student of mathematics will soon be as extinct as the Bachelor of Salamanca.

As for the second part of the mathematical tripos the standard has been raised not quite to infinity, as there are still a few stray candidates, but they barely outnumber the examiners. Contrast this with the good old days when Lord Kelvin was an examiner and there were fifty wranglers out of a total of one hundred candidates; the men had the advantage then of three years and a half, an extra eight months of the most valuable time, including a third long vacation and fourth October term, to revise their work and digest it thoroughly, not to mention the stimulus for the teaching staff of dealing with a greater variety of subjects than in the present elementary dull round.

Perry's book is probably considered very unsuitable for the Cambridge student, but it would serve as a corrective to the tendency to run after such a singular attraction as the Ostrogradsky Paradox, so recurrent as showing the lack of physical touch in the recent school of thought. The student of physical proclivities is driven away now into the natural or mechanical science tripos. In former days, there was a mathematical school of natural philosophy which produced Adams, Stokes, Thomson, Tait, Maxwell, Rayleigh and Hopkinson; this school, which the Germans envied, has been thrown into the melting pot, and an attempt is made instead to rival the Germans in their own particular line of pure abstract analysis, starting twenty or thirty years behindhand, and no wonder the Germans despise such servile imitation.

The last century closed with events which have called up heart-searching as to the cause of our state of decadence and decrepitude. Prominent among the causes was the low state revealed of our intellectual ideal in the public service. But what else can be expected from a system which allows our Civil Service Commission to lower this ideal to mere mark-hunting hunger and to play into the hands of the crammer, so that we go forth with jaded, undisciplined brain and intellectual dyspepsia to encounter a keen, intellectual foe? Our Government experts on education for the public service have shown they are ignorant of the psychology of their profession in producing such universal distaste for all the mental resources required to keep the mind in an active, healthy state. We must have a substitute as near to the high ideal of the American West Point Military Academy standard as we can attain if we are to recover lost ground.

With our present system, there is no incentive to effort once the obstacle of the Civil Service entrance examination is past by the aid of the crammer, and so the intellectual pace is set by the slowest. Double as many should be entered as are allowed to pass out, as at West Point, and the weeding-out process should go on continually, so as to excite competition to escape the last place, as great as among the Chinaman's ducks.

"What is to be said of an institution (Coopers Hill) where 20 per cent. of the candidates fail?" Lord George Hamilton asked, thinking perhaps of Sandhurst, where all pass out without exception; what would Lord George have to say about West Point, we wonder, where 50 per cent. do not graduate?

Hitherto, even in the Navy, there was room for improvement in intellectual alertness; the young aspirant was required to show more scripture knowledge than a bishop would exact from a candidate for ordination; but he knew no Greek, so his culture was of the middle class, Hebraistic rather than Hellenistic, as Matthew Arnold has said. He lost the inspiration of the history and strategy of the first great naval power in the Mediterranean to show him the identity of the tactics of the triremes and galleys and of the modern torpedo-flotilla; and it is perpetual stimulus of this kind that is required to keep him fresh and active in mind, like a Nelson, ready prepared by historical analogy for all possible events.

We lost the American colonies from defects in our naval strategy and the absence of loyal cooperation by sea and land; the same will happen again under our present system, where the admiral, with the fear of Byng's court-martial before him, plays his own game regardless of his partner; the force of Voltaire's proverb, *pour encourager les autres*, is not lost on the foreign strategist.

Prof. Perry, in his writings and addresses, has done much to introduce a higher ideal and to combat prejudiced

officialism; he is having a hard battle, but there are signs of victory in sight; the appearance of this translation will add to the discomfiture of his antagonists, when they see that he has secured an influential following in Germany.

The translation is very faithful—rather too much so in parts where misprints and slight errors have not been corrected, as, for instance, in § 189, where an attempt is made to show why alternators tend to synchronism when in parallel; Prof. Perry should develop the facts more thoroughly, as we know now that the tendency to synchronism exists only under very restricted conditions not always to be secured in practical working.

Dr. Robert Fricke's experience as a professor at a technical high school has had a useful effect of correction on the sublimity of his researches in the exalted regions of modular and automorphic functions, and has led him and his colleague to appreciate a work which most professional mathematicians are too prejudiced to understand.

A. G. GREENHILL.

A MUSEUM CATALOGUE.

Descriptive and Illustrated Catalogue of the Physiological Series of the Museum of the Royal College of Surgeons, London. Vol. ii. Pp. ix + 518. Second edition. (London: Taylor and Francis, 1902.)

IT is now more than two years since we reviewed the first volume of this series (NATURE, vol. lxii. p. 385), and to the present one, the second, we are disposed to extend even greater praise than to the first. The book has thrice the bulk of its predecessor, and it is wholly concerned with the descriptions of the nervous system of certain Invertebrates, and the brain and spinal cord, with their membranes and blood-vessels, of Vertebrates. Its main portion is the work of Prof. Elliot Smith, of Cairo, now our foremost authority on the Vertebrate brain; and in it he describes the brains of the Reptilia and Mammalia in a manner never before attained. He was induced to undertake the task by Prof. C. Stewart, the curator of the museum, at the time at which, in the ordinary course of work, the unparalleled series of mammalian brains which the College possesses were being remounted. Ripe for the opportunity of handling this material, Dr. Elliot Smith has given us, not a mere catalogue, but a masterly treatise teeming with revisionary and new observations, which make for orderly treatment and simplification in a manner surpassing those of most previous essays of the kind.

Some notion of his methods and results may be formed from a brief *résumé* of his work on the "pallium" and "Sylvian fissure," two of the most important things of which he treats. In dealing with the former, he applies to the pyriform lobe and the hippocampus the terms "basal" and "marginal" pallium, in order sufficiently to emphasise, for the first time, the fact that the intervening area or "neopallium," the most variable, is both morphologically and physiologically the most important pallial constituent, and that in the study of this, which he defines as "the organ of associative memory," lies the clue to the chief determination of the real nature of at least the cerebrum of the leading mammalian types.[1] As to the "Sylvian fissure," we meet with an ever-recurring treatment of it throughout the book; and in establishing the fact that the cortical areas from which its lips are formed are non-homologous in different mammals, the author shows that by failure to appreciate this in the past an inextricable confusion has arisen. Concluding that the Sylvian fissure proper is in its complete form found only in the human brain, and proving that it results from the meeting of three sulci phylogenetically distinct and variable in extent and interrelationship among the lower forms, introducing a rational terminology, he has systematised this complex subject on entirely new lines; and it is worthy of remark that he of necessity once more establishes a distinction between the pallial surface of man and the higher apes.

This much is simply revolutionary, but it is characteristic of the whole book; and when it is seen that the brains of representative members of every family have come under review, that in the case of many extinct forms casts of the brain-cavity have been studied, that there are 220 new illustrations, in themselves as accurate as the text, and that an all-sufficient bibliography is given, the result is one upon which all concerned are to be heartily congratulated.

The book forms the framework of an arch, of which the parts necessary for its completion have been obtained by the study, in Cairo and elsewhere, of such material as was originally lacking. There will shortly appear in the *Transactions* of the Linnean Society two memoirs directly related to this catalogue, which, as read, give promise of results at least equal to those of the author's great achievements with the Edentata, the Monotremes and Marsupialia, now everywhere recognised as of prime importance and in the highest degree luminous. Whenever possible, series of brains of each individual species have been studied, and memoirs and catalogue combined will furnish the finest contribution of the last quarter of a century to the science of cerebral topography and the analysis of the commissural systems of the brain.

The minor portion of the catalogue is contributed by Mr. R. H. Burne, the assistant to the curator, and is based on anatomical preparations fully equal to those through which he has obtained distinction in the building up of the collections. The Echinodermata, Annelida, Arthropoda and Mollusca, with the Protochordata, Cyclostomi, Pisces, Amphibia and Birds, have fallen to his lot; and he is responsible for the concluding sections on the membranes, blood-vessels, and spinal cord. Accuracy of detail is the distinctive feature of all that he has put on record, and he has introduced a novel method of display. He gives us new and welcome drawings of microscopic sections of the ganglia of not a few invertebrate forms and of the teleostean pallium, with a bibliography sufficient for the first needs of those who may desire further information. He has played a good second to his distinguished co-author, and a magnificent volume has been produced, worthy the best associations of the great institution whence it originates, the

[1] Pp. 465-466, in which the author elaborates this theme, are fascinating reading.

enthusiasm and foresight of its curator, and the cost of its production, which must have been heavy, and which its council have so liberally borne. Inseparable from the great collections it elucidates, this book should attract workers to them. It furnishes the basis from which all future research on the morphology of the mammalian cerebrum that shall be exact must take its start.

LIGHT FOR STUDENTS.

Light for Students. By Edwin Edser, A.R.C.Sc., &c. Pp. viii + 579. (London: Macmillan and Co., Ltd., 1902.) Price 6*s*.

THIS book is intended to meet the wants of the same class of students as the author's "Heat for Advanced Students," published three years ago. It gives a comprehensive account of the phenomena and laws of geometrical and physical optics, with a number of simple, illustrative experiments and examination questions. Special pains have been taken throughout, as in the author's "Heat," to make all the explanations as simple as possible, so that the private student, who has not the advantage of a teacher's assistance in explaining his difficulties, should find the book particularly helpful. Advanced mathematical methods have been scrupulously avoided, and the calculus is rigidly excluded. This necessarily limits the scope of the work, but the author has found it possible to give a very good general idea of the more difficult parts of the subject and of comparatively advanced theories, such as Sellmeier's theory of dispersion, without making any extravagant demands on the mathematical knowledge of the student.

The first ten chapters are devoted to geometrical optics, the last ten to the development of the wave theory of light. A brief summary is given of the properties of thick lenses, as introducing an account of the eye and of vision through lenses and spectacles. In the chapter on optical instruments, the construction of eye-pieces is dealt with at unusual length, but on the other hand, the account of telescopes is somewhat scanty. Little or nothing is said about the conditions affecting the brightness of the image or the extent of the field of view. The ray diagrams are drawn, following the prevailing custom, without indicating the correct position of the eye. The diagram of Galileo's telescope shows a pencil of rays full and centrical on the object-glass, and small and excentrical on the eye-lens. This is the common practice in text-books, but it does not correctly represent the conditions of vision through this instrument.

The following experiment is given as a proof that the spherical aberration of the eye is over-corrected:—

"Expt. 35.—Close one eye, and place the other at a distance of less than ten inches from a printed page, so that the type cannot be clearly seen. Then place a pinhole immediately in front of the pupil. The printing will become clearly visible, although rendered fainter owing to the loss of light."

Simple experiments of this kind are very helpful to the student, but in this particular instance the conclusion is hardly justifiable. The pinhole would also make the print clearer if held near the margin of the pupil or if the print were beyond the distance of distinct vision of a short-sighted eye. The experiment would be more appropriate as an illustration of increased depth of focus produced by stopping down a lens. An adequate test of the spherical aberration of the eye is not quite so simple.

The wave theory of light is introduced by a chapter on vibrations and waves in general, including an elementary account of the propagation of transverse waves in an elastic solid. This is followed by a general explanation of the rectilinear propagation of light, and of the reflection and refraction of waves. The chapter on the spectrum contains many illustrations from astronomy, such as the proof of the nature of Saturn's rings derived from the Doppler effect. But no account is given of theories of colour vision or of experimental methods of investigation. The chapters on interference, diffraction and polarisation contain photographic illustrations by Mr. W. B. Croft and others of fundamental phenomena. Some account is also given of recent instruments and experiments, such as the echelon grating and Rubens's experiments on infra-red rays of great wave-length. Limits of space have prevented the author from giving an account of the electromagnetic theory of light. The advisability of this would also have been questionable on other grounds. The book, considering its size, already contains an unusually large amount of information, and more could not reasonably be expected by the class of student for whom it is written.

H. L. C.

OUR BOOK SHELF.

Mr. Balfour's Apologetics Critically Examined. Pp. vi + 232. (London: Watts and Co., 1902.) Price 3*s*. 6*d*.

THIS book, issued anonymously by the Rationalist Press Association, is explicitly directed against Mr. Balfour's defence of Christianity (p. 10). To those who read with an animus against this "decaying creed," the author's vigour and lavish use of epithets may appear conclusive reasoning. To the impartial, it will scarcely appear to be criticism at all. Mr. Balfour's method in the "Foundations of Belief" was to advance from the more general philosophic position to the problem of "Provisional Unification." However much his critic believed that Mr. Balfour's theism was based on "emotion and sentiment" (p. 222), or that it could be explained by a review of his pedigree (p. 224), he had no right to rely too much on this application of the historical method.

At least, one expects to find that the "frontal attack" which the author prefers to Mr. Balfour's "sap and mine" (p. 222) shall be directed against the real stronghold. Yet, so far as this book goes, the author leaves untouched the questions, Has experience any elements which cannot be treated as we treat knowledge of "things"? If so, do these elements constitute data from which we may infer that "the whole circuit of belief" has wider foundations than "science" as such requires? And lastly, if the foundations are thus widened, do they admit Theism or Christianity as a form of it? It is easy to call the Incarnation a manifest absurdity; what is

wanted in a criticism of Mr. Balfour is some recognition of the philosophic position which led "a man of Mr. Balfour's intellectual power and high social standing" into a position which our author thinks "in many respects absurd and in all respects untenable" (p. 221). What is the author's philosophy? He thinks "all knowledge is science" and "science is all knowledge" can be interchanged; no explanation or defence is given; he considers sense-perception "the sole foundation of knowledge" (p. 149), and elsewhere asks whether Mr. Balfour has any channels of knowledge other than the senses and the intellect—an addition not without significance. Science (p. 26) is based on the evidence of the senses; theology is vitiated by having no such immediate contact with the evidence of the senses; yet "science is the only reasonable foundation on which Mr. Balfour's theology could be built" (p. 25).

The author considers Mr. Balfour has "uprooted the fabric of science" (p. 26). The careful reader will remember that the passage from which the author quotes the words "habitually mendacious" (p. 23) occurs in "Foundations of Belief," part ii., chap. 1, § iv., and that there Mr. Balfour does not argue that "we are unable to prove the reliability of the senses or the existence of an external world" (p. 147), but only that the "immediate experience" upon which so much has been said is really mediate, and that science now refutes the philosophy which shelters its bad psychology under so good a name. This may be enough to save the unphilosophic reader from thinking that the author writes from an assured position. His discussion of the cardinal questions of "cause," "uniformity" and the like is inadequate; he is equally unfortunate in labouring to disprove (p. 132) a theory which in Mr. Balfour appears as an example of individual bias and is put into the mouth of "the third of our supposed jurymen" ("Foundations of Belief," ed. 1895, p. 314); while the chapter on "Ethics," in itself good, is equally irrelevant; to say that by "religious truths Mr. Balfour means ethical truths" is a gratuitous assumption. The book has far too few references, always inverted and sometimes inaccurate. The index is designed to be amusing; occasionally it is useful.

G. S. B.

La Vie des Animaux illustrée. By E. Perrier. Pp. xxviii+124. (Paris: Baillière et Fils, n.d.) Price Fr. 6.

IF we may judge by the first number, of which we have received a copy from the publishers, this new natural history bids fair to eclipse all publications of a similar nature by the number and beauty of its coloured plates. The name of the Director of the Paris Museum of Natural History is a sufficient guarantee that the text will be all that it should be; while the fact that the coloured plates are from sketches by Herr W. Kuhnert testifies that from both the artistic and the realistic points of view they will have few rivals. The authorship of the sections devoted to mammals and birds has been entrusted to Dr. H. Menegaux, who, in the part before us, treats in a popular, but at the same time exact, manner of the apes, monkeys and lemurs. No less than eighty coloured plates, as we learn from the title-page, are to be assigned to the illustration of the mammals, and of these, nine appear in the present part of 124 pages. All are first-class examples of three-colour printing, and we believe that such a wealth of illustration has never before appeared in a popular natural history. In addition to the coloured plates, the part before us contains a large number of text-figures, all reproduced from pen-and-ink sketches by Herr Kuhnert. As the publishers state in their prospectus, such illustrations are far superior, both from the artistic and the zoological aspects, to reproductions from photographs drawn from miscellaneous sources, which are generally out of harmony with one another and too often fail to display the characteristic features of the animals they represent. We notice that the author refuses to accept modern innovations in nomenclature, retaining, for instance, the familiar Mycetes (in place of Alouatta) for the howling monkeys. One of the main arguments used by the advocates of such changes was that it would conduce to uniformity; but experience seems to suggest that it will have exactly the contrary effect, and if so, where is the justification for such changes?

The work, so far as we can at present judge, is worthy of all commendation, and ought to obtain a large circulation on the other side of the Channel. The price is six francs per part. R. L.

Das biomechanische (neo-vitalistische) Denken in der Medizin und in der Biologie. By Prof. Moriz Benedikt. (Jena: Gustav Fischer, 1903, published 1902.) Pp 57. Price 1.50 marks.

PROF. BENEDIKT protests against the distinction often drawn between mental and natural sciences. Mental science should have an experimental basis; natural science cannot complete itself apart from philosophical psychology. Physical and chemical formulæ do indeed apply to vital phenomena, but they are inadequate for a complete interpretation; "Biomechanik" requires to be supplemented by a "Seelen-mechanik." Every "manifestation" (M) or expression of vital activity (Lebensäusserung) is a function of the inherited "nature" or heritage (N); of the "second nature" or external "nurture" of appropriate environment, psychical as well as physical (N'); of less essential developmental or environmental influences (E); and of incidental or occasional interruptions (O). Thus we reach the vital equation

$$M = f(\pm N, \pm N', \pm E, \pm O).$$

This does not strike us as particularly novel, but Prof. Benedikt works it out in an interesting essay—an apologia for neo-vitalism—in which he discusses cell-life, action at a distance among cells, nervous activities, circulation-phenomena, growth and reproduction. The author hopes that "der feinfühlige Leser" will appreciate his effort at simplicity; but we must condemn ourselves in confessing that we have found his essay exceedingly difficult. It suggests a half-revealed secret, but what the secret is we have been unable to discover. J. A. T.

Monographie des Mutillides d'Europe et d'Algérie. Par Ernest André, Membre de la Société entomologique de France. Pp. 478. Avec 15 planches coloriées et noire. Forme le Tome viii. du "Spécies des Hymenoptères." (Paris: Hermann, 1903.)

IT is only a short time since we had the pleasure of noticing the first half of vol. vii. of this important work, which contained the commencement of the Cynipidæ, and already vol. viii. lies before us, containing the Mutillidæ, edited by Ernest André, the brother of Edmond André, the founder of the work, to whose memory this volume is dedicated.

The Mutillidæ are an interesting family of insects, which were thus named by Linnæus because the females of the commonest species are apterous. They were formerly called solitary ants and were placed near the Formicidæ, but are now more properly regarded as forming a family of the Fossores, or burrowing wasps. There are only three species in Britain, which are not very common; but in warmer countries, and even in the Mediterranean region, they are much more numerous. About 120 species are discussed in the work before us, besides very numerous varieties. The total number of described species is estimated at 1600. The family is divided into four tribes, or subfamilies, Fedschenkiinæ, Apterogyninæ, Methocinæ and Mutillinæ but only

seventeen species are referred to the first three subfamilies altogether, the whole of the remainder falling under the fourth, and typical, subfamily.

The sexes are very different, and it is not always easy to identify them, the males being winged, and often much smaller and slenderer than the females. The head, thorax and abdomen are usually sharply separated, and the body is clothed with very thick down, and is more or less brightly coloured, for even where the prevailing colour of the abdomen is black, it is usually marked with bands or large spots of red, yellow or silvery white.

So far as their habits have yet been observed, the Mutillidæ are parasitic in the nests of various ground-bees and burrowing wasps.

We have so recently reviewed one of the volumes of this series that it is, perhaps, unnecessary to say more than that the arrangement of this volume is similar to that of its predecessors and that it appears to be fully equal to them in execution, both as regards the text and plates. W. F. K.

Publications of West Hendon House Observatory, Sunderland. No. 2. By T. W. Backhouse, F.R.A.S. Pp. viii + 161. (Sunderland: Hills and Co., 1902.)

THIS volume contains the detailed observations which have been made by Mr. Backhouse on the structure of the sidereal universe, comets Barnard (1886) and Holmes (1892), the Zodiacal Light, the Aurora Borealis, and variable and suspected variable stars.

The first part of the observations of the sidereal universe was contained in a previous similar publication (No. 1), and in this second part the author deals with the observations of radiating systems, lines and parallelisms amongst the stars, and the Milky Way.

The author has arranged his table of observations of "Auroræ" (which extend from January, 1860, to Midsummer, 1896) so as to indicate whether or not there is any foundation for supposing the appearances of this phenomenon to have a periodic fluctuation. The table, together with the accompanying curve, indicates a period of sixty-five days, which includes a well-marked succession of maxima at intervals of twenty-eight days.

The last section of the book, dealing with the observations of variable and suspected variable stars, includes an introduction on the "Calculation of Star Magnitudes," observations of the "Orange Stars near η Geminorum" and the "Brighter Stars in Hercules and Neighbourhood," together with a descriptive diagram of the variation of V Aquilæ.

Buttermaking on the Farm and at the Creamery. By C. W. W. Tisdale and T. R. Robinson. (London: John North, the *Dairy World* Office, 1903.) Price 1*s*.

THIS little book is, strictly speaking, a handbook on practical buttermaking. It has the merit of being thoroughly up-to-date, in that the whole process of buttermaking is dealt with in minute detail, and the practice recommended is based on the latest scientific research connected with dairying. It does not describe dairy implements or breeds of cattle, but simply the making of butter and the management of the milk and cream from which it is produced, and it is probably the best of the handbooks on practical buttermaking. The treatment of milk and cream at the factory is fully dealt with, as well as at the farm, and also such subjects as pasteurisation, ripening of cream on a large scale, purchase of milk according to quality, and the packing and marketing of butter. There are also one or two excellent illustrations, showing the appearance of butter in different stages of churning and making. DOUGLAS A. GILCHRIST.

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.*]

Sir Edward Fry on Natural Selection.

I HAVE only just read the memoir of Sir Edward Fry in the January number of the *Monthly Review* on "The Age of the Inhabited World." With its general purport I am in sympathy, and I rejoice in the opportunity of offering a tribute of praise to the extreme lucidity of the language in which it is expressed; but for those very reasons I desire to protest against one of his arguments, which seems to me so faulty as to seriously compromise the value of the memoir as a whole. He is endeavouring to show that natural selection is incapable of doing much that has been accredited to its agency, and uses, p. 78, these words in respect to mimetic insects:—

". . . . the useful deception will not take place until the protected form is nearly approached. Thus during the whole interval occupied in passing from the normal form of group A to near the normal form of group B, natural selection will have been entirely inoperative. . . . Either birds are deceived by a small amount of imitation or they are not. If they are, natural selection cannot have produced perfect imitation; if they are not so deceived, then group A has passed over from its original form to something close upon the form of group B without any guidance from this principle."

I deny this sharp dilemma and assert the existence of many intermediate stages. Two objects that are somewhat alike will be occasionally mistaken for one another when the conditions under which they are viewed are unfavourable to distinction. The light may be faint, only a glimpse of them may have been obtained, the surroundings may confuse their outlines. While these conditions remain unchanged, the frequency of mistake serves as a delicate measure of even the faintest similarity. Prof. McKeen Cattell measured in this way the relative resemblances (in other words the want of distinction) between various printed letters of the alphabet. He placed them on a screen behind a drop slide that had a horizontal slit, giving a uniformly brief glimpse of the letters while the slide was falling. He found, as might have been expected, that "i" was often mistaken for "l," "k" for "h," and so on, each couplet with its own special degree of frequency, which gave a numerical measure of the relative resemblances of the letters. Many other letters that seem ordinarily very unlike were occasionally mistaken for one another, each in a definite percentage of cases. So it must be with insects. If one of the edible group A has individual peculiarities within the limits of variation, that give it a resemblance, however slight, to one of the noxious group B, it will occasionally be mistaken by a bird for a B and allowed to live unharmed. The similarity may be due to a characteristic attitude, to a blotch of colour, to a preference for resting on a part of the foliage to which its own form bears some likeness, or to other causes. In any case, it may well prove to be the salvation of 1, 2 or more per cent. of those that would otherwise have been seen and eaten. If so, the thin edge of natural selection will have found an entrance, and its well understood effects must follow. FRANCIS GALTON.

Hotel Europe, Rome.

The Principle of Least Action.

MR. HEAVISIDE has done good service in calling attention to the *misuse* of this principle; and certain theories of electromagnetism, which have been recently proposed, afford a striking illustration of the value of his remarks and the limits within which the legitimate application of the principle is confined.

In many branches of physics, the equations of motion and the boundary conditions of the dynamical system under consideration cannot be obtained without making some hypothesis, which may or may not be true. One method of testing the truth of the hypothesis is by appeal to experiment, but the legitimate use of the P. of L. A. frequently supplies another. For the original hypothesis, when expressed in terms of mathematical symbols, leads to an energy function, from which the equations of motion and

the boundary conditions can be obtained by the aid of the P. of L. A.; and if the application of this principle leads to results which are dynamically unsound or impossible, the original hypothesis is vitiated even though the formulæ to which it leads should be found to agree with experiment. To endeavour to explain some new phenomenon by introducing a hypothetical term into the energy function, and to deduce the equations of motion and the boundary conditions by means of the P. of L. A., is perfectly legitimate as a tentative process; but the results thereby obtained require careful examination in order to ascertain whether or not they violate any of the fundamental principles of dynamics.

In some theories on the action of magnetism on light, the hypothetical term introduced into the energy function gives rise to certain additional terms in the equations, by means of which the motion and forces are specified, which make some of the forces discontinuous at the surface of separation of two different media. Theories of this kind consequently violate Newton's third law of motion, and can at best be only regarded as stop-gaps until some better theory has been discovered. On the other hand, the introduction of hypothetical terms into the equations which determine the forces, or some of them, *may* lead to an energy function which fails to reproduce the original expressions for the forces when the P. of L. A. is applied; and in cases of this kind the principle affords a valuable test of the correctness of the previous work. The principle, like a great many other mathematical theorems, has its uses, but to convert it into a "graven image" is to court disaster. A. B. BASSET.

Fledborough Hall, Holyport, Berks, January 30.

The Horny Membrane of Neohelia porcellana.

Two years ago, Miss Edith Pratt published in vol. v. of Willey's "Zoological Results" a paper on the anatomy of *Neohelia porcellana*. In this paper attention was directed to a horny membrane lining the hollow tube which forms the axis of the colony, and the suggestion was made that this horny membrane is secreted by the Neohelia itself. The single specimen which Miss Pratt had to investigate was, unfortunately, a small one, and in the criticisms which appeared some doubts were expressed as to whether this horny membrane was not secreted by some tubicolous worm which formerly inhabited the hollow tube of the corallum, and not by the Neohelia itself. I have recently had the opportunity of examining specimens of two species of the closely related genus Amphihelia, one (*A. oculata*) from a depth of 240 fathoms off the coast of Florida, the other (*A. ramea*) obtained by H.M.S. *Porcupine* in the Faeroe Channel, 363 fathoms. In both of them there is a horny membrane similar in character and position to that described for Neohelia. Now it is difficult to believe that a worm forming the same kind of tube, with the same habit of mysteriously disappearing when the corals are preserved, occurs in such widely separated districts as Florida, deep water, New Britain, shallow water, and the Faeroe Channel, deep water. The only reasonable conclusion is that these madrepores do actually secrete this horny membrane themselves. SYDNEY J. HICKSON.

Owens College, Manchester, February 2.

Genius and the Struggle for Existence.

MR. BULMAN, in NATURE of January 22, urges that what is good for the individual or race will survive unaided. But surely this is contrary to well-known facts. Man, with the increase of specialisation, which (whether it be an unmixed good or no) we find associated with his advance to a greater mastery over the rest of Nature, has become, so to speak, a polymorphic species, like the ants, bees or termites; and while in all species we find more or less mutual aid, in polymorphic species it is especially obvious that it is not the isolated individual types, but the total combination that natural selection regards, since the isolated types may be quite incapable of reproducing their kind and performing their special duties unaided.

In all such cases, the "survival" of the individual types, and of the community as a whole, depends, not on the competence of individuals to survive unaided, but on the recognition, instinctive or conscious, of each other's value, and the resulting mutual aid, given either under instinct or in conscious exchange. Now, as I understand, Sir O. Lodge has simply pleaded that steps be taken which, while (*pace* Mr. Bulman) not interfering one whit with the education of the 9999, shall lead to the recognition of the one exceptional genius, with a view to mutual aid, *i.e.* so that he may be set free to do the work of pioneer and leader, which he alone can do; and early, because *ars longa, vita brevis*.

We know that genius can be reared in night-schools, and about Palissy the potter; but ought we to count on our potter burning his furniture for our good, if we, with plenty of ordinary fuel, deny it him?

In the essay to which he refers in his letter in NATURE of January 29, Dr. Wallace attaches less importance to the rearing of a few men of exceptional qualities than to the weeding out of the worst and raising the average; but surely, without giving undue and exclusive credit for advance to the pioneers and prophets, we may take it that men like Darwin and Wallace himself, to mention only one type, will, under natural selection, render the later more conscious steps of man's evolution easier.

Dr. Wallace, in the letter referred to, speaks of the "fittest" not surviving under existing civilisation, meaning that many of the specialised types, which form important elements in our polymorphic communities, are not fittest to survive, and continue to reproduce their kind in more primitive or more ideal communities. But this, of course, accords well with the principle of the "survival" of those types "fittest" to the actual environment. (Survival, of course, does not postulate direct reproduction any more than it postulates long life; the "worker" bees "survive.") Further, Dr. Wallace's hopeful attitude shows that he really trusts "natural selection" to steer the best races of man to a point whence their further, more self-conscious, progress (still, as always, under natural selection) will be more and more in accord with Nature's will, and so less wasteful and pain-fraught.

Man is a self-conscious part of Nature, with the power to "look before and after"; and doubtless the races of man, which will rise highest under natural selection, will not let their faculty of taking counsel from natural and human history rest idle; but, just as Dr. Wallace himself showed years ago that "sexual selection," in the sense of choice of mates, had no power at all *against* "natural selection" (such selection being, I would say, of a faculty or instinct developed by natural selection, and from time to time modified by natural selection to suit changes in the environment), so this conscious "human selection" is but a faculty of man that is being developed (indirectly, perhaps) by natural selection, and can have no power at all to thwart "natural selection," though its wise use may save our race much of the pain that results from fruitlessly "kicking against the pricks." G. W. BUTLER.

February 3.

IT is, of course, true that genius has no survival-value in the struggle for existence between individuals or against physical conditions. But the case is very different when we come to the struggle between groups—tribes, village communities or nations. A tribe which produces a fine bard has far more fighting power than a tribe which has no singer. The possession of a noble literature makes England far more formidable than she otherwise would be. And from the days of flint instruments until now, the inventor has been the salvation of his people.

F. W. HEADLEY.

Remarkable Meteorological Phenomena in Australia.

ON Wednesday, November 13, 1902, we experienced here in Australia some most extraordinary meteorological phenomena. For the previous five or six days, exceedingly hot, dry weather had prevailed, owing to winds blowing from the Australian interior, where a huge anticyclone was resting, in a coastward

direction, the winds taking in Queensland and New South Wales a westerly, and in Victoria a northerly, direction. The hot weather culminated in terrific dust-storms in Queensland, New South Wales, Victoria and South Australia, and during these storms "fireballs" were seen hovering in the air. On the sea, "red rain" was experienced by several passing vessels.

The following is an abstract of what happened :—

Melbourne, Wednesday, November 13. Weather phenomenal, great heat, dust-storms, in all parts of Victoria.

At Boort, great fireballs fell in the street, throwing up sparks as they exploded. The whole air appeared to be on fire ; intervals of complete darkness ; lanterns had to be used in daytime, and fowls went to roost.

At Longdale, a house set on fire by a fireball.

Balls of fire burst on the poppet heads of the New Barambogie mine, Chiltern, Victoria, putting the timbering of the shaft on fire. Almost every meteorological station in Victoria sent in similar reports—fireballs, darkness in daytime, and people stumbling about with lanterns.

Sydney. On November 14, Mr. Bruggman, of Parramatta, was paralysed by a fireball bursting over his head.

Harden, Wednesday, November 13. During a storm yesterday at Murrumburrah, a huge "fireball" hovered over the houses for a considerable time and then disappeared.

H. I. JENSEN.

Caboolture, Queensland, January 1.

A New South Wales Meteorite.

ON reading the account of the fall of the Crumlin meteorite given by several correspondents in your issue of October 9, 1902, I was struck with the parallelism between this occurrence and the fall of the Mount Browne stone in this State on July 17 of this year. Mount Browne is situated near the township of Milparinka, in the extreme north-west corner of New South Wales. About 9.30 a.m. on that date, a loud explosion was heard. In the direction of the sound, a hut is said to have caught fire, this being immediately followed by a whizzing sound and the raising of a cloud of dust at some distance. The stone was picked up within five minutes, while still warm. It may now be seen at the Mining and Geological Museum, Sydney. Its present weight is about 25 lb., but a small piece has been broken off one end. The fractured surface is exceptionally light in colour, the stone being largely non-metallic.

An account of the phenomena attending the fall has been given by Mr. H. C. Russell in a paper recently read before the Royal Society of New South Wales. GEORGE W. CARD.

Sydney, December 23, 1902.

The Holy Shroud of Turin.

I AM sorry to find, from an interesting paper by the Rev. Father Thurston on the Holy Shroud in the current number of *The Month*, that I have mistranslated the passage from Chifflet's "De Linteis Sepulchralibus, &c." p. 198, in which he refers to the spirituous tincture of cinnamon and cloves being used for giving the correct colour in making a copy on linen of the Besançon shroud for King Philip II. of Spain, and not for depicting the King himself. Not having Chifflet's book at hand when writing, I overlooked the reference to the Besançon shroud, but the mistake does not affect the argument regarding the use of such tinctures by painters in the Middle Ages.

J. WATERHOUSE.

A Simple Sensitive Flame.

A USEFUL sensitive flame may be obtained from a Bunsen burner with the usual gas supply by completely excluding the air and lowering the gas pressure until the flame becomes lop-sided but quiet. Its range of sensibility extends for singing over the three octaves of the bass and treble clefs, for whistling over the middle octave of these three. The recovery is prompt enough to allow of a response to each note of a slow staccato passage. The type of burner found best is one with a brass tube three-eighths of an inch bore, with one side hole for air which is quite closed by a half-turn of its tightly-fitting sleeve. E. H. BARTON.

University College, Nottingham, January.

THE FUNERAL OF SIR GEORGE STOKES.

THE funeral of Sir George Stokes at Cambridge on Thursday last was an impressive ceremony in which distinguished representatives of many branches of learning took part. The University church was crowded in every part, and the assembly constituted a living witness to the esteem in which the memory of Sir George Stokes is held in the intellectual world.

The coffin containing the late Master's body was first carried round the court of Pembroke College, in accordance with an ancient custom reserved for Masters, the procession being formed of the choir and officiating clergy, the fellows of the College, former fellows, masters of arts, bachelors of arts and undergraduates.

At the gate of the College, the relatives in carriages took their place in the procession immediately after the fellows. All the other members of the College followed the carriages in their order to Great St. Mary's Church.

In the meantime, another procession was being arranged in the Senate House, comprising the Vice-Chancellor, the heads of houses, doctors, University officers, professors, and members of the council of the Senate, together with the representatives of learned societies. This procession included :—

The Vice Chancellor (Dr. F. H. Chase), with the registrary (Mr. J. W. Clark), in front of whom walked the Esquire Bedells ; Lord Braybrook, Lord Kelvin, Sir Richard Jebb, M.P., the Masters of Trinity, Clare, Peterhouse, Trinity Hall, St. Catherine's, Jesus, Christ's, St. John's, Emmanuel, Downing, Magdalen, and Selwyn, Profs. Allbutt, Mason, Swete, Clark, Macalister, Bevan, Ward, Hughes, Lewis, Liveing, Ridgeway, Barnes, Marshall, Newton, Westlake, Mayor, Ewing, Skeat, Stanton, Ward and Reid ; the Public Orator (Dr. Sandys), Dr. Routh, Dr. Guillemard, Dr. Harmer, Dr. W. G. Lax, Dr. D. Macalister, Dr. Haddon, Dr. James, Dr. Dalton, Dr. Jackson, Dr. Baker, Dr. Langley, Dr. McTaggart, Rev. Dr. Cunningham, Archdeacon Emery, the Rev. J. O. F. Murray, Rev. H. J. Sharpe, Messrs. Berry, H. Darwin Headley, Wright, Mollison, Scott, Shipley, Grey, Durnford, Wyatt, Magmisson, and many others.

The representatives of learned societies and other bodies were as follow :—

The Royal Society—Lord Kelvin (past president), Mr. A. B. Kempe (vice-president and treasurer), Dr. W. T. Blanford (vice-president), Prof. J. W. Judd (vice-president), Prof. G. Carey Foster (vice-president), Prof. R. B. Clifton, Sir Michael Foster (secretary), Dr. J. Larmor (secretary), Dr. T. E. Thorpe (foreign secretary), Sir Arthur Rücker and Prof. A. Schuster (fellows), Mr. R. W. F. Harrison (assistant secretary), together with Profs. Liveing, J. J. Thomson, G. H. Darwin, J. Dewar, A. R. Forsyth, Sir Robert Ball and Dr. Glazebrook. The president of the Royal Society was absent by medical advice.

Victoria University—Prof. Horace Lamb.

Owens College—Prof. Osborne Reynolds and Prof. A. Schuster.

Manchester Literary and Philosophical Society—Prof. Osborne Reynolds.

London Mathematical Society—Prof. Horace Lamb (president), Prof. A. E. H. Love and Prof. W. Burnside (secretaries), Dr. J. Larmor (treasurer).

University of Oxford—Profs. Turner and Clifton.

University of London—Sir A. Rücker (principal), Prof. Tilden (Dean), Sir William Ramsay.

British Association and Royal Institution—Prof. Dewar.

National Physical Laboratory—Dr. R. T. Glazebrook.

Solar Physics Committee and Observatory—Sir Norman Lockyer, Prof. George Darwin.

Institution of Electrical Engineers—Prof. W. G. Adams.

Victoria Institute—Prof. Hull and Mr. Martin Rouse.

Cambridge Antiquarian Society—Mr. T. D. Atkinson.

Chemical Society—Prof. W. A. Tilden (treasurer).

Cambridge Philosophical Society—Dr. H. F. Baker (president), Prof. A. Macalister (past president), Mr. H. F. Newall (treasurer), Mr. A. E. Shipley, Mr. S. Skinner and Mr. H. M. Macdonald (secretaries), Prof. Liveing, Prof. J. J. Thomson and Dr. Hobson (members of the council).

Royal Astronomical Society—Dr. J. W. L. Glaisher (president).

Royal College of Science—Prof. W. A. Tilden.
Meteorological Council—Admiral Sir W. Wharton.
Christian Evidence Society—The Rev. C. Lloyd Engstrome.
Corporation of Cambridge—The Mayor (Councillor P. H. Young), the Ex-Mayor (Ald. G. Kett).

After the service, the procession left the church in the following order:—The officiating clergy, the body, the fellows of the college, the relatives, honorary fellows and former fellows of the College, the Vice-Chancellor and other representatives of the University, together with representatives of learned societies, members of the Senate, bachelors of arts, scholars, other members of the College, and all those desiring to attend the service at the Mill Road Cemetery, where the interment took place.

EXPLORATIONS IN ICELAND[1]

DURING the nineteenth century, and up to the present time, a considerable number of books and magazine articles were published in England and America giving an account of travels in Iceland. The greater part of these writings contain merely personal details, interesting only to the narrator himself and his nearest relations; some remind us pleasantly of Mark Twain's "Innocents Abroad"; others are well written and possess some literary value, though these also are very liable to contain errors.

Some of these travels have a quasi-scientific tendency, but do not contain anything new, and very few contain anything of real scientific importance. We may, perhaps, say that the oldest books describing

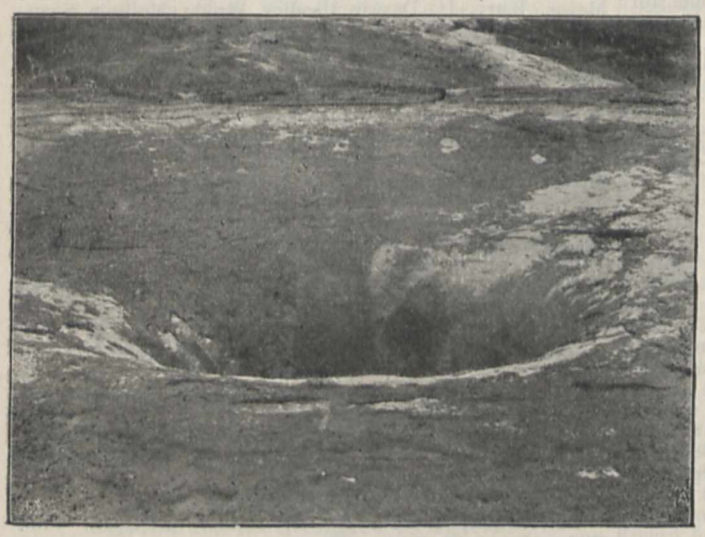

FIG. 1.—The Funnel or Crater of Geysir. (From Bisiker's "Across Iceland.")

travels in Iceland are also the best, and that the books of Hooker (1809), Mackenzie (1810) and Henderson (1814-15) are far superior to nearly all later works. At that period, the traveller had time to study the literature and the people, and to investigate for himself the language of the country and the history and customs of the inhabitants. At the present day, people travel much more, and generally study very little; the traveller passes over half the world without any serious preparation beforehand, and, when he returns home, he considers it to be his duty to enlighten the reading public with a thick book containing observations and discoveries about matters which hundreds of other travellers have described much better before him. Fortunately, however, there

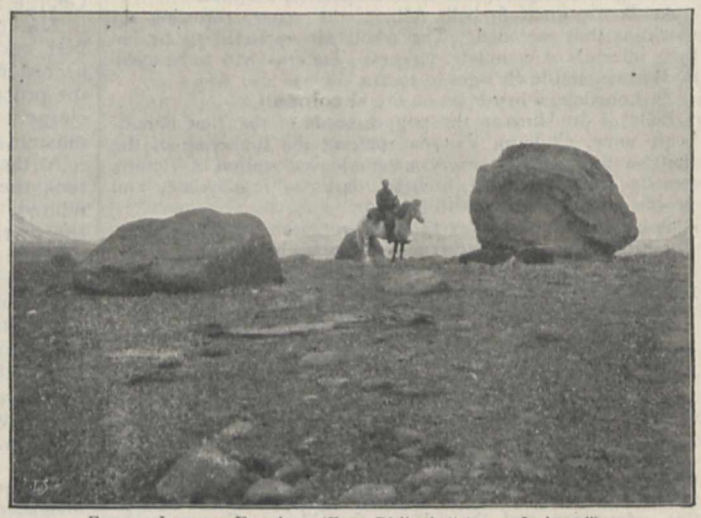

FIG. 2.—Immense Erratics. (From Bisiker's "Across Iceland.")

are some honourable exceptions, and we are always delighted to welcome a book that really contains anything new. Mr. W. Bisiker's book belongs to this class. The author made it his object to explore and map out the district of Kjalvegur in Central Iceland, one of the most beautiful parts of the interior, which had never been surveyed in detail, and Mr. Bisiker's admirable map of the district is, therefore, of permanent geographical importance. The book also contains numerous photographs, which give a very good idea of the various geological and physico-geographical characteristics, and there are some good illustrations of the mode of travelling in Iceland. In addition, Mr. Hill has given some interesting notices of the distribution of plants in Kjalvegur, with a list of the plants which were found, among which is *Ophioglossum vulgatum*, which had not previously been found in Iceland.

TH. THORODDSEN.

[1] "Across Iceland." By W. Bisiker, F.R.G.S. With an Appendix by A. W. Hill, M.A., on the Plants Collected. Pp. xii + 236. (London: Edward Arnold, 1902.) Price 12*s.* 6*d.*

ROYAL COMMISSION ON LONDON LOCOMOTION.

IT was announced on Saturday last that the King had been pleased to appoint a Royal Commission to inquire into the means of locomotion and transport in London. The Commission is also asked to report upon the following points:—

(*a*) As to the measures which they deem most effectual for the improvement of the same by the development and interconnection of railways and tramways on or below the surface, by increasing the facilities for other forms of mechanical locomotion, by better provision for the organisation and regulation of vehicular and pedestrian traffic, or otherwise;

(*b*) As to the desirability of establishing some authority or tribunal to which all schemes of railway or tramway construction of a local character should be referred, and the powers which it would be advisable to confer upon such a body.

The following are the Royal Commissioners :—

Sir David Miller Barbour, K.C.S.I., K.C.M.G., chairman; the Earl Cawdor, the Viscount Cobham, the Lord Ribblesdale, the Right Hon. Sir J. C. Dimsdale, Bart., K.C.V.O., Sir J. P. Dickson-Poynder, Bart., Sir R. T. Reid, G.C.M.G., K.C., Sir Francis J. S. Hopwood, K.C.B., Permanent Secretary to the Board of Trade, Sir J. Wolfe Barry, K.C.B., F.R.S., Sir G. C. Trout Bartley, K.C.B., Mr. Charles S. Murdoch, C.B., Mr. Felix Schuster and Mr. George Gibb; Mr. Lynden Livingston Macassey will act as secretary.

It will be seen that the reference to the Commission is very wide, and the Commissioners will have before them a task of no small difficulty and complexity. There can be little question but that the time was ripe for the appointment of a Commission, and it is to be hoped that the intricacy of the problem will not unduly delay the presentation of the final report, which, judging from the names of the Commissioners, may be confidently relied upon to furnish valuable suggestions for evolving order out of the present chaos.

London is said to have lagged far behind the large towns in other countries in its development of facilities for transport and locomotion. Whether this is due to our natural inertia in the application of the latest engineering developments or to the much greater difficulty of the problem in London, it is a fault which results in some advantages. Now that we are awake to the necessity of speedy and thorough reform, we are able to look round at what has been done elsewhere and select the methods which seem most suited to our special requirements. In this respect, the Royal Commissioners will have an abundance of material from which to choose. On the one hand they will have to consider the various methods of constructing tramways and railways, and on the other the means for relieving the congestion of the ordinary horse and motor traffic. Although it is probably recognised by all that electric traction has proved itself to be far the most suitable for urban and suburban tramways and railways, people are by no means in such close agreement as to the best methods of construction. The success and popularity of the Central London Railway have led many to suppose that the solution of London's traffic problem lies in the indefinite multiplication of "tubes." The experiences of the past Parliamentary session have, however, clearly shown that we cannot look forward to any such simple solution to be provided by private enterprise alone, and the fiasco which then occurred has emphasised the desirability of holding an authoritative inquiry to suggest some definite line of development even if only in reference to this point. The deep-level railway, however, possesses many obvious drawbacks, such, for example, as its lack of ventilation and its unsuitability for coping with short-distance traffic. Some of these might be avoided by the adoption of the shallow-subway railway or tramway, so strongly advocated by the London County Council, and this, at any rate in some localities, would go far towards satisfying the needs of the public. In addition to these, there is the overhead railway to be considered, and also the possibility of developing and extending the use of surface tramways.

The Royal Commission will have to consider, not only the relative merits of these different types of railways, but also the very important question of intercommunication. It is in this respect that progress by undirected private enterprise is least satisfactory, for it may be said that the most essential point is the provision of a number of independent units, each satisfying the wants of the district it particularly supplies, but yet forming a part of a definite and connected whole. Such vexed questions as what type of junction is best, which is the best method of charging, and many others of minor importance, all have to be considered in relation to this point. The appointment of a central authority with power to deal with questions such as these as they arise in the future, as is suggested in the second paragraph of the reference, cannot fail to have a beneficial influence on the orderly and systematic development of traction facilities in London. The problem is, of course, considerably complicated by the existence of several railways already, with which any new scheme will have to fit in; but if this makes it impossible to carry out an ideal arrangement, as could be done if we were starting with a clean slate, it need not prevent the Commissioners from framing a satisfactory scheme.

The Commissioners are asked to report on the means of locomotion generally, and the railway and tramway question is only a small part of the traffic problem. Even with the diversion of as much traffic as possible to suitable railways, the London streets would still be congested. Let us hope that some means will be found for so regulating the horse traffic that it will become possible to make the most of the great advantages which are afforded by mechanical traction—whether by the private or public motor-car—and by the bicycle. The bicycle has already become, and motor-cars are rapidly becoming, a necessity, but the state of the London streets at present does not allow the capabilities of either to be used to the best advantage, and to this may be largely ascribed a part of our backwardness in the development of the engineering and technical side of the subject. Whether or not it may be found feasible to reserve certain roads or parts of roads for motor traffic, as suggested by the Prime Minister a short time ago, must remain at present an open question. Provision of some sort will have to be made, either in this way or by altering the methods of regulating traffic, to enable the mechanically propelled vehicle to properly perform its share in expediting London transport.

The whole question of London traffic is bound up with many side issues of the utmost importance to the community. Of these may be mentioned the housing question, the solution of which is certainly only to be obtained concurrently with the solution of the transport question. The breaking up of the streets for gas, water, electric light, telegraph, telephone and the many other public services also bears very directly on the locomotion question; it is, indeed, one of the County Council's chief recommendations for their shallow-subway tramways that they will afford also a means of getting over this difficulty. The decentralisation of factories and workshops also depends largely on facilities of transport and locomotion. These and many other kindred problems will doubtless receive the consideration of the Commissioners. Lastly, the very important questions of cost and finance will have to be dealt with, since these form the touchstone by which the merits of any scheme will have to be finally tested.

Although we have only been able to touch on a few of the subjects with which the Commissioners will have to deal, enough has been said to show that they have before them no light task, and no one will feel surprised if it occupies them for a long period. The extreme urgency of the question makes it desirable that their report shall be forthcoming with the least possible delay, and still more that, when it has been presented, it should be immediately given practical application by the necessary legislation. There is no fear that on the scientific side of the subject any difficulties need be anticipated. It may be safely said that our engineers are capable of coping with the practical difficulties of any scheme that may be recommended. The difficulty lies, not in providing convenient means of transit—these, and many of them, are ready to hand—but in providing the facilities for their utilisation. Short of establishing a service of aërial cars, there is probably nothing in the way of "means of locomotion and transport" which modern engineering cannot provide, and this being the case, it is to be hoped that we may look forward to London being in a few years the first, instead of the last, of the large cities in its transit facilities.

MAURICE SOLOMON.

RECENT EARTHQUAKES.

IN connection with the announcement made in our notes columns (p. 349) of a remarkable disturbance in the Pacific on January 13 and of an earthquake in Jamaica on February 5, the following abstract of recent earthquakes recorded at Shide, Isle of Wight, which Prof. Milne has made at our request, is of interest:—

The most remarkable disturbance recorded at the Isle of Wight station during the month of January was one which commenced at 1h. 59m. a.m. on January 14. Maxima occurred at 2h. 36m. and 2h. 39m. At 3h. 34m. these are apparently repeated, indicating an origin 137° distant, and therefore possibly to the east of Tahiti—the scene of the recent disasters occasioned by hurricanes and sea-waves. Similar records were obtained at Kew, Bidston, Edinburgh, and probably at all stations furnished with instruments capable of recording the unfelt movements of large earthquakes.

Since the commencement of February, the earthquakes noted at Shide in the Isle of Wight have been as follows:—

Date.	Commencement. h. m.	Maximum. h. m.	Duration. h. m.	Amplitude. mm.
Feb. 1 ...	10 1·6 ...	10 18·9 ...	1 5 ...	6
„ 4 ...	6 51·8 ...	6 54·9 ...	—10 ...	0·75
„ 5 ...	19 4·5 ...	19 46·2 ...	2 30 ...	2 to 0·75
„ 6 ...	8 5·5 ..	8 14·7 ...	—30 ...	1·0

The first is a large disturbance which had its origin at some place about 4500 kms. distant, possibly in Turkestan. The third disturbance—which as recorded at Shide is small—may refer to the West Indies.

J. MILNE.

JAMES GLAISHER, F.R.S.

WE regret to see the announcement that Mr. James Glaisher died on Saturday last, February 7. Born April 7, 1809, he had nearly attained the great age of ninety-four years, the major portion of which was devoted to unceasing work of a varied nature, mainly, however, directed to practical meteorology.

At the age of twenty he was appointed as assistant on the principal triangulation of the Ordnance Survey of Ireland, and from 1833-1836 was an assistant at Cambridge University, whence he proceeded in the latter year to the Royal Observatory, Greenwich, and having been, in 1840, promoted to the position of superintendent of the magnetical and meteorological department, he remained there until his retirement from official life in 1874.

His contributions on subjects bearing on meteorology and astronomy were too numerous to allow of our giving more than a passing notice. His hygrometrical tables, published in 1847, which have reached their eighth edition, are still the standard work on the subject for the British Islands, and "Travels in the Air" (1871 and 1880), "Diurnal Range Tables" (1867), "Mean Temperature of Every Day for Greenwich, 1814-1873," "Report on the Meteorology of India" and "Meteorology of Palestine" are among his chief writings.

From 1862-1866 he made twenty-nine balloon ascents in the interests of meteorological science, and the results were given in reports to the British Association at their annual meetings of those years. The ascent on September 5, 1862, is particularly memorable from the fact that he and the late Mr. Coxwell attained the highest distance from the earth (37,000 feet) ever reached, and formed the subject of a most thrilling experience, which nearly had a tragic termination for both of the intrepid aërial explorers.

As the pioneer of systematic organisation of meteorological observations, the results of his endeavours may be seen in his weekly, quarterly and annual reports on the "Meteorology of England," contained in the periodical returns of the Registrar-General of Births, Deaths and Marriages for England and Wales during the long period of sixty-one years (1841-1902). He was a juror in the class of scientific and philosophical instruments at the exhibitions of 1851 and 1862, and, apart from his scientific work, was actively engaged in other useful spheres of labour.

He was a fellow of several of the learned societies. For upwards of half a century he was on the roll of membership of the Royal Society, to which he was elected on June 7, 1849, and from time to time he contributed papers to the *Philosophical Transactions*. In 1850 he was one of the founders of the British Meteorological Society—now the Royal Meteorological Society—and for many years took a leading part in the conduct of its affairs, being its original secretary, "who nursed it through its infancy and youth, and left it to other hands only when it was old enough and strong enough to walk alone" (president's address in the jubilee year). He was also a past-president of the Royal Meteorological Society, the Royal Microscopical Society, the Royal Photographic Society and the Aëronautical Society of Great Britain, a fellow of the Royal Astronomical Society, and for many years was on the executive committee of the Palestine Exploration Fund, of which he was for twelve years the chairman. He had also been honoured with the honorary fellowship of several foreign scientific bodies.

NOTES.

WE are fortunate in being able to publish the appreciative notice of the late Sir George Stokes's scientific work, contributed by Lord Kelvin to another part of the present issue. So long ago as 1875 (vol. xii.) Sir George Stokes was one of our Science Worthies, and the account of his career then given is now supplemented by the record of his life's work and estimate of its influence on scientific progress, which Lord Kelvin has sent us. The funeral at Cambridge on Thursday last was a striking ceremony, in which men of distinguished eminence in many branches of knowledge took part, as will be seen from the list given on pp. 345, 346, of some of the people present. It is but rarely that such an assembly is drawn together, and the presence of so many men of light and leading showed the high regard in which Stokes was held, and testified to a widespread desire to do honour to his memory. It is inexplicable that no attempt was made to find a place for the body in Westminster Abbey. Great by his works and personality, Stokes was a man whose memory the nation should delight to cherish, and if such men as he are not buried at Westminster, it is difficult to understand who should find a place there.

THE gold medal of the Royal Astronomical Society has this year been awarded to Prof. Hermann Struve, of Königsberg, for his work on the satellites of Saturn. The medal will be presented at the annual general meeting to be held to-morrow, February 13. The Councillor of the German Legation will attend the meeting and receive the medal for Prof. Struve, who is unable to be present.

A CENTRAL NEWS message from New York reports that earthquake shocks were felt on Sunday evening in Indiana, Illinois, Kentucky and Missouri.

A DESPATCH from Kingston, through Reuter's Agency, states that an earthquake with loud subterranean rumblings occurred in Western Jamaica during the evening of February 5.

ACCORDING to news from San Francisco, a hurricane and great wave struck the Society or Tahitian Islands and the Tuamotu Archipelago, 500 miles further east, on January 13. The hurricane lasted for several days, but it was most severe between January 14 and 16. Eighty islands are said to have been overwhelmed and 1000 natives killed. Native refugees at Tahiti state that the sky began to assume a peculiar aspect on January 11, and that the inhabitants were all greatly alarmed. The air was very oppressive, and the wind began blowing fiercely from the south-east. Hour by hour it increased in violence, and every wave was higher than its predecessor. The natives on several of the adjacent islands succeeded in making their way to Hikuera, which has the greatest elevation of all the islands in the group. A wall of water, said to have been at least forty feet in height, rose and rushed hundreds of miles wide through the islands. For ten hours this state of affairs prevailed. The storm extended to Raiatea in the Leeward Isles, where much damage was done, but no fatalities occurred. In connection with this disturbance, the earthquake records described by Prof. Milne on p. 348 are of interest.

THE *Daily Mail* announces that excellent telephonic communication was established on February 3 between the central State office in Copenhagen and Frankfort and Mayence in Germany, a distance of about four hundred miles. The Dutch Vice-Consul at Kallundborg, North-West Seeland, also spoke to Frankfort, every word being distinctly audible.

DR. A. S. GRÜNBAUM has accepted the post of director of cancer research at the invitation of the committee appointed to administer the fund initiated for that purpose by a gift of 10,000*l.* from Mr. Sutton Timmis, of Liverpool. The work will be carried on at the University College, Liverpool, and the Royal Infirmary.

WE learn from the *Athenaeum* that the King of Sweden and Norway has instituted a gold medal in honour of the centenary, last autumn, of the famous mathematician Niels Abel. The medal, which will be given by the Academy of Science in Christiania every fifth year, will be awarded for eminent work in pure mathematics, without regard to nationality.

MR. H. BALFOUR, the curator of the Pitt-Rivers Museum at Oxford, has been elected president of the Anthropological Institute for the year 1903. The council has selected for election as honorary fellows of the Institute, Mr. A. W. Howitt, of Melbourne, for distinguished services to the ethnology of Australia; Dr. F. von Luschan, for numerous contributions to ethnology; and Dr. Salomon Reinach, for his researches into the early history of civilisation in the Mediterranean and western Europe.

REMARKABLE results in the way of swift locomotion are said by the *Westminster Gazette* to have been obtained with the new Midland Railway compound engines, which for a distance of fifteen miles between Leeds and Carlisle attained a speed of more than eighty-two miles an hour, with a load of about 350 tons. The total weight of engine and tender is eighty-five tons, but the weight in working order is 112 tons. These engines are working express passenger trains between Leeds and Carlisle.

To encourage investigations into the increase of fertility in soils by the action of bacteria and other micro-organisms, under the influence of mineral manures, with special reference to manuring with basic slag, the Berlin Association of Thomas's Phosphate Works has instituted a competition, with prizes amounting to a total of 1950*l.* Scientific essays and experiments conducted by practical farmers will be admissible in the competition. The competition is to be open to all, without regard to nationality. Competitors are requested to send in their essays, written in German, to the address of the association, Berlin, S.W., Hafenplatz 4, not later than February 1, 1906.

THE Berlin correspondent of the *Times* states that Dr. Sven Hedin delivered a lecture on February 7 to the Geographical Society of Berlin upon his recent journeys in Central Asia and Tibet. The Imperial Chancellor, Count von Bülow, who had intended to be present, was at the last moment prevented from attending. The Imperial Secretary of State for Foreign Affairs, Baron von Richthofen, appeared on behalf of the German Foreign Office. At the conclusion of the lecture, Prof. Hillman announced that the German Emperor had conferred on Dr. Hedin the second class with the star of the Prussian Order of the Crown. Dr. Sven Hedin was elected an honorary member of the Berlin Geographical Society, and was presented with the golden "Nachtigal" medal, which was founded in memory of a well-known Central African explorer.

THE United States Commercial Agent at Vladivostock states in a recent report that a German engineer has found new naphtha ground on the eastern part of Sakhalin Island, and also a large lake filled with dry naphtha. This, he says, would be excellent material for preparing asphalt. This engineer thinks the prospects for naphtha promise to be richer than those of Baku.

THE *Scientific American* gives an account of some experiments in wireless telegraphy which were recently carried out with a moving train, and proved very successful. Several difficulties peculiar to the case presented themselves; a vertical collecting wire could not be used, and horizontal wires inside the cars had to be substituted. It was also found that the receiving relay could not be used at its maximum sensitiveness on account of the vibration of the train. In spite of these and other minor drawbacks, it was found possible to keep the train in touch with the station for from eight to ten miles. The experiments were carried out by Dr. E. Rutherford and Dr. H. T. Barnes, of McGill University, Montreal.

DR. R. T. GLAZEBROOK, writing to the *Electrician*, states that the arrangements for carrying out photometric work at the National Physical Laboratory are now nearly completed. The photometric laboratory has been largely equipped by the generosity of Messrs. Crompton, who have presented a potentiometer outfit, the Electrical Power Storage Co., which is giving a battery of 150 cells, and Mr. Trotter and Sir Wm. Preece, who have presented other apparatus. A 10 c.p. pentane standard is being compared with that of the gas referees by Mr. Vernon Harcourt, and Mr. Glazebrook is in correspondence with the Reichsanstalt as to obtaining standard lamps. As soon as everything is in working order the laboratory will be able to assume the position and responsibility of a standard photometric authority, so far as this is possible without legislation. The establishment of this laboratory will be a great boon to electrical engineers, who will be able to look to it for guidance in some of the many vexed questions of photometry. The possibility of obtaining

a constant candle power incandescent lamp, such as that described by Prof. Fleming in his paper on photometry read before the Institution of Electrical Engineers, and of having it standardised by a competent and recognised authority, should act as an inducement to electrical engineers to pay more attention to the testing of lamps, and cannot fail to have a beneficial effect on the electric lighting industries.

WE learn from a short notice in the *Scientific American*, translated from *l'Illustration*, that the dirigible balloon constructed for the brothers Lebaudy by MM. Julliot and Surcouf has been experimented on with continuous success. The start has been made in every case from a cemented trench in front of the shed. A number of ascents have been made with the guide rope trailing on the ground, and finally the rope was drawn up, though so arranged that it could be instantly thrown to the ground and caught by people who followed the balloon on foot. Even though a fog came on so heavily as to cause fear that the balloon would be pulled down by the weight of the condensation, a safe return to the starting point was made, and M. Juchmes then took charge of the balloon and caused it to describe a figure of eight with great dexterity. MM. Julliot and Surcouf propose to attempt the journey from Moisson to Mantes and back as soon as a fine day occurs.

MEASUREMENT of electric resistance has been employed by M. Lesage as a method of analysis for certain fermentations and in pathological cases. A note on these experiments is given by M. Dongier in the *Bulletin* of the French Physical Society (No. 188). Samples of Parisian milk were found at a temperature of 16°.7 to vary in resistivity between 230 and 275, but it was found that watering the milk increased the resistivity while lactic fermentation lowered it. The resistance of culture broths generally was affected by the growth of the bacilli. The tetanus bacillus lowered it, and this lowering was not due to the toxin; others raised it, some left the resistance unaltered. The serum of the blood of man and animals, taken from healthy adults, varied from 97 to 104 ohms at a temperature of 16°.7. Most diseases did not affect the resistivity, but some, notably typhoid fever, produced a noticeable increase, reaching to 117 ohms. The maximum in the case of typhoid occurred at the commencement of convalescence.

DR. J. MOUNT BLEYER has sent us a copy of the introductory address delivered by him at the American Congress of Tuberculosis, on "Light—its Therapeutic Importance in Tuberculosis as Founded upon Scientific Researches." Barely ten of the eighty pages are devoted to the subject in question, the bulk of the communication being occupied by the consideration of the vibratory theory of light and its relation to other forms of motion familiar to every student of elementary physics. The fact that tuberculous patients are benefited by light is well known, and the author describes a method of treating consumptives by exposing them to sunlight in specially constructed solaria, and to the electric light from powerful arc lamps. He relies upon the violet and ultra-violet rays for his results, and maintains that they have the power of penetration, ignoring the fact that Finsen has proved that the red colouring matter of the blood prevents the passage of the radiations at the violet end of the spectrum. If the blood circulating in the lobule of the ear is sufficient to prevent the blackening of photographic paper, it is obvious that a very small proportion of the actinic rays can penetrate the lung, and it is known that to destroy bacteria, concentration of the actinic rays is necessary. The beneficial effect is probably due to the stimulation of the skin by the light rays and not to any direct influence upon the deeper tissues. The author does not, of course, rely upon light alone in the treatment of consumption, but combines with it "hygienic food, fresh air, exercise and such suitable remedies as are indicated." By a judicious combination of these measures, he claims that 75 per cent. of tuberculous patients are curable "to a certain extent."

THE fourth volume (1901) of the *Publicationen der Kön. ung. Reichsanstalt für Meteorologie und Erdmagnetismus* contains an interesting summary and discussion of the lightning strokes that have been recorded in Hungary during the years 1890 to 1900. The author, Herr Ladislaus von Szalay, chief assistant of this institute, has written the text in two languages in parallel columns, so that those who cannot follow the Hungarian will probably be able to read the German. In his discussion of the observations, he treats of the distribution, frequency, periodicity, &c., of thunderstorms, and brings together a useful number of statistics relating to the same phenomena in other countries. A coloured map shows the geographical distribution of the thunderstorms, while an interesting diagram illustrates the eleven-year means of the frequency of incendiary flashes over 1000 square kilometres in Hungary. Full details, given in tabular form, of the thunderstorm records made at the several storm stations for the years 1896–1900 are added.

HERR VON SZALAY also contributes an interesting note on the peculiarity of lightning flashes to the *Meteorologische Zeitschrift* (Heft 10, 1902). He has found that the coherer of his instrument constructed to record the approach of thunderstorms was found sometimes to be quite insensitive to some flashes of lightning that were practically very near to it, while, on the other hand, it was in nearly continuous agitation during a distant storm when the sky overhead was cloudless. He relates that by watching the coherer and the lightning flashes simultaneously, he observed that flashes having sharp contours, whether from cloud to cloud or to the earth, agitated the coherer, but those that were diffuse were not recorded at all.

THE United States Weather Bureau has issued its report for the year 1901–2. It need scarcely be said that the work, which contains 342 quarto pages, mostly tables, contains a large amount of very useful information. In addition to the results relating to the year in question, it includes a valuable series of tables, showing, for each month, the highest and lowest temperatures recorded in each State since the time observations were commenced. The work also contains monthly and yearly results for a number of stations in the West Indies. The weather forecasts and storm warnings appear to have been very successful, and an important recognition from the secretary of Lloyd's is quoted as to the accuracy of forecasts of bad weather issued for the North Atlantic Ocean. A programme of aërial research in the upper strata of the atmosphere has been inaugurated under the care of Prof. Abbe, and, further, a valuable set of nephoscope observations at eleven stations in the West Indies has been secured between May, 1899, and May, 1902; these observations furnish, for the first time, the necessary data for discussing problems connected with the circulation of the atmosphere in the tropical zone, and possess especial interest in connection with the distribution of the ashes ejected from the volcanoes in May and June last. Experiments on wireless telegraphy are being made; the opinion at present seems to be that for permanent communication between land stations, wire is the more trustworthy means of communication, and probably the more economical.

THE current number of the *American Journal of Psychology* contains an elaborate experimental study of Fechner's colours (the colours of the "artificial spectrum top") by Miss F. W.

Bagley. The work was done, under Prof. Titchener's direction, in the psychological laboratory of Cornell University. Miss Bagley examines the effects of rate of rotation, length of black line, variation in size of sectors, width of line, position on the disc, contrast, intensity of illumination, colour of background, besides those of the general psychological factors, practice, attention and fatigue. She obtains particularly interesting results as regards the production of a subjective yellow and concludes that only a four-component theory of vision is adequate to her facts. The theory chosen, tentatively, is Ebbinghaus's modification of Hering's well-known hypothesis.

THE *Pioneer Mail* quotes a letter from a Ceylon paper in which a correspondent records killing a cobra that had partially swallowed a rat-snake. The cobra itself measured 4 feet 8 inches, and the disgorged rat-snake 5 feet.

WE have received vol. xx. part iv. of the *Schriften* of the Scientific Society of Dantsic. Among its contents is an illustrated account of the insects of West Prussia harmful to agriculture and horticulture, with suggestions as to the best means of combating their ravages.

THE fourth part of Prof. L. Bolk's important memoir on the anatomy of the Primates appears in part i. of vol. xxxi. of Gegenbaur's *Morphologisches Jahrbuch*. In this section the author describes in detail the cerebellum of the New-World monkeys. It is to be followed by an account of the same organ in the orang-utan.

DR. W. H. GASKELL, at the conclusion of a series of papers on the origin of vertebrates, published in the *Journal of Anatomy and Physiology*, summarises, in the January number, his views as follows:—"The consideration of the formation of the vertebrate cranial region indicates that the ancestor of the vertebrates was not an arachnid purely or a crustacean purely, but possessed partly crustacean and partly arachnid characters. In order to express this conclusion, I have used the term Protostraca, invented by Korschelt and Heider, to indicate a primitive arthropod group from which both arachnids and crustaceans may be supposed to have originated, and have therefore stated that the vertebrates did not arise directly from the annelids, but from the Protostraca."

IN the *Biologisches Centralblatt* for January 15, Herr E. Wasmann commences an account of an investigation into the phenomenon of "symphilism," that is to say, the harbouring of insects, &c., of various foreign species in the nests of ants and termites. It is stated that the number of symphilous arthropods exceeds a hundred, of which from eighty-five to ninety are beetles. All these symphilous insects, and more especially beetles, possess certain peculiarities by which they can always be recognised. Among the most notable are special exudation organs, such as pits or pores in the exoskeleton, mostly associated with pencils of yellow or reddish-yellow hairs. Moreover, most symphilous beetles have a characteristic colour, namely, oily reddish-yellow or reddish-brown. They also show certain modifications of the mouth-organs, especially of the labium, as well as "physogastrism," accompanied by excessive development of the fat-bodies, or sexual glands.

THE effects of natural selection and race-tendency upon the colour-patterns of the Lepidoptera formed the subject of an investigation recently undertaken by Mr. A. G. Mayor, the results of which are published in the *Science Bulletin* (vol. i., No. 2) of the Brooklyn Institute. It appears that the colour-markings of Lepidoptera consist of spots and bands, or of a combination of these two, the "combination-markings" being the least frequent. Certain general types of variation in these markings are noticeable, but each family or genus has characteristic modifications of these types of variation. A definite relation exists between the number of markings on the fore- and the hind-wings. The species of a genus and the genera of a family are differentiated by modifications of certain dominant conditions, each genus or family displaying its own dominant conditions and following its own peculiar law of differentiation. On the whole, the investigation favours the view that new species have originated by mutation independent of environment, and generally not interfered with by adverse selection.

PROF. POTONIÉ, in a small work published by Gustav Fischer, gives an explanatory account of his pericaulom theory of the structure of plants. Probably the author would hardly accept as a description of his position the suggestion that it is an attempt to combine the views of Goethe and of Alex. Braun, but it seems nevertheless very much like it. The plant is conceived of as primarily originating from a dichotomising thallus, which gradually becomes, by unequal development of the two limbs, a sympodium. The leafy part seems to be formed as the outward prolongations of the terminations of the dichotomising arms. The theory is complicated by notions of congenital concrescence, but it does not seem to render the task easier of deciding as to what parts are to be attributed the properties of "Leaf-nature" and what "Stem-nature." He concludes (p. 40), on grounds that will probably not satisfy all anatomists, that in the highest plants the pith is to be regarded as the "urachse," the peripheral tissues belonging to the "pericaulom." It may be doubted whether these academic speculations will appeal to many botanists at the present day.

A SUBJECT list of the works on general science, physics, sound, music, light, microscopy and philosophical instruments, in the library of the Patent Office, has been issued at sixpence. The list consists of two parts: a general alphabet of subject headings (occupying 170 pages), with entries, in chronological order, of the works arranged under these headings; and a key (12 pages) or a summary of these headings, which serves the purpose of an index.

THREE more volumes of the first annual issue of the "International Catalogue of Scientific Literature" have reached us. Volume v. contains astronomical works and runs to 301 pages. Volume vii. deals with pure mathematics in 201 pages, and volume viii. with bacteriology in 314 pages. Those portions of the literature of 1901 which are not catalogued in the volumes of pure mathematics and bacteriology will form a part of the second annual issue of the catalogue.

MESSRS. JOHN BARTHOLOMEW AND CO., Edinburgh, have commenced the publication, in twenty one monthly parts, of "The Survey Atlas of England and Wales." The atlas is to contain eighty-four plates of maps and plans, with descriptive text, illustrating the topography, physiography, geology, climate, and the political and commercial features of the country. The maps have been designed and prepared under the direction of Mr. J. G. Bartholomew. The basis of the atlas is the Ordnance Survey, reduced, by permission, to the uniform scale of half-an-inch to the mile, in sixty-seven section maps, which are coloured according to contour lines. In order to correct the maps to date, the sheets have been submitted to local authorities for systematic revision, and the general maps have also been revised by specialists.

PROF. A. M. WORTHINGTON'S "Dynamics of Rotation," which was written several years ago to provide engineering

students with an elementary treatment of rigid dynamics, and was reviewed in NATURE of May 5, 1892 (vol. xlvi. p. 4), has so successfully fulfilled its purpose that it is now in its fourth edition. In this edition the author directs special attention to the use of the "inertia skeleton," in which a body is replaced by a dynamically equivalent system of three thin wires placed along the three principal axes at its centre of mass. This method of representation has been found to appeal to non-mathematical students far better than the conventional momental ellipsoid. Further attention has also been given to experiments with a gyroscope, which are so easily made that it is a matter for congratulation that they can now be studied in an elementary treatise. The author introduces the name "slug" to denote the mass to which a foot-pound unit of acceleration is produced by a gravitation unit of force.

ACCORDING to recent investigations, liquid sulphur dioxide is a solvent in which a large number of substances, organic and inorganic, are readily soluble. From experiments of Walden and Centnerszwer, published in the *Zeitschrift für physikalische Chemie*, it appears that sulphur dioxide forms complex compounds with many of these substances. From solutions of potassium iodide in liquid sulphur dioxide, they have obtained a crystalline compound of the formula $KI.4SO_2$, which melts at +0°·26 C. Similar compounds are in all probability formed by other salts, and the name of "sulphones" is ascribed to this class of bodies.

IN the current number of the *Zeitschrift für physikalische Chemie* is a noteworthy paper by Messrs. Alexander Smith and W. B. Holmes in which the nature of amorphous sulphur is discussed. This so-called amorphous sulphur is formed when liquid sulphur is maintained in the molten condition for some time, and its amount increases as the temperature is raised. A method of determining the proportion of amorphous sulphur in the liquid variety has been worked out which depends essentially on the great difference in solubility of the two forms in carbon bisulphide. From parallel determinations of the proportion of amorphous sulphur and of the freezing point of the melt, it is shown that the lowering of the freezing point below 119°·25 C. is proportional to the quantity of the dissolved amorphous sulphur. The molecule of the latter in the solution of the soluble liquid form is found to be represented by the formula S_8.

A NEW reducing agent which promises to be of considerable service is described by Mr. E. Knecht in the current number of the *Berichte*. From the analogy between titanium and tin, it appeared likely that the chloride of titanium on reduction would give a lower chloride $TiCl_2$, analogous to stannous chloride. The reduction of the acid solution of the tetrachloride of titanium, however, produced the trichloride already known instead of the expected dichloride, but this, on examination, proved to possess remarkable reducing properties. Whilst applicable to reduction in a similar manner to stannous chloride, titanium trichloride is more powerful. Copper salts can be reduced to metallic copper; sulphites may be quantitatively reduced to hyposulphites, or, if the action be pushed, sulphur is produced. By careful neutralisation with soda, the titanium can be completely removed as the hydrated oxide. The behaviour of titanium trichloride towards organic substances is also of interest; nitro-bodies are reduced immediately to amines, and in the case of substances containing more than one nitro group, the partial reduction is readily effected. Azo-bodies are attacked so sharply that they may be quantitatively estimated, and other reactions are given showing the wide range of applicability of this reagent.

SOME time ago it was shown by M. C. E. Guillaume that it was possible to obtain nickel steel alloys which possessed extremely low coefficients of expansion, and in the current number of the *Comptes rendus* he gives a more detailed study of the conditions necessary to obtain such alloys. The expansion is influenced considerably by the presence of foreign elements such as manganese, carbon and silicon, and it has been found that if these are reduced below a certain amount, the alloy cannot be worked. Working under the most favourable conditions, an alloy has been obtained possessing a coefficient of expansion $\alpha = (+0{\cdot}028 - 0{\cdot}00232\theta)10^{-6}$, a figure which can be better understood when it is stated that a wire made of this steel, one kilometre in length, would alter in length in passing from 0° to 20° C. less than 0·4 mm. The importance of an alloy possessing such properties in geodetic work is obvious, and extensive use has already been made of it in the geographical service of the French army, in the marine hydrographical service and elsewhere. All temperature corrections in geodetic work become superfluous.

THE additions to the Zoological Society's Gardens during the past week include a Barnard's Parrakeet (*Platycercus barnardi*) from Australia, presented by Mrs. Jebb; a Hawfinch (*Coccothraustes vulgaris*), British, presented by Miss H. Brown; a Rufous Rat-Kangaroo (*Æpyprymnus rufescens*) from New South Wales; two Corean Cattle (*Bos taurus*, var.) from Corea, six Proteus (*Proteus anguinus*) from the Caves of Carniola, deposited.

OUR ASTRONOMICAL COLUMN.

ELEMENTS AND EPHEMERIS OF COMET 1903 *a*.—The following elements and ephemeris for this comet have been calculated, by M. G. Fayet, of Paris Observatory, from observations made at Nice (January 19), Besançon (January 24) and Paris (M. Bigourdan, January 27); the necessary corrections for aberration and parallax have been made.

T = 1903 March 28·9468 M.T. Paris.

$\omega = 130° 40' 55''$
$\Omega = 0\ 41\ 56$ } 1903·0
$i = 35\ 35\ 6$
$\log q = 9{\cdot}67479$

Ephemeris 12h. M.T. Paris.

Date.	α app. h. m. s.	δ app. ° ′	log r	log Δ	Brightness.
Feb. 9 ...	23 24 50	+ 8 7·1	0·0619	0·2517	2·1
13 ...	23 31 17	+ 9 27·7	0·0348	0·2395	2·5
17 ...	23 38 16	+10 53·7	0·0056	0·2257	3·1
21 ...	23 45 49	+12 25·1	9·9742	0·2101	3·8
25 ...	23 54 3	+14 2·5	9·9403	0·1923	4·8
March 1 ...	0 3 2	+15 45·5	9·9039	0·1721	6·3

The brightness on January 19 (about 10m. 0–11m. 0) is taken as unity (*Astronomische Nachrichten*, No. 3845).

THE CONSTANT OF ABERRATION AND THE SOLAR PARALLAX.—In No. 529 of the *Astronomical Journal*, Dr. Chandler gives the results of an exhaustive inquiry, which he has conducted during the last ten years, into the various values obtained for the constant of aberration by different observers and methods. After discussing the trustworthiness of the methods employed, Dr. Chandler apportions various weights to the results obtained, and then rejects a number of these results as being too uncertain. He then determines the constant from the accepted results, and obtains, as the general mean, the value 20″·521 with a probable error of ± 0″·005.

In order to show the effect of incorporating *all* the results, he determines the weighted mean of all the values and thereby obtains the value 20″·517.

As a final result of the inquiry, Dr. Chandler accepts the value of 20″·52 for the constant of aberration, and this produces the value 8″·78 for the solar parallax.

A NEW FORM OF SPECTROSCOPE.—In No. 12, vol. xxxi.,

of the *Memorie della Societa degli Spettroscopisti Italiani*, Signor Antonio Sauve describes a new form of spectroscope which he has devised and calls the "Filtro Spettroscopico."

This instrument enables an observer to view directly, or to photograph, the monochromatic image of any object which emits light of the desired wave-length.

Among the various observations for which the author suggests the instrument may be used, he includes the observing of prominences and other solar phenomena, and claims the following advantages for his method over the methods now practised:—(1) The prominences on the *whole* of the solar disc may be observed visually, and (2) the surface may be observed, visually or photographically, as a whole, instead of having to be taken in sections as is done at present.

REPORT OF THE UNITED STATES NAVAL OBSERVATORY.—This comprehensive report deals with the work done during the fiscal year ending June 30, 1902, and is full of interesting descriptions of the methods employed and the results obtained.

A large diurnal temperature change in the azimuth constant of the 6-inch transit circle has been eliminated by substituting brick and Portland cement piers for the marble piers on which the instrument formerly rested.

With the 26-inch equatorial, important work has been done in determining the diameters of the planets and their satellites, and, by comparing the diameters obtained at night-time with those obtained at twilight, the constants of the variations due to irradiation have been determined. The results are given in a complete and interesting table. The value for irradiation in the case of Mars varies from 0″·70 when the planet is in aphelion to 1″·02 when it is in perihelion, and should, therefore, always be taken into account in observations made at different epochs.

During the year, photographs of the sun were obtained with the 40-feet photoheliograph on 200 days, and these showed the presence of spots on 45 days. Although the average number of spots for the whole year is less than during the previous year, the average frequency from October to July is slightly greater, thus indicating that the sun-spot minimum has probably been passed.

Reports on the 12-inch equatorial, the prime vertical transit instrument and 5-inch altazimuth, the magnetic and meteorological sections, and several other instruments and departments are also given in detail.

A NEW 18-inch refractor is being made by Messrs. Alvan Clark and Sons for Amherst College Observatory.

WE are pleased to learn that the recent fire at Yerkes did no injury to the 40-inch refractor, but some damage was done in the coelostat room.

FORESTRY IN THE UNITED STATES OF AMERICA.

TWENTY years ago, the people of the United States did not trouble themselves much about their forests. It was said that enormous areas were stocked with an inexhaustible amount of timber and fuel. Since then a great change has taken place. It has gradually been ascertained that, although the total forest area is estimated at about 700 million acres, the average stand does not amount to more than about five tons per acre, which is equivalent to about one-tenth of what it would be in systematically managed forests; in other words, the stand of timber in the United States forests is equal to the stand in about 70 million acres of forests such as are to be found in Germany and a great portion of France. Since it has been ascertained that the actual cuttings of timber in the United States exceed already 100 million tons a year, it follows that the present stand must be used up in about thirty years. Nor is the quantity removed annually from the forests replaced by new growth, as the latter has been estimated to amount to about 75 million tons. Moreover, it must not be forgotten that the annual forest fires destroy enormous quantities of material.

As already stated, these matters began to attract attention some twenty years ago. Thoughtful people wrote about them, societies were formed, information collected and made available to the general public. The State Governments issued regulations so as to prevent further destruction by fire, and they established certain State parks. Nor did the Federal Government neglect the matter. A Chief of the Forestry Division of the Agricultural Department was appointed, Mr. Fernow, who got together statistics and spread sound ideas regarding the rational treatment of forests. He was succeeded, a few years ago, by Mr. Gifford Pinchot. The latter went, about fourteen years ago, to study forestry in Germany and France. After his return to America, he set up in New York as a "consulting forester" (though a very wealthy young gentleman). Mr. George Vanderbilt engaged him to manage his forests at Biltmore, now amounting to more than 100,000 acres, having for his object to see whether systematic forestry can be made to pay in the States. In this post Mr. Pinchot was succeeded, about eight years ago, by Dr. Schenck, a first-class German forester.

When Mr. Fernow left his post at Washington, he became Professor and Dean of the Faculty of Forestry at Cornell University, endowed by the State of New York with money, and 30,000 acres of forest lands in the Adirondacks for systematic management and practical instruction. Soon after Mr. Gifford Pinchot took up the post at Washington, he and his family presented Yale University with the sum of 30,000*l.* for the purpose of endowing a second forest school in connection with the University; they also established a summer school for the study of forestry by those who could not afford to proceed to a regular degree at the University. According to the report for 1901–2, there were thirty-one students of forestry at Yale University and twenty-seven attending the summer school.

At Biltmore, Dr. Schenck has established a third forest school, where, on October 1, 1902, sixteen students were in attendance. I had on two occasions the pleasure of conducting students of this school through some of the most interesting forests of south Germany (seven in 1900 and six in 1902), these young gentlemen having, at the conclusion of their course at Biltmore, come to see something of systematic forest management in Europe.

Apart from the above three higher schools, forestry is now taught at about forty other educational establishments in the United States. In this way, quite a respectable number of well-trained forest experts has become available, in addition to about half-a-dozen young men who followed Mr. Pinchot's plan and studied in Germany.

The Federal Government has, by degrees, inaugurated a systematic forest policy, progress having been specially rapid since Mr. Pinchot became head of the Forestry Bureau. An area of 46 million acres of Government land has been declared (chiefly in Mr. Cleveland's time) "reservations," by Presidential proclamation. These areas are situated in the west. And now President Roosevelt has sent a message to the Senate and House of Representatives recommending a national forest reserve of considerable extent in the Southern Appalachian region, this measure being, as he states, "an economic need of prime importance to the welfare of the south, and hence to that of the nation as a whole."

Another matter vigorously taken up by the Bureau of Forestry is the preparation of rational working plans for private forests. A considerable number of field assistants have been engaged, who are sent out to prepare working plans for the forests of such private proprietors as apply for them. So great has been the demand in this respect that, although last year plans were prepared for more than one million acres, the field assistants could deal with only about one-tenth of the applications received at the head office.

All the while, the collection of statistics and dissemination of useful information proceeds at a most rapid rate. In this respect I may mention that I have during the last three months received the following reports and pamphlets:—

(1) "The Timber Resources of Nebraska," by W. Hall, Superintendent of Tree Planting, Bureau of Forestry.

(2) "Grazing in the Forest Reserves," by Filibert Roth, of the United States Department of the Interior, in charge of the work in the Government forest reserves.

(3) "A Working Plan for Southern Hardwoods and its Results," by J. Foley, Field Assistant, Bureau of Forestry.

(4) "A History of the Lumber Industry in the State of New York," by Colonel W. Fox, Superintendent of Forests, New York State.

(5) "The Western Hemlock," by G. E. Allen, Field Assistant, Bureau of Forestry.

(6) The above-mentioned message by President Roosevelt, transmitting a magnificent volume of reports on the forests, rivers and mountains of the Southern Appalachian region.

(7) "First Book of Forestry," by Filibert Roth. This little elementary book is most charmingly written, giving in simple terms, and in an attractive form, the first principles of forestry. Although the illustrations are taken from species growing in the United States, I can strongly recommend the little book (published by Ginn and Company, pp. 261, price 3*s.* 6*d.*) to landed proprietors and foresters in this country.

I have no doubt that these publications form only part of those which have lately appeared. All show signs of a good grasp of the subject, and prove the vigour with which it has been taken up. As already indicated, the forests of the United States are at present worked under a heavy deficit, as compared with production. This deficit will increase with the growth of the population and the further development of the industries of the country, and this will go on until a sufficient area of forests has been placed under systematic management. That measures to bring this about have not been taken a day too soon will be evident when it is considered what the requirements of the country are. Not only are enormous quantities of wood fuel wanted for a population of some 80 million peoples, but timber in proportion is required for pulp wood, posts, railway ties, poles for telegraphs and for piling, mining timber, ship timber, cooperage and wagon timber, lumber generally, and for many other purposes. To give an idea of what the total requirements may amount to, I shall pick out one or two items. There are upwards of 200,000 miles of railways in the States, which require annually some 70 million railway ties. To keep up this supply, some 8 to 10 million acres of well-managed forests are wanted. The annual requirements of general lumber are at present estimated at 30 billion feet, board measure, requiring not less than some 100 million acres of forests to keep up the supply. The demands for pulp wood and mining timber are already enormous, and likely to increase. The exports of timber from the States amount to a little more than one million tons a year, and these are already considerably exceeded by imports from Canada.

On the whole, then, the reservations made up to date can be considered only as a moderate beginning in the right direction. To meet the future requirements of the nation, the present area of reservations must be largely increased and they must all be brought under systematic protection and management. However, the people and the Government are evidently determined to do what is necessary, and their efforts up to date bear testimony to the energy with which any question bearing on the general welfare of the nation is taken up and carried through.

Can we in this country not learn a lesson from the above facts, as we have been obliged to do in more than one other respect of late years? Our timber imports have latterly grown very rapidly, far more so than the increase of the population, while the sources of supply are becoming more and more precarious. It is all very well to say that we can pay for the imported timber, but what when the sources of supply fail? And all this time we have some 13 million acres of waste land and some 12 million acres of mountain and heath land used for light grazing in these islands, or a total of 25 million acres which yield a very small return or none at all. One-quarter of that area put under forest and treated in a rational manner would supply all the timber we require (apart from limited quantities of tropical timbers) and keep some 25 million pounds sterling in the country which we now send abroad every year to pay for the imported timber. And how many of the unfortunate unemployed, who are becoming the nightmare of our city authorities, would not find healthy employment in the country if a real effort were made to grow our own timber at home?

W. SCHLICH.

THE ELECTROCHEMICAL SOCIETY.

LAST March a few of those interested in the advancement of the study of electrochemistry in this country held a meeting in London. After some discussion as to the best means of advancing the object which it had in view, the meeting unanimously agreed to endeavour to form a society of electrochemists. A small committee was then appointed, which, after holding several meetings, sent out circulars to those who it was thought would be interested in the formation of such a society. A considerable number of favourable replies was received, but some who wrote deprecated the idea of adding yet another to the already large number of scientific societies. The committee then approached several existing societies, in order to see whether it might not be possible to work in conjunction with one or other of them. But although the replies received were couched in friendly terms, none of these societies seemed inclined to make any special effort to help forward the movement.

In these circumstances it was decided to call a general meeting of supporters of the movement to inaugurate an Electrochemical Society. By the kind permission of the committee of the Faraday Club, the meeting was held in the club rooms at the St. Ermin's Hotel, on the afternoon of February 4.

Mr. Swinburne, chairman of the committee, took the chair, and briefly reviewed the circumstances which had brought the meeting together. He emphasised the importance of the electrochemical industry abroad, and pointed out how exceedingly backward we are in this country. Mr. Swan, in a brief speech, then proposed the formation of the society, and said that there was no doubt but that it would be of great scientific and commercial value. Mr. Alexander Siemens seconded the motion, which was carried unanimously.

Mr. Swinburne then read out a list of those who had been nominated by the committee and had expressed their willingness to serve on the council of the society. Mr. Swan, F.R.S., was elected president, the vice-presidents being Lord Kelvin, Prof. Crum Brown, F.R.S., Sir Oliver Lodge, F.R.S., Lord Rayleigh, Mr. Ludwig Mond, F.R.S., Mr. Alexander Siemens and Mr. J. Swinburne. The committee's recommendations were unanimously endorsed, and after a short discussion, and a vote of thanks to the committee of formation, the meeting separated.

The youngest of scientific societies in the country started off with a promised membership of 150. There is, however, very little doubt but that in a short time many more, who have only been waiting for the movement to become an assured success, will join. Already since circulars calling the meeting were sent out, several who in the first place refused their support have sent in their names for membership.

The science of electrochemistry, which was initiated in this country through the splendid work of Davy and Faraday, has been allowed to languish, and but little attention has been paid to its great advancement abroad. In Germany a flourishing society, which issues a weekly journal, has been in existence for more than eight years. The Americans have a very vigorous society, which was established last year. The British society has been established with the object of advancing both pure and applied science. One is often met by the cry that electrochemical industry is all very well in countries where there is plenty of cheap water-power, but that it will never be a success when you have to depend upon coal as an initial source of energy. But there is such a source of power as the Mond gas, and gas engines are every day becoming more perfect. Again, coal is cheaper in this country than in most places where there is an abundance of water-power. In some directions we may be handicapped; to a large extent this is due to our own inertness—our great chemist, Faraday, laid the foundation-stone of electrochemical science—we have left it to others to build thereon. But the building is not complete; indeed, it may require to be partially pulled down and rebuilt. The Electrochemical Society has been formed to rehabilitate the science in this country, and its promoters look forward with the sanguine hope that when the scientific history of the next decade is written, British discoveries and inventions in the domain of electrochemistry will not be behind those of any other country.

All interested in electrochemistry and physical science and who are willing to help forward this society should send in their names to Mr. F. S. Spiers, Grosvenor Mansions, Victoria Street, Westminster.

AGRICULTURAL NOTES.

IN a shilling pamphlet published at the offices of the *Mark Lane Express*, Mr. W. J. Malden, of the Colonial College, Hollesley Bay, discusses the merits of ten new "potatoes with money in them." Hundreds of new varieties have been raised in the past few years, but nearly all of those named in the pamphlet have been produced by one grower—Mr. Findlay, of Markinch—and this fact indicates that to raise valuable new

kinds very special gifts are necessary. On the other hand, the developing of new sorts already on sale in limited quantities is much less difficult, and Mr. Malden shows that handsome profits may be made by those who are shrewd enough to recognise the coming varieties. Last year, for example, the kind known as "Northern Star" was selling at 10*s.* per lb.; this season the price was 5*s.* per lb., but it has now advanced to 15*s.* The tubers exhibited at the Smithfield show were priced at 7*s.* 6*d.* each! By growing plants from a single "eye" under garden conditions, the produce may be increased a hundredfold in one season. Thus Mr. Malden produced 168 plants and 418 lb. of tubers from 4 lb. of "setts" planted in the spring of 1902. At the present time, there are a number of first-class kinds awaiting development, and it is to be hoped that Mr. Malden's remarks may induce a larger number of farmers and gardeners to give attention to the subject. From the public standpoint, it is much to be desired that good new sorts should be rapidly multiplied and brought into the vegetable market.

A simple demonstration conveying a useful lesson to the farmer has just been carried out at the new Harper-Adams Agricultural College, Shropshire. Seven cwt. of an ordinary compound manure (a "special turnip manure" sold at 6*l.* 15*s.* per ton) was applied to an acre of roots; to a second acre, the same quantity of plant food was given in the form of a mixture of superphosphate and sulphate of ammonia, followed by a top-dressing of nitrate of soda. The cost of the special manure was 47*s.* per acre, of the other 27*s.* 9*d.* The result, as was anticipated, was an almost equal yield of roots, and a saving by using the home-mixed manure of 1*l.* per acre. This demonstration wants repeating in every county, for there are two classes who have not yet learned to assess "special" manures at their real value—manure manufacturers and farmers.

Under the suggestive title of "A new Departure in the Science of Fattening," Mr. Warington contributes a valuable paper to the *Agricultural Students' Gazette* (Cirencester). He discusses the recent work of Kellner on the feeding of farm animals, with special reference to the comparative effects of such fibrous fodders as hay and straw in the fattening of cattle. Agricultural chemists have held that the digestible nutrients in fodders of a similar character, such as oat and wheat straw, must have a similar value for the fattening animal, and they have argued that the comparative value must be shown by the composition. Practical agriculturists, on the other hand, hold that the chemical composition is not a correct index of the fodder's value, and they have never attached much weight to their scientific advisers' opinions of common farm foods.

The recent work of Zuntz (Berlin) and Kellner (Möckern) has shown that the farmer's opinion is correct and that a chemical analysis does not indicate the relative values of fodders grown under different conditions. The mechanical as well as the chemical composition has an important influence on the effects produced by a food on the fattening animal. A hard or tough straw requires more energy for its digestion than a softer one, this energy becomes a first charge upon the food, and thus the "efficiency" of an indigestible food is lower than that of a digestible one of the same chemical composition. It has, of course, been known that digestion involves an expenditure of energy, but Zuntz and Kellner have been the first to show how great the effect of this may be on the value of a fodder.

The former worker so long ago as 1896 wrote a paper for the *American Experiment Station Record* in which he discussed this question, pointing out that in the case of the horse the nutrients assimilated from hay yielded 20 per cent. less available energy than the same nutrients assimilated from grain; but the importance of Zuntz's work does not seem to have been appreciated in this country. Kellner's experiments are, however, likely to arouse widespread interest. He has compared the effects produced on fattening oxen by nutrients derived from various sources, and among other results he finds that to produce the same increase as is due to 100 lb. of starch it is necessary to supply 147 lb. digestible nutrients in meadow hay, 157 lb. in oat straw, and no less than 374 lb. in wheat straw. The figures, of course, hold good only for the particular samples of hay and straw used by Kellner; the importance of the result lies in the fact that a wide variation in value has been proved. Kellner's experiments may not, perhaps, affect the rations given by the farmer to his cattle, but they will very greatly affect the rations which he (the farmer) has hitherto been *recommended* to use.

The December number of the United States *Experiment Station Record* contains a short report of the sixteenth annual convention of the Association of American Agricultural Colleges and Experiment Stations. Among the papers read was one which emphasised the importance of breeding and selecting corn for different purposes, showing how much the market value might be affected by slight variations in the composition. The composition of the grain of cereals is a subject to which our English seed growers have hitherto given little attention. Wheat, for example, has been selected for appearance, for yield and for stiffness of straw, but the chemical composition has been neglected, with the result that the miller and baker condemn our present English wheats as inferior and unsuitable for flour-making. We grow about one-fourth only of what we consume, but so small is the proportion of home-grown wheat which millers can profitably mix with imported grain that the markets are often glutted with English wheat which millers will not buy. A very slight alteration in the chemical composition would enable millers to employ profitably 35 per cent. to 40 per cent. of English wheat in their mixtures, instead of 25 per cent. to 30 per cent. as at present, and would thus remove the possibility of glutting the market with English wheat. In ten or fifteen years time, we may hope to see this change in composition effected. In the meantime, it would be interesting to follow the lead of the American writer, trace the effect of composition on market value, and investigate the loss the nation has suffered in the past decade or two and must continue to suffer for years to come from this oversight on the part of our seed growers. T. H. M.

WEST INDIAN NOTES.

THE third number of vol. iii. of the *West Indian Bulletin*, issued by the Imperial Agricultural Department, contains a large amount of information on a variety of subjects. Mr. Francis Watts deals with "Raw Sugars for Brewing Purposes," Mr. P. C. Cork with "Stock Rearing in Jamaica," Mr. Maxwell-Lefroy with "Scale Insects of the West Indies," &c. A lengthy account, 23 pages, of the volcanic eruptions in the West Indies includes a reproduction in full of a most interesting series of observations taken by the Rev. N. B. Watson, at his residence, about twelve miles east of Bridgetown, Barbados, from 5 a.m., October 14, to 6 a.m., October 17, covering the period of the Soufrière eruption in St. Vincent on October 15–16 and the dust fall in Barbados. Careful notes were taken of the direction and force of the wind, temperature, clouds, aspect of the sun, sky, the atmosphere, &c., and the rate at which the dust fell was frequently measured, the heaviest being 38·1 grammes per square foot, from noon to 1 p.m. on October 16.

The Department has also just published Nos. 19 and 20 of its pamphlet series, dealing with seedling and other canes at Barbados and in the Leeward Islands respectively. Of the large number of varieties of seedlings experimented with, the results for the past season show B. 208 to be the best all-round cane, beating all its rivals in Barbados, Antigua, St. Kitts and Trinidad. In Barbados, its juice was described as "exceedingly rich and pure," in Antigua as "exceptionally rich in sugar," and in St. Kitts as "of remarkable richness and purity." Part i. of the report on the sugar-cane experiments conducted at Antigua and St. Kitts in the season 1901–02, published at the same time, contains the complete statistical results for the two islands.

The report on the Antigua Botanic Station for the year ending March 31 last contains full particulars of the working of a "Peasant's Garden," in which nothing is done that cannot easily be accomplished by a working man having a similar small piece of land. In the previous year, the experimental plot was one-tenth of an acre; it required an expenditure, for labour, seeds and manure, of 1*l.* 15*s.* 3*d.*, and the varied produce, when sold, fetched 2*l.* 15*s.*, leaving a profit at the rate of nearly 10*l.* per acre. Last year the area was increased to one-seventh of an acre; the expenditure was 3*l.* 11*s.*, and the produce realised 4*l.* 16*s.* 11*d.*, showing a profit of about 9*l.* per acre. In re-afforestation experiments, about a dozen varieties of trees were being tested, the best growing being found to be mahogany and white cedar. It is curious that, while in neighbouring islands sugar-cane seedlings have been successfully raised, the several attempts made in Antigua have almost invariably turned out failures, very few fertile

seeds being, apparently, produced. Carefully selected arrows from different varieties have produced only about twenty germinating seeds, and of these only four seedlings have been saved and planted out. This is the total result of many trials in the island.

Reviewing agriculture in the West Indies in 1902, the official *Agricultural News* states that solid success attended the efforts to establish industries other than sugar in some localities, the progress made in onion cultivation standing out conspicuously. Both Antigua and Montserrat were able to export considerable quantities of onions, and Dominica and Barbados made satisfactory starts in cultivation. Cotton growing also showed substantial progress, a considerable acreage being under cultivation in Montserrat, St. Lucia and Antigua. At St. Lucia, cotton was grown on 105 acres last year, the whole southern seaboard, about forty-five square miles, being considered excellent soil for cotton, where it can be grown at about one-fourth of the cost of sugar-cane.

TECHNICAL EDUCATION AT HOME AND ABROAD.[1]

A NATION'S view of the expected outcome of its system of education is frequently shown by the recurrence of a typical question. Thus a Frenchman, when considering a young man's qualifications, will naturally ask, What examinations has he passed? A German will ask, What does he know? An Englishman will inquire, What kind of a fellow is he? An American will ask, What can he do? These varied questions reflect the form of education in vogue. In them we see the French tendency to formalism, the German disposition to over-intellectualise their schools, the English love of an all-around gentleman and the American fondness for achievement.

Since the close of the Franco-Prussian war, the development of Germany has been remarkable. Hamburg has risen from the sixth largest port in Europe to nearly the first; German cottons are sold in Manchester, German steel in Sheffield and Leeds, German silks in Paris, and "Made in Germany" is a familiar mark to us. From 1875 to 1895, the population increased from 45,730,000 to 52,250,000. The working energy, during the same period, increased from twenty-five to more than forty-six million foot pounds daily, or about four times as fast as the population. Between 1889 and 1896, the exports from Germany to China increased 86 per cent.; to Japan 92 per cent. The tonnage of German vessels trading with these countries has trebled since 1886 The number of German steamers in 1871 was one hundred and fifty; in 1897 this number had increased to eleven hundred and twenty-five. During the same period, the tonnage increased from 82,000 to 900,000. That Germany has been successful in a commercial way during the past thirty years is not to be denied. Her success can be traced to her belief in the industrial value of scientific research and to her fostering care of the technical education of her people.

From an examination of special industries, we can obtain a clearer idea of this influence. Consider the beet sugar industry. In 1840, 154 000 tons of beets were treated, yielding 8000 tons, or 5½ per cent. of raw sugar. In 1899, with improved scientific processes, 12,000,000 tons were crushed, yielding 1,500,000 tons, or 13 per cent. of raw sugar. This increase of yield from 5½ to 13 per cent. is the direct result of the work of technical men in control of the industry. Not only is Germany no longer dependent upon the West Indies for her sugar, but in one year she has sold Great Britain fifty million dollars worth. The manufacture of alcohol from potatoes is another lucrative field for German technologists. The cost has been reduced to about 25 cents per gallon, and experiments are in progress to determine its efficiency as fuel on steamers. The manufacture of artificial indigo by a chemical process was discovered in Germany in 1866. Less than forty workmen were then employed; now more than six thousand men and a staff of one hundred and forty-eight scientific chemists are employed in the industry. The natural indigo is almost driven out of the market. They have also discovered a method for obtaining from steel processes ground slag which is used as a fertiliser; and England, although she produces quite as much steel as Germany, has become a good customer for the article. Recently there came the discovery, by a chemist, named Giebler, of a process of hardening steel which makes it, it is said, 14 per cent. stronger, 50 per cent. lighter and one-third less costly than the Krupp or Harvey steel. Twenty-five years ago, the English and French makers of scientific instruments of precision were far in advance of the German. However, through the organisation of the Reichsanstalt, an institution for original research and the standardising of instruments, supported by the Government, Germany has become the manufacturer of the best scientific instruments in the world. The value of her exports in this line is nearly 2,000,000 dollars, three times what it was fifteen years ago, and the work gives employment to 15,000 people.

The Germans are fully alive to the necessity of being well prepared to engage in the struggle for industrial supremacy. Prince Bismarck once said: "The war of the future is the economic war, the struggle for existence on a large scale. May my successors always bear this in mind and take care that when the struggle comes we are prepared for it." Bismarck's behest has been heeded. The Germans, by dint of long and thorough preparation, are ready for an economic war. For more than thirty years they have been preparing, and we can see in all directions the steps that have been taken to improve the technical sides of education, so as to produce men who are capable of carrying Germany to the front in this industrial and commercial struggle. The system of German technical schools comprises first a group of Technischen Hochschulen, situated at the capitals of the German States, like those of Berlin, Dresden, Munich and Carlsruhe. These are of the very highest grade, admitting only students who have completed a Gymnasium or Realschule course of study. They have without exception developed gradually from mere trade or building schools. Most of them were founded in the twenties and thirties of last century, and one—the Charlottenburg—was founded as early as 1799. These schools are all beautifully housed, have superb equipments, and are doing a high grade of professional engineering work. Next below them in educational rank comes a great number of trade schools, like the Textile School of Crefeld. These trade schools are located at the centre of the industry to be benefited and are distinctly utilitarian in character. Besides these, there are many continuation and manual training schools. So numerous are these specialised schools that a German can always find one in which he can learn the latest and best principles, devices and methods of any trade or profession he may desire to follow. Add to all these the latest German innovation of commercial high schools and colleges of commerce, then wonder, if you can, why German competition is so keen and why German trade and industry are reaching every market the world over. The Germans have discovered that the secret of success in trade and industry depends upon education; not upon the education of the library and cloister, but upon the education of the laboratory, the shop and the modern lecture room.

Contrast with this the condition of England.

In 1870, Great Britain, exclusive of her colonies, did one-quarter of the world's business, and, including her colonies, 35 per cent. In 1895, her share had fallen to 18 per cent., or, including her colonies, to 31 per cent., showing that while she still held the lion's share, that share was steadily diminishing. From another point of view, a similar tendency can be seen. Between 1870 and 1895, British exports increased only 13 per cent., while during the same period the exports of Russia increased 17 per cent., of France 20 per cent., of Germany 42 per cent., and of the United States 110 per cent., showing that England's commercial advancement during this period was relatively the least of all.

American tools and labour-saving devices are rapidly entering British workshops. One firm recently expended 100,000 dollars in new machinery, two-thirds of which was of American make. In other branches of manufacture, the American and Continental engineers have succeeded in introducing into England many articles which the English imagined, but a short time ago, could not be made cheaper or better than in Great Britain, like electrical machinery, locomotives, steel rails, sugar-producing machinery, and even stationary engines, the pride of the British engineering industry. The year 1901 was noteworthy in that the output of steel in Great Britain fell behind that of the United States by 5,000,000 tons and behind that of Germany by more than a million tons. The machine tool trade is also fast becoming Americanised. In agricultural machinery, the United States is outstripping England with giant strides. In gas machinery, Continental orders are seldom

[1] Abridged from a paper on the need of technical education, by Prof. Victor C. Alderson, Dean of the Armour Institute of Technology, read before the Chicago Literary Club, October 20, 1902.

placed in England except for patented apparatus or by gas concerns controlled by British capital. The National Physical Laboratory, the British institution corresponding to the Reichsanstalt of Germany and the U.S. National Bureau of Standards, gets the absurdly small sum of 20,000 dollars per year, while the "beer money" appropriated to technical schools of the second and third rank amounted in 1898–9 to 4,152,000 dollars and in 1899–1900 to 4,380,000 dollars.

That there is "something the matter" with English economics seems evident to an impartial observer. Public opinion is slowly awakening to a realising sense that in some unseen manner England is being fed, clothed, reorganised and educated by foreigners. Prominent Englishmen, whose warnings are sincere, are trying to tell her that decline is at hand unless she adopts a sweeping reform in the whole content of her educational system, so as to bring it into close relationship with present-day necessities.

The Englishman learns slowly; he prefers to use methods formerly successful in spite of the fact that they are inapplicable to-day; he is slow to disturb established tradition and can scarcely be made to believe that any new forces have entered into the struggle for industrial supremacy. The rest of the world is learning the value of technical training in its varied forms as a foundation for industrial success, but the English still cling to their antiquated ideas. England has not kept alive to the requirements of the new scientific age into which we are now being thrust; she has not recognised the close connection that exists between science and industry; she is, as it were, using mediæval methods in modern industrial warfare; by neglecting the technical education of her people, she has failed to train her industrial army. This alone explains at once her own decadence and the advance of Germany and the United States.

The educational status of England is far lower than many suppose. We are pleased to juggle with the names Eton, Rugby, Oxford and Cambridge, but we must remember that these schools are only for the highest social classes and are maintained to educate the English gentleman of rank, not the plain everyday Englishman, and have little or no good influence upon industrial or commercial life. Through their graduates, who influence much of the editorial writing in London, they are seriously impeding the advance of correct ideas by their ultra conservatism and even ignorance of the scientific spirit of the age. The whole trend of an Oxford or Cambridge education is away from the masses. The primary and grammar schools of England are not only weak and inefficient, but are partly under State and partly under religious control; public high schools, as Americans know them, are non-existent; the higher college and university training is mostly classical and out of harmony with modern necessities; technical education, which in Germany and the United States must be preceded by a good high-school course of study, follows in England a weak grammar school education. Outside of her college preparatory schools and her two universities, which reach only an exceedingly small fraction of her people, England provides educational facilities which are utterly inadequate, both in character and extent, to the enormous needs of her people. To a certain extent, the view of Dr. Johnson still prevails that education is "needed solely for the embellishments of life and is useless for ordinary vermin."

The temper of the British mind is against scientific and technical progress. Research work, which is really the guiding star for all human progress, is sadly neglected. New ideas are imported from Germany and the United States; they seem unable to germinate on British soil. London, which was the first city to be lighted by gas, is the last to accept electricity. Germany teaches England electrochemistry and the United States gives her lessons in electric traction. Low-grade technical schools, evening schools and polytechnics she has in abundance; but they train only the imitative, not the creative faculties. England hates the specialist; Germany glories in him. England relies upon the practical man; Germany upon the technically trained man. England exalts the "rule-of-thumb" method; Germany insists upon scientific accuracy. England has no national system of education; Germany has a highly organised, Government-controlled system; England places her technical training next above a weak elementary education; Germany, believing in specialised education, which must be concerted and not premature specialisation, places her technical training after a thorough general education.

The race for industrial supremacy is on; the first three places are undoubtedly held by England, Germany and the United States. In view of the need of economic progress, it is not difficult to see that the outcome of the feeling of unrest which now pervades the educational world will be the enlargement of the sphere of technical education. All the signs of the times point in this direction. The trained technical man is rapidly taking the place of the untrained man. No nation can successfully oppose this world-wide movement. When the philosophers, educators and economists have risen to a full comprehension of the meaning of the present world-wide educational unrest, they will see that the solution of their doubts and anxieties lies in a fuller and more comprehensive development of the sphere of technical education.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—On Saturday last, Mr. H. Brereton Baker, F.R.S., Balliol College, was elected to the Lees readership in Chemistry, which had become vacant owing to Mr. Vernon Harcourt's resignation. Mr. Baker came up to Balliol as a Brackenbury scholar in 1880, and took a "first" in natural science in 1883. He was a pupil of Prof. Dixon, at that time lecturer in chemistry at Balliol, and he also worked under Mr. Harcourt at Christ Church. On leaving Oxford, Mr. Baker went to Dulwich, where he remained until last May, when he was appointed head-master of the Alleyn's School. His election is naturally very popular, and Oxford will gladly welcome back one of her most distinguished chemists, particularly one who has shown that the duties of a schoolmaster are not incompatible with the carrying on of research.

On Saturday, February 14, a meeting of the resident members of the University who are interested in the teaching of natural science will take place in the examination schools to meet a deputation from the Association of Public School Masters, consisting of Mr. H. B. Baker, of Dulwich, Mr. Hill, of Eton, Mr. Sclater, of Charterhouse, and Mr. Shenstone, of Clifton. The following proposals of the association, respecting entrance scholarship examinations to the universities, will be brought before the meeting:—(1) That the science part of the examination should consist of (*a*) a paper on elementary physics and chemistry for all candidates; (*b*) papers and practical work in not more than four subjects: (i.) physics; (ii.) chemistry; (iii.) botany and zoology; (iv.) geology. Of these subjects, candidates must not offer more than two. (2) That very marked excellence in one of the four advanced subjects should have due weight.

CAMBRIDGE.—Mr. T. Manners-Smith, Downing, and Dr. Marett Tims, King's, have been appointed additional demonstrators of anatomy.

Mr. W. A. Cunnington, Christ's, has been appointed to work at the University table in the Naples Zoological Station.

The Library Syndicate report that the cost of providing suitable accommodation and catalogues for the Acton Library, presented by Mr. John Morley, will amount to more than 7300*l*.

Dr. MacAlister, Prof. Woodhead and Dr. Nuttall have been appointed to represent the University at the Brussels Congress of Hygiene and Demography, to be held next September.

The following have respectively been appointed electors to the professorships named:—*Chemistry*, Dr. T. E. Thorpe; *Plumian of Astronomy*, Mr. W. H. M. Christie; *Anatomy*, Dr. T. C. Allbutt; *Botany*, Mr. A. Sedgwick; *Geology*, Dr. S. F. Harmer; *Jackson of Natural Philosophy*, Lord Rayleigh; *Downing of Medicine*, Dr. A. Macalister; *Mineralogy*, Prof. J. J. Thomson; *Zoology*, Dr. D. MacAlister; *Experimental Physics*, Lord Rayleigh; *Mechanism*, Mr. O. Reynolds; *Physiology*, Prof. G. S. Woodhead; *Surgery*, Dr. A. Macalister; *Pathology*, Dr. W. H. Gaskell; *Agriculture*, Dr. W. Somerville.

Sir James Blyth, Bart., has been appointed a member of the Board of Agricultural Studies.

DR. VICTOR LEBEUF, of the University of Montpellier, has been appointed director of the astronomical observatory at Besançon, and Dr. Marcellin Boule to the professorship of palæontology at the Paris Natural History Museum.

THE trustees of the Michigan College of Medicine and Surgery have established, the *British Medical Journal* states, two new chairs in tropical diseases with the object of preparing medical practitioners to deal with those affections in the Philippines and in Cuba. Dr. Robert S. Linn and Dr. V. J. Hooper have been appointed to the chairs.

THE fifth annual dinner of the Association of Old Students of the Central Technical College will be held at the Trocadero Restaurant, Piccadilly Circus, on Friday, February 20, at 7.30 p.m. Prof. W. C. Unwin, F.R.S., president of the Association, will take the chair. Tickets (price 5*s.* 6*d.*) can be obtained on application to the hon. secretary, Dr. E. F. Armstrong, 55 Granville Park, Lewisham, S.E.

IT is stated by the *Times* that the announcements recently made that Rhodes scholars have been elected in South Africa and the United States are inaccurate. The trustees have not yet awarded any scholarships. It is hoped that the scholars from the Cape Colony, Natal and Rhodesia may be elected in time to go into residence in Oxford in October next and also the first students from Germany, who are to be elected by the German Emperor, but the other scholarships will not commence before October, 1904.

THE effort made to clear off the debt of 5000*l.* on Bristol University College has, we learn from the *Times*, been successful. Sir William H. Wills and Sir Frederick Wills, M.P., agreed to give 1000*l.* each, provided that three like donations could be secured. In this the council of the college was not successful, but the offer was allowed to remain open on the understanding that the remaining 3000*l.* should be raised in any sums during the year. On the occasion of the recent University Colston dinner, it was announced that the 5000*l.* had been raised all but 500*l.* In the course of the evening, one of the guests gave 250*l.*, and since then 700*l.* has been received, the total of 5500*l.* now reached including a contribution from the Bishop of the diocese, who presided at the dinner.

THE Government of the United Provinces is, the *Pioneer Mail* understands, considering the possibility of establishing a teaching university at Allahabad. The evidence given before the recent Universities Commission showed that the higher learning is almost entirely neglected by the Indian Universities, all the energies of their professors being taken up with pass work for the intermediate and B.A. examinations. The scheme which is being considered by the Local Government is that the Muir Central College should be strengthened and devoted to the higher branches of learning. The intermediate classes would be given up, and this work would be undertaken by a new college to be created for the purpose in Allahabad with its own principal and its own professors. Several new chairs would be added to the present college, and it would thus be able to devote its time to scholarship in the sense understood in Europe and to advanced work in science. In a recent speech, the Agha Khan, president of the Mohammedan educational conference, suggested that ten million rupees should be raised by voluntary subscription among the Mohammedan community to convert the Mohammedan Anglo-Oriental College at Aligarh into a university. It seems clear from such facts as these that educational requirements are receiving great attention in India.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, January 21.—Prof. Emerson Reynolds, F.R.S., in the chair.—The following papers were communicated :—Researches on silicon compounds. Part viii. Interactions of silicophenylamide with thiocarbimides, by Prof. Emerson **Reynolds.** Silicophenylamide readily combines with one or two molecules of the thiocarbimides to form crystalline compounds, which dissociate into their generators at 100° C.; it also reacts with thiocarbimides when heated in sealed tubes, with the formation of silicodiphenylimide and a disubstituted thiocarbamide.—On the relation between the absorption spectra and the chemical structure of corydaline, berberine and other alkaloids, by Drs. **Dobbie** and **Lauder.** It is shown that corydaline and tetrahydroberberine, which are known to possess similar constitutions, give absorption spectra which differ in general absorption, but show no specific absorption differences. This is found to be the case generally for related alkaloids, and the authors suggest that such observations may occasionally be useful in deciding between possible formulæ for an alkaloid.—Absorption spectra of laudanine and laudanosine in relation to their chemical constitution, by Drs. **Dobbie** and **Lauder.** An application of the results of the foregoing paper to these two alkaloids, which are shown to belong probably to the reduced berberine group.—Phenocycloheptene, by Dr. **Kipping** and Mr. **Hunter.** A description of the properties of this hydrocarbon.—The influence of molybdenum and tungsten trioxides on the specific rotations of *l*-lactic acid and potassium *l*-lactate, by Dr. **Henderson** and Mr. **Prentice.** These oxides increase the specific rotations of *l*-lactic acid and of its potassium salt, probably as the result of the formation of salts of the *tartar emetic* type.—Estimation of ethyl alcohol in essences and medicinal preparations, by Dr. T. E. **Thorpe** and Mr. **Holmes.** The mixture is diluted with water, saturated with sodium chloride and shaken out with light petroleum to remove volatile substances other than alcohol; the latter remaining in the residue is estimated in the usual manner.—Carbon monoxide as a product of combustion of the Bunsen burner, by Dr. **Thorpe.** A laboratory burner consuming 6 cubic feet of coal gas per hour under 0.95 inch pressure evolves 0.022 cubic foot of carbon monoxide when burnt under a sand bath at such a height that the inner cone just impinges on the metal of the bath.—The following papers are descriptive of the compounds mentioned, and are not of general interest :—Derivatives of β-resorcylic acid and of protocatechuic acid, by Dr. W. H. **Perkin,** jun., and Mr. **Schiess.**—Synthesis of *N*-ethyl-, *N*-methyl- and *N*-benzyl-benziminoethers, by Dr. **Lander.**—The condensation of phenyl ethyl ketone with benzalacetophenone and of acetophenone with benzalpropiophenone, by Dr. **Abell.**—Synthesis of 1 : 3 : 5 triphenyl-2 : 4-dimethylcyclopentane and of 1 : 3 : 5-triphenyl-2-methylcyclopentane, by Dr. **Abell.**—Formation of carbazoles by the interaction of phenols, in the orthoketonic form, with arylhydrazines, by Prof. **Japp** and Mr. **Maitland.** (1) Dimorphism of α-methylanhydracetonebenzil. (2) The oxidation products of the methyl homologues of anhydracetonebenzil, by Prof. **Japp** and Mr. **Michie.**—Action of hypobromites on amides, by Dr. **Lapworth** and Mr. **Nicholls.**—Derivatives of menthyl cyanoacetate, by Messrs. **Bowack** and **Lapworth.**—The influence of nitro-groups on the reactivity of halogen derivatives of benzene, by Dr. **Lapworth.** A restatement of the view that the reactivity of the halogens in *ortho-* and *para*-halogenated nitrobenzenes is due to the assumption of the elements of a molecule of water by the nitro-group, with subsequent intramolecular changes, leading to the production of a tautomeric form of a nitrophenol with the loss of a molecule of a haloid acid.

EDINBURGH.

Geological Society, February 5.—Dr. J. Horne presided.—Mrs. Dr. Ogilvie **Gordon** gave a demonstration of some of the results obtained by her geological survey of the Fassa district in South Tyrol, made in 1900–1901. The lecture, which was entitled "The Fassa-Monzoni District : r Simultaneous Duplex Crust Movements," was illustrated by Mrs. Gordon's lantern views, geological maps and sections, rock specimens and mineralogical slides. In describing the succession of Triassic strata, Mrs. Gordon pointed out two distinct advances made by her work : (1) She had discovered the presence of Wengen-Cassian Marls with characteristic fossils in the midst of the Middle Triassic Limestones, whereas hitherto these fossiliferous strata had been reported to be absent in Fassa. The Wengen series comprise bedded tuffs and lavas, tufaceous grits, shales, and limestones like those in Gröden and Enneberg; the Cassian strata are chiefly marls and marly limestones. (2) She had determined the presence of a definite band of fossiliferous marls and Crinoidal and Oolitic Limestones between the Lower and Middle Trias, as a constant member in all undisturbed sections. Hitherto these limestones had been described as a rarely present facies of the lower horizons of Middle Triassic Limestones. The fossils collected in them by Mrs. Gordon were examined by Dr. Broili, Munich Museum, and identified by him as Upper Werfen (Lower Trias) or closely allied types. The establishment of this definite passage-zone between Lower and Middle Trias was an important addition to the geology

of South Tyrol. Further, it corresponded to the horizon of the "Reichenhall Limestone" and the "Myophoria Beds" in North Tyrol, and probably also to the well-known "Röth" horizon in the North German Trias. Throughout the Tertiary crust-movements in the Alps, this passage-zone had been the *great crush-zone* of the district. It occurred in Fassa below a massive development of calcareous rocks, and above an almost equal thickness of mixed deposits; it was, therefore, a well-marked "critical" zone, within the earth's crust, interleaved between rock material presenting strongly contrasted physical characters. One of the *general* results of the lecturer's detailed survey had been to prove that porphyrite sills and sheets had been intruded in Fassa into the local fault lines and planes of crust deformation which developed during Middle and Late Tertiary Alpine movements. After indicating on her geological map the complete sequence of the igneous rocks which she had proved at Monzoni (see *Geological Magazine*, July, 1902), Mrs. Gordon proceeded to describe her results regarding cross-fold formation. Several deformational movements had affected this district. In the first place, undulations directed east and west had formed a steep southern face and a long northern slope, the width of an undulation being about four and a half miles. These had been deformed by *oblique* cross-folds, which developed along two directions, E.N.E., W.S.W. and W.N.W.-E.S.E., the E.N.E.-W.S.W. direction being the principal axis of deformation. During these "Asta" movements the steep south faces of the original plications were overthrust towards S.S.E., or locally towards S.S.W., and the first inrush of molten rock occurred into zones of crust-attenuation and fracture. Still later another duplex deformational system (the Judicarian) was superinduced upon the earlier; the principal axis was N.N.E.-S.S.W. in direction, but the leading N.N.E.-S.S.W. faults were cut by N.N.W.-S.S.E. companion faults. Horizontal differential movements had occurred, and local thrusts and shear slips took place again, fragmenting the previous thrust-masses and igneous intrusions. Mrs. Gordon showed by reference to her map that the most intense effects of crust-deformation had been coeval with this advanced stage in the superposition of duplex deformational systems upon the original and fundamental east-west undulations. The larger intrusions of augite porphyrite had passed into fault-planes, which were associated with the advanced stages of movement. A subsequent epoch of crust-adjustment and surface-erosion had ensued, characterised by local subsidences taking place preeminently along the previous crust-fractures. Local crumplings had then occurred, chiefly around large masses of igneous rock or the larger deformation fragments of Triassic Limestone. Small igneous intercalations of highly differentiated rock material accompanied these inthrows. Mrs. Gordon's interpretation of this remarkable series of cross-movements was based upon the principle of the simultaneous action of paired resultant strains acting along N.E.-S.W. and N.W.-S.E. directions, the precise directive angle varying in proportion as the east-west or the north-south stresses due to crust-compression were the more powerful, and also in accordance with particular local modifications of the regional strains. The address gave rise to prolonged discussion, in which Mr. Cadell, Mr. Clough, Mr. Cunningham-Craig, Mr. Bailey and the chairman took part.

PARIS.

Academy of Sciences, February 2.—M. Albert Gaudry in the chair.—Remarks by M. Ph. van **Tieghem** on a memoir "Sur les Ochnacées."—Contribution to the history of fossil man, by M. Albert **Gaudry**. Most of the fossil remains of man date from the Glacial epoch, contemporary with the reindeer and mammoth. But there are a few fossil specimens which appear to be earlier than the Glacial epoch, and to date from a warmer period of the Quaternary. It has been generally concluded that, as a result of the extension of the Scandinavian glaciers, the existing animals, including man, were driven south. The question of the origin of the men of the warmer period is more difficult. From a comparison of the dentition of a skull discovered at Mentone, and dating from the latter period, with that of the fossils of the Glacial period and of existing races, the conclusion is drawn that these men were indigenous to the southern regions, but as these results are arrived at from the examination of a single specimen, further confirmation of this view is necessary.—On the heart of tuberculous subjects, by MM. Ch. **Bouchard** and **Balthazard**. A preliminary comparison of the hearts of healthy and tuberculous subjects appeared to show that in tuberculous males the heart is smaller than in healthy males, whilst in tuberculous females the heart is very nearly normal. A more detailed study of these subjects showed, however, the influence of the stage of the disease and also the effect of predisposition. The opinion which has often been expressed, but never clearly demonstrated, that smallness of the heart predisposes to tuberculosis is now confirmed by these observations.—On the absorption of light in symmetrical crystalline bodies and in certain disymmetrical media, such as substances naturally isotropic, solid or fluid, affected by magnetism and submitted to its action, by M. J. **Boussinesq**.—On the latest comet, by M. **Perrotin**. The Giacobini comet is not identical with the Tempel-Swift comet, and is probably new.—Approximate algebraic expressions for transcendental, logarithmic and exponential functions, by M. J. A. **Normand**.—On the viscosity in a vitreous medium, by M. P. **Duhem**.—On the polarisation of the X-rays, by M. R. **Blondlot**. All attempts made hitherto to produce polarisation of the X-rays have been without positive results, and the possibility of their being actually polarised on emission from the tube seemed worthy of examination. The use of a small electric spark, similar to that already used by the author in his researches on the velocity of propagation of the X-rays, as an analyser, showed that this view is in accordance with the facts observed; a bundle of X-rays has the same asymmetry as a bundle of polarised light rays. Quartz and sugar turn the plane of polarisation of the X-rays in the same sense as that of light, rotations up to 40° having been observed. The secondary X-rays, or δ-rays, are equally polarised; active substances turn the plane of polarisation in the contrary sense to that of light. The author regards it as extremely probable that magnetic rotation exists both for the X-rays and the δ-rays, and further experiments upon this are in progress.—The perpetual secretary informed the Academy of the death of M. Rebouł, correspondent in the section of chemistry.—M. Léon Labbé was elected a free academician in the place of the late M. Damour.—Observations of the comet 1903 *a*, made with the 35 cm. equatorial of the Observatory of Lyons, by MM. J. **Guillaume** and G. Le **Cadet**.—Provisional elements of the new Giacobini comet (1903 *a*), by M. G. **Fayet**.—Observations of the sun made at the Observatory of Lyons with the 16 cm. Brunner equatorial during the fourth quarter of 1902, by M. J. **Guillaume**. The results are summarised in three tables, giving the number of sun-spots, their distribution in latitude and the distribution of the faculæ in latitude.—On a rectilineal band of Jupiter, oblique abnormally to the equator, observed in December, 1902, and January, 1903, by M. **Amann**.—On groups of substitutions, by M. G. A. **Miller**.—On active couples of permutations, by M. Désiré **André**.—On slipping in fluids, by M. **Hadamard**.—On the reciprocal influence of two neighbouring oscillators: the character of the discontinuities, by M. Marcel **Brillouin**.—New researches on the expansion of nickel steel, by M. C. E. **Guillaume** (p. 352).—On the esterification of mannite by phosphoric acid, by M. P. **Carré**.—On the signification of experiments made in balloons on the respiratory exchanges, by M. J. **Tissot**. A criticism of some results published by Schrœtter and Zuntz. The author sees no reason to doubt the accuracy of the experimental results previously published by him, and summarises the conclusions to be arrived at from these experiments.—Contribution to the morphology of the ligaments accessory to the temporomaxillary articulation, by M. J. **Chaine**.—On the presence of ergastoplasmic formations in the follicular epithelium of birds, by Mlle. Marie **Loyez**.—Observations on the genesis of giant cells, by M. V. **Babes**. Besides simple cell division, budding occupies an important place in the growth of tissues, and a large proportion of giant cells are only modifications of these buds. This view is applied to the consideration of the growth of the placenta, giant tuberculous cell myxo-sarcoma, and other cases.—The ratio of the weight of the liver to the total weight of the animal, by M. E. **Maurel**. Except during

the earliest period of life, for the same animal species of different ages, the ratio of the weight of the liver to the surface remains constant. This constancy of ratio exists also for different varieties of the same species, although, as in the case of the dog, there may be considerable differences of volume.—Observations on *Monas vulgaris*, by M. P. A. **Dangeard.**—Mendel's law and the constant characters of hybrids, by M. Hugo **de Vries.**—On the comparative structure of the point of junction in grafted plants, by M. Lucien **Daniel.** A study of the point of union of the graft showed that even when the operation is made between plants as like as possible, and by the same process, the structure is essentially variable and is dependent on the mode of cicatrisation. As a result of these differences of structure, the conduction of the sap is modified more or less in each graft. The great differences observed explain the contradictory results obtained by different observers.—On vegetation in atmospheres rich in carbon dioxide, by M. E. **Demoussy.** It was shown that the gases given off by earth and manure are favourable to vegetation, and further experiments proved that this result was due to the influence of carbon dioxide alone. The conclusion is drawn that plants may profit to a very high degree from the presence of a small excess of carbonic acid in the atmosphere.—On the granitic rocks of the *massif* of Beni-Toufout, between El-Milia and Collo, Algeria, by M. Pierre **Termier.**—The existence of the Upper Jurassic and the infra-Cretaceous in the Island of Crete, by M. L. **Cayeux.**—On the quantities of phosphorus contained in flour, by M. **Balland.**

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 12.

ROYAL SOCIETY, at 4.30.—On the Decline of the Injury Current in Mammalian Nerve, and its Modification by Changes of Temperature. Preliminary communication: Miss S. C. M. Sowton and J. S. Macdonald.—On the Negative Variation in the Nerves of Warm-Blooded Animals: Dr. N. H. Alcock.—On the Optical Activity of Hæmoglobin and Globin: Prof. A. Gamgee, F.R.S., and A. Croft Hill.—On the Nucleo-Proteids of the Pancreas, Thymus and Suprarenal Gland, with especial reference to their Optical Activity: Prof. A. Gamgee, F.R.S., and Prof. W. Jones.—Studies in the Morphology of Spore-producing Members. No. V. General Comparisons and Conclusion: Prof. F. O. Bower, F.R.S.—Primitive Knot and Early Gastrulation Cavity coexisting with Independent Primitive Streak in Ornithorhynchus: Prof. J. T. Wilson and J. P. Hill.—The Brain of the Archæoceti: Prof. Elliot Smith.

ROYAL INSTITUTION, at 5.—Arctic and Antarctic Exploration: Sir Clements Markham, K.C.B.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—If the adjourned discussion on the Metric System is concluded at the Meeting on February 5, the adjourned discussion of Messrs. Scott and Esson's paper will be taken.

MATHEMATICAL SOCIETY, at 5.30.—Note on a Point in a Recent Paper by Prof. D. Hilbert: E. T. Dixon.—Some Properties of Binodal Quartics: H. Hilton.—The Field of Force due to a Moving Electron: Prof. A. W. Conway.—On Birational Transformations of the Type of Inversion: Prof. W. Burnside.

FRIDAY, FEBRUARY 13.

ROYAL INSTITUTION, at 9.—Health Dangers in Food: Prof. Sheridan Delépine.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Anniversary Meeting.

PHYSICAL SOCIETY, at 5.—Address by the President elect.

MALACOLOGICAL SOCIETY, at 8.—Annual General Meeting.—Address on the Molluscan Larva in Classification: Prof. G. B. Howes, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Construction and Setting-out of Tunnels in the London Clay: H. A. Bartlett.

MONDAY, FEBRUARY 16

VICTORIA INSTITUTE, at 4.30.—The Cheesewring, Cornwall, and its Teachings: Prof. Edward Hull, F.R.S.

SOCIETY OF ARTS, at 8.—Paper Manufacture: Julius Hübner.

TUESDAY, FEBRUARY 17.

ROYAL INSTITUTION, at 5.—The Physiology of Digestion: Prof. Allan Macfadyen.

ZOOLOGICAL SOCIETY, at 8.30.—On some new Species of Spiders belonging to the Families Pisauridæ and Senoculidæ: F. Pickard-Cambridge.—On the Marine Fauna of Zanzibar and British East Africa, from Collections made by the Author in 1901–2: Cyril Crossland.—On the Habits of the Hoolock: G. Candler.

SOCIETY OF ARTS, at 8.—Heraldry in Decoration: George W. Eve.

ROYAL STATISTICAL SOCIETY, at 5.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*:—The Manufacture and Efficiency of Armour-piercing Projectiles: D. Carnegie.—*Paper to be read, time permitting*:—Mechanical Handling of Material: G. F. Zimmer.

WEDNESDAY, FEBRUARY 18.

ROYAL MICROSCOPICAL SOCIETY, at 8.—A Demonstration on the Photomicrography of Opaque Objects as Applied to the Delineation of the Minute Structure of Chalk Fossils: Arthur W. Rowe.

SOCIETY OF ARTS, at 8.—Three-Colour Printing: Harvey Dalziel.

CHEMICAL SOCIETY, at 5.30.—(1) The Molecular Rearrangement of *N*-substituted Imino-Ethers; (2) The Nature and Probable Mechanism of Metal Replacement in Tautomeric Compounds: G. D. Lander.—The Chlorine Derivatives of Pyridine. Part VIII. The Interaction of 2:3:4:5-Tetrachlorpyridine with Ethyl Sodiomalonate: W. J. Sell and F. W. Dootson.—The Biological Method for Resolving Inactive Acids into their Optically Active Components: A. McKenzie and A. Harden.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Report on the Phenological Observations for 1902: E. Mawley.

THURSDAY, FEBRUARY 19.

ROYAL SOCIETY, at 4.30.—*Probable Papers*:—On the Formation of Definite Figures by the Deposition of Dust: Dr. W. J. Russell, F.R.S.—Mathematical Contributions to the Theory of Evolution. On Homotyposis in Homologous but Differentiated Organs: Prof. Karl Pearson, F.R.S.—The Evaporation of Water in a Current of Air: Dr. E. P. Perman.—On the Determination of Specific Heats, especially at Low Temperatures: H. E. Schmitz.

ROYAL INSTITUTION, at 5.—Arctic and Antarctic Exploration: Sir Clements Markham, K.C.B.

LINNEAN SOCIETY, at 8.—Electric Pulsation in *Desmodium gyrans*: Prof. J. C. Bose.—*Cerataphis Lataniae*, a remarkable Aphid: Alice L. Embleton.—Specialisation of Parasitism in the Erysiphaceæ: S. E. Salmon.

FRIDAY, FEBRUARY 20

GEOLOGICAL SOCIETY, at 3.—Annual General Meeting.

ROYAL INSTITUTION, at 9.—The Measurement of Energy: Principal E. H. Griffiths.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Hydraulic Experiments on a Plunger Pump: Prof. John Goodman.—Experiments on the Efficiency of Centrifugal Pumps: Thomas E. Stanton.

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