THURSDAY, MARCH 13, 1913.

THE PHILOSOPHY OF ENERGY.

Der energetische Imperativ. Erste Reihe. By Wilhelm Ostwald. Pp. iv+544. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1912.) Price 9.60 marks.

IT was at the Leeds meeting of the British Association in 1890 that three foreign chemists, van't Hoff, Arrhenius, and Ostwald, propounded and defended a new theory of solution which has since then been generally accepted. One of them, Wilhelm Ostwald, simultaneously imported another germ of thought, which for some years afterwards exercised the minds of Poynting, Lodge, Heaviside, and numerous other physicists. It was a development of the conception of the conservation of energy. It was the question as to whether energy, being indestructible, had an existence independent of matter, whether it retained its identity, and whether it could be followed up from point of point of space in its various transformations.

To Ostwald the idea came with the force of a revelation, and in the work before us he describes his "spiritual" experience with the most engaging candour. He confesses that the idea of the identity of energy and its commanding importance as the most fundamental of all realities has coloured and controlled his whole subsequent life.

This conception has undergone many vicissitudes. The Deutsche Naturforscher at Lübeck in 1895 appeared to dispose of it finally, and its discussion on that occasion was described as a "summary execution." Ten years afterwards Einstein put forward a plea for the identity of matter and energy, equating one gram with v^2 ergs, where v is the velocity of light in cm./sec. Planck's more recent hypothesis of the discrete or atomic structure of radiant energy lends unexpected support to Ostwald's original conception, and although it is difficult to see much advantage in substituting an elusive entity like energy for matter as a fundamental reality, it is quite possible that the identity of energy may play a considerable part in the future development of theoretical physics.

The present volume is a collection of essays strung (somewhat loosely sometimes) upon this central idea, propounded in the form of a precept which the author calls the "energetical imperative." This precept enjoins us never to waste energy, but to utilise it in its highest form. The four sections of (1) philosophy, (2) organisation and internationalism, (3) pacifism, (4) education, and (5) biography serve to group these essays with regard to the author's activity as a publicist.

In reading these brilliant essays, one is not surprised at the sobriquet of the "genial revolutionary" which their author earned among his friends in Leipzig. The energetical imperative is vigorously used to enforce economy and efficiency of organisation. It is propounded and proclaimed as the supreme guide in mundane matters, from the establishment of new universities to the binding of books. In organising, let us say, the science of chemistry, it is necessary to begin with the most commonplace details such as the spelling and division of words and the size of the printed page. Thus a "Weltformat" for printed books, based upon the centimetre, is suggested. It is designed in such a manner that every size can be obtained by the successive duplication of the smallest fundamental size, the sides of which are 1 cm. and $\sqrt{2}$ cm. respectively. No. 2 size is $\sqrt{2}$ by 2 cm., and so on. No. 9 size, 16 by 22·6 cm., is proposed as a universal size for scientific periodicals; No. 8 size, 11·3 by 16 cm., is a convenient pocket size; and No. 10, 22·6 by 32 cm., a good quarto.

Then we find a proposal to adopt one gram of pure gold as the basis of an international currency, and another to abolish the months of the calendar and count the days in numerical order. If, in addition, January 1 is made a supernumerary Sunday, with a similar interpolation at midsummer in leap years, the difficulty of determining days of the week is greatly reduced. The reading of numbers in thousands, hundreds, and the other powers of ten is to be abandoned, and numbers are to be read by a simple succession of figures, as is already the practice in quoting telephone and motor numbers. This reform applies, of course, with greater force in France or Germany than in England.

Then follows, very properly, the question of an international language. Ostwald is an enthusiastic supporter of the principle of an artificial international language, and defends it with conspicuous force and ability. Dr. Zamenhof's "Esperanto" was, by common consent, the finest and most successful solution of this problem hitherto proposed, and one naturally would have expected a born organiser like Ostwald to make the most of it. But his action in supporting Couturat's improved Esperanto ("Ido") was a very serious blow to the cause of Esperanto and of any artificial world-language. No doubt the abolition of the accented consonants was intended to facilitate the work of printing, but no such consideration justified the abandoning of the accusative case which gives Zamenhof's "lingvo" its marvellous flexibility.

If either of the rivals could thoroughly vanquish the other, or if they could settle their few differences, all would be well, but time alone will show whether Ostwald was in this instance a friend or foe of progress.

The author's proposal to divide words at any letter instead of by syllables would scarcely get rid of the difficulty of spacing out the line. Incidentally, one is led to hope that such blemishes as the substitution of "Zukunft" for "Folgezeit" (p. 484, line 4) and the adjective "vielfachen" for the corresponding adverb (p. 384, penultimate line) are accidental slips rather than premature reforms.

The distinguished founder and editor of the *Zeitschrift für physikalische Chemie* is at his best in discussing university problems, whether in connection with his biographical notes on Curie, van't Hoff, Abbe, and Ramsay (the latter was originally written for NATURE), or with the proposed foundation of new universities at Hamburg and Frankfort. He maintains that the unit of the future university must not be the faculty, but the laboratory, the institute, or the clinic. Teaching must be by work rather than lecture, and the work must be under the personal direction of a capable and enthusiastic chief in close touch with theoretical advances and practical problems.

The process of reasoning by which the irreversibility of all actual transformations of energy is made a fundamental ethical principle is one of daring originality. If, says Dr. Ostwald, occurrences were completely reversible (like ideal mechanical processes), then any mistake or wrong action could be completely annulled by reversing it. In fact, the whole world-history would read just as consistently backwards as forwards. What gives purpose and value and choice to life is the inevitable dissipation of energy. This must be directed into the most fruitful channels and put to the best use before it is lost in space. Peace is more fruitful and less wasteful than war, hence peace is good and war is bad. This is probably the first occasion on which a general physical law has been made the foundation of a system of ethics. E. E. FOURNIER D'ALBE.

THE PRESENT POSITION OF RADIO-ACTIVITY.

Radio-active Substances and their Radiations. By Prof. E. Rutherford, F.R.S. Pp. vii+699. (Cambridge University Press, 1913.) Price 15*s.* net.

MUCH water has flowed under the bridge since 1906, when the second edition of Prof. Rutherford's "Radio-activity" was reviewed in NATURE by the present writer. Though its title has been changed, the work is not essentially different in plan from its predecessor. The fundamental aspect of the subject has not changed, but the pioneer investigations have for the most part been supplemented, and in a sense superseded, by subsequent work traversing the same ground, and the author has found it impossible to incorporate the newer work satisfactorily without entirely rewriting the book.

A pioneer has to encounter all the uncertainties of a voyage into the unknown. A vast expanse often lies before him. He has great difficulty in reaching the unknown country, and cannot survey it in the leisurely and methodical manner which is afterwards attainable. His first hurried impressions must often be erroneous. It is no easy matter to hold the due balance between the credit which properly belongs to him and that due to the successors who tread in the path which he has made. The skilful way in which this has been accomplished is a feature of the present work.

The process of gleaning after the original rich harvest is as yet far from complete. It is an open secret that Prof. Rutherford and his colleagues are now engaged on a revision of their fundamental determination of the properties of the α particles. We may confidently expect that the charge, the electrochemical equivalent, the velocity of expulsion, and the number of α particles emitted by radium will soon be established within a fraction of 1 per cent. It is scarcely to be hoped, however, that these researches will be so immediately fruitful as were the less accurate determinations which they will supersede.

The mass of detailed knowledge which Prof. Rutherford is now able to record may suggest that the wonderfully productive vein opened by Becquerel's discovery of radio-activity is approaching exhaustion. It may be that this view is not without foundation. The number of radio-active substances now known is no fewer than thirty-four, as against twenty recorded in 1906. It scarcely seems likely that the next six years will see an equal addition to the number, though prophecy on such subjects is notoriously rash.

In this connection it may be remarked that progress has not for the last few years altogether followed the lines that might have been anticipated. Some of the more obvious problems have been little pursued, such as the isolation of pure actinium and ionium and the determination of their atomic weights. The position of actinium in the disintegration series is still a mystery. We are still unable to state definitely whether atomic transformation ever occurs without the emission of any ionising radiation, though the steadily diminishing proportion of products regarded as "rayless" suggests an answer in the negative.

Finally, we know little more than before of the nature of the final products of radio-active transformations. In the case of radium, we have, indeed, strong indirect evidence that lead is the product, but direct evidence is still wanting. The recent investigations of Prof. Rutherford's school on "lateral disintegration," *i.e.* the formation of collateral branches of descent, make it not improbable that more than one final product of thorium exists. It may be hoped that now that powerful mesothorium preparations are produced commercially, a direct chemical investigation of these final products may eventually prove feasible. Each such final product identified may be expected to form a link connecting up common elements with the scheme of radio-active evolution. The early hopes of bringing these elements into the scheme have been disappointed. The β radiation of potassium and rubidium remain isolated and perplexing facts. It may be that the studies now so eagerly pursued on the *rôle* of β rays in the more rapid changes associated with the radium series will afford a clue.

The principal focus of interest at the present time is indeed in connection with the β and γ rays. The discovery of v. Baeyer, Hahn, and Meitner that the β rays from certain radio-active bodies can, by improved technique, be resolved into a line spectrum by the magnet has given the lead which was needed, and now we begin to see order and definiteness where all appeared before to be hopelessly involved.

In this subject, as in all others which have arrived at any maturity, the labour of keeping abreast of the literature becomes increasingly heavy, and the value of a complete and authoritative treatise up to date proportionately great. Even more gratitude will be felt to the author by workers in this field for the present work than for its predecessors. R. J. STRUTT.

MAP PROJECTIONS.

Map Projections. By Arthur R. Hinks. Pp. xii + 126. (Cambridge: University Press, 1912.) Price 5*s.* net.

NOTWITHSTANDING the large amount of surveying which has been done in this country and throughout the Empire, there are few works in English which treat of the various ways in which portions of the earth's surface may be most conveniently and correctly represented on the plane surface of a map. The subject has been treated partially by several eminent mathematicians, and valuable summaries occur in some encyclopædias, but we do not in this country possess any works such as those by Germain, Tissot, Hammer, and others. There are also many works of a less advanced type which are available to Continental geographers, but this class, too, is very insufficiently represented here. We therefore welcome the appearance of the present volume, in which the subject is treated clearly and in a manner which makes but small demand upon the mathematical training of the geographer, while at the same time the important points in any projection, suitability for special purposes, and facility of construction are given especial prominence.

After indicating the inevitable limitations of all projections, in representing length, area, and shape of any portion of the earth's surface, the author reviews the principal systems, and here the question of nomenclature has to be faced. There is as yet no general agreement in this matter, and the same projections are differently named by different writers, and in different counties. In the present work it is laid down that the first name of a title should describe the method of construction, a second name should indicate its principal quality, while the author's or introducer's name may be added in the case of projections which are specially associated with any individual. But even this arrangement cannot as yet be conveniently used in all cases, and several well-known projections are referred to by their usual names.

This difficulty of a suitable classification certainly increases the difficulties of the beginner, so that a tabular statement of the principal projections in this part of the book would be a useful addition. Conical, cylindrical and zenithal, as well as certain conventional projections, are well described and clearly explained, their special advantages and points of weakness being indicated. A chapter on the projections in actual use is an instructive addition, especially as at the present time there is much more activity in selecting the most suitable projections, both for wall-maps and for atlas maps, than was formerly the case.

The chapter on the simple mathematics of projections treats of the theory of each particular case, and discusses the errors which may arise in its use under different conditions. Several actual examples are worked out, so as to show the procedure in a particular case. The present volume will be of great use to all geographers, and should pave the way for a more serious study of cartography on scientific lines than yet generally obtains. Great care and labour are expended on the measurement of various regions in order to produce trustworthy surveys, and the utilisation of the results should be based on sound cartographical principles, and in such work this book will be a valuable assistance.

H. G. L.

OUR BOOKSHELF.

Miners' Nystagmus: its Causes and Prevention. By Dr. T. Lister Llewellyn. With a preface by Prof. J. S. Haldane, F.R.S., and a legal appendix by Douglas Knocker. Pp. xix+158+ plates. (London: *The Colliery Guardian* Co., Ltd., 1912.)

MINERS' nystagmus is a disease which incapacitates a large number of coalminers, and is estimated by Dr. Lister Llewellyn to cost the country 100,000*l.* a year. It is characterised by rapid involuntary movements of the eyes, associated with defect of vision, photophobia, and night-blindness. Many theories have been brought forward to account for the disease. Of these the myopathic theory has been most supported in England, chiefly owing to the writings of the late Mr. Simeon Snell, of Sheffield. The work is carried on in constrained positions, often necessitating prolonged exercise of the extra-ocular muscles in an abnormal manner. It is now generally admitted that undue weight was attached to this factor, and attention has been specially directed to the view that the real cause is the poor illumination, a suggestion first made by Romiée, who, however, thought that excessive accommodation was an essential concomitant.

Dr. Llewellyn, as a former medical officer to a South Wales coal and iron company and as Tyndall Research Mining Student of the Royal Society, has had excellent opportunities for investigating the disease. He has used his opportunities to the full, and his work is a model of what such a research should be. He has shown conclusively that miners' nystagmus is practically limited to coal mines in which safety lamps are used, those in which naked candles are employed being exempt except for cases which have been transferred from safety-lamp mines. He has made exhaustive inquiries into the conditions of work and the illumination at the coal face. The estimations of illumination appear to have been made with great care and accuracy, and the same may be said of the clinical investigations. In addition to his own researches, his book contains an admirable *résumé* of the opinions and work of previous writers on the subject. The criticisms are judicial in tone, and the exposition of his own views allows the facts and arguments to carry conviction without undue stress. The work is of interest not only to those specially associated with the mining industry, but also to the physician and physiologist. We consider that Dr. Llewellyn has accomplished a difficult task with distinguished success.

Catalogue of the Lepidoptera Phalaenae in the British Museum. Vol. xii.: Catalogue of the Noctuidæ in the Collection of the British Museum. By Sir George F. Hampson, Bart. Pp. xiii+626. (London: Printed by Order of the Trustees, 1913.) Price 17*s.* 6*d.*

THE subject of this volume of the "Catalogue of Moths" is the classification of part of the Noctuid subfamily Catocalinæ. The remaining portion of the subfamily, together with the small subfamilies Mominæ and Phytomatrinæ, will appear in vol. xiii. The Catocalinæ are represented in the present volume by sixty-three genera and 643 species, and are characterised as follows:—Vein 5 of the hind wing is developed fully and arises close to the lower angle of the cell; the eyes are smooth and not overhung by "cilia"; the mid tibiæ are always spined, and the fore and hind tibiæ may also be armed similarly. The subfamily is a modification of the Quadrifid section of the Noctuidæ; it is distributed fairly evenly in the temperate and tropical zones, but has few arctic or alpine forms.

Volcanoes: Their Structure and Significance. By T. G. Bonney. Third edition. Pp. 379. (London: John Murray, 1912.) Price 6*s.* net.

PROF. BONNEY'S well-known volume was reviewed at length in the issue of NATURE for May 11, 1899 (vol. lx., p. 27), at the time of its first publication. Many minor alterations have been made in the present edition, and several paragraphs inserted dealing with volcanic eruptions which have take place recently. The chapter on the theories of volcanoes has been considerably modified so as to incorporate the results of research accomplished during the last fourteen years. Some new illustrations also have been added.

LETTERS TO THE EDITOR.

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

The Radio-elements and the Periodic Law.

AT a meeting of the Royal Society on February 27th, Mr. F. Soddy made a verbal communication which was published under the above title in the *Chemical News* of the following day. The importance of the conclusions which are drawn justifies an examination of the evidence on which they rest. I do not approach the question unsympathetically, and I am quite willing to take some risks, but, when asked to accept a theory, I like to draw a distinction between a guess, a reasonable generalisation, and a well-established conclusion. If Mr. Soddy only wishes to put forward a theory which is not inconsistent with the facts so far as they are known at present, I have nothing to say, but if he claims anything approaching to experimental proof, some critical comment may be forgiven.

Mr. Soddy believes in the existence of a number of bodies which differ in molecular weight but "are non-separable by any known process"; these are also supposed to have identical spectra. Among "known processes" I count gravitation, diffusion, and mechanical processes, such as separation by centrifugal forces, among which diffusion, perhaps, is the only available one. Is there any reason to suppose that molecules which, ex hypothesi, differ in mass, cannot be separated by diffusion? Some of the bodies concerned are gaseous, others no doubt are volatisable, and though diffusion may not act very effectively, owing to the close approximation of the densities, the presumption is that the molecules, having different masses, travel with different speeds, and that it is

therefore incorrect to call two gases with different densities "non-separable by any known process."

Electrical and magnetic forces are also agents which can be applied to distinguish between molecules having different masses. Such forces should be considered before any sweeping assertions are made.

It is possible that Mr. Soddy wishes his statement to be limited to the ordinary chemical processes, and as he is trying to prove a negative, it is perhaps unfair to be too critical, but one cannot help remembering the time when neodym and praesodym were "non-separable," and reflecting how many substances might not be separated at the present moment if their optical properties had not given us a clue. No doubt radio-active tests are severe, and the chemical properties of the bodies in question are probably more nearly equal than those of the older chemistry, but there is a vast interval between "very similar" and "identical."

Incidentally, we may reflect that these bodies which are believed to be "non-separable" actually separate themselves of their own free accord in the natural course of their subsequent history, but this may only prove the perversity of nature.

According to Mr. Soddy's theory, the non-separable bodies have identical spectra. This is the vital issue, which, if made good by experiment, will help us to overlook many weaknesses in the argument. The evidence here rests entirely on one experimental fact. It was shown by Russell and Rossi, and also by Exner and Haschek, that a mixture of ionium and thorium does not show in the electric arc lines which can be assigned to ionium, the spectrum of the mixture being identical with that of pure thorium. Assuming that ionium is the only intermediate product between thorium-II. and radium, the life of ionium is 100,000 years, and the ionium-thorium preparation of Russell and Rossi must have contained about 16 per cent. of ionium. But these authors also point out that if the length of life is reduced to 12,000 years, the preparation would only contain 2 per cent., and the absence of ionium lines would be accounted for. At present the radio-active evidence seems in favour of the longer period, and the absence of ionium lines wants explaining; nevertheless, it seems to me to be going ahead too quickly to make a sweeping assertion that not only is the spectrum of ionium identical with that of thorium, but that the same holds in all similar cases, for the accumulated evidence of the spectra of known bodies has all been in the direction of indicating that optical properties of absorption and radiation discriminate in the most decisive manner between bodies which are otherwise similar in chemical properties.

Granting now for the sake of argument that the bodies in question have spectra which cannot be distinguished from each other, it remains to examine the alternative that the bodies are actually identical. It is said that they have different molecular weights, because one has been formed from the other by an expulsion of one α and two β particles. This argument is not necessarily conclusive, as a mass equal to that expelled may have been picked up again in the process. It may be urged that the subsequent history of these bodies shows that they are essentially different. Though a strong argument, this is not quite the last word, because, granting for a moment the temporary identity of two systems, the particular instability which determines their future may depend on their past.

Taking all arguments into consideration, we are left with an interesting theory consistent with our present knowledge but supported by very little real evidence. It may be presumptuous for one who can only claim to be an amateur in modern physics to express an opinion, but having in a previous generation taken part in establishing the fact that the same element can have different spectra according to its molecular constitution, one cannot, without good cause, accept the belief that different elements can have the same spectrum. Mr. Soddy's case would be much strengthened if he could adduce positive instead of merely negative evidence, and this might be supplied if the bodies grouped together with thallium lines could be shown to give the thallium spectrum, assuming thallium not to be present in the raw material.

ARTHUR SCHUSTER.

Manchester, March 7.

Atmospheric Electrification during South African Dust Storms.

THIS short note on the variation in the atmospheric electrical charge due to the presence of dust is not intended to be exhaustive, but merely to direct attention to a factor which has a very great influence in modifying the positive potential gradient existing in the atmosphere during fine weather. Very few observations as to the causes of the variations have been recorded, but Prof. Michie Smith seems to have observed (*Phil. Mag.*, vol. xx., p. 456) something of the same kind during dust storms in India. He notes that "the negative electrification was strongest during gusts of dust-laden air," and, further, "the potential would often run up so rapidly that it was impossible to measure it accurately, whilst during lulls it would often fall almost to zero."

I was, however, unaware of any work having been done in this direction until the present year, though I have been making a study of the variations in the potential gradient over the high veld in South Africa, and have published several short papers on the subject.[1] The general result has been to show that very extraordinary variations are caused by the presence of dust in the atmosphere, whether due to the natural dust-storms or to any artificial means, such as the clouds of dust raised from the mine refuse heaps formed during the working of the cyanide process. At all the places where observations have been taken the dust is either sand or is of siliceous character, and invariably has the effect of lowering the positive potential gradient, and if present in sufficient quantity, to reverse it and give a very high negative gradient.

During the past six months systematic observations have been taken at Bloemfontein with a Bendorf recording electrometer, furnished with a radium-coated plate to act as collector. (The apparatus was obtained by aid of a grant from the Royal Society of South Africa.) The normal potential gradient in South Africa is, of course, positive, but varies considerably with the elevation. The diurnal range is also considerable under fine weather conditions, and during stormy weather very great deviations are shown if rain is falling or dust is blowing. It may be noted here that during the past eighteen months, when very little rain has fallen, the charge brought down by the rain has been invariably negative. A study of the records made by the electrometer shows that three types have to be considered, viz.:—(1) The ordinary fine weather record; (2) record taken on a day when some dust is blowing; (3) record taken on a very dusty day.

In the first case, the positive gradient rises to a maximum at about 7 to 8 a.m., falls to a minimum at midday, remains fairly uniform over a period of several hours, and then rises to another maximum. The slope of the curve is steeper for this second maximum than for the first one. Fig. 1 shows such a curve which was taken in July, from midnight to midnight. The horizontal line shows zero potential,

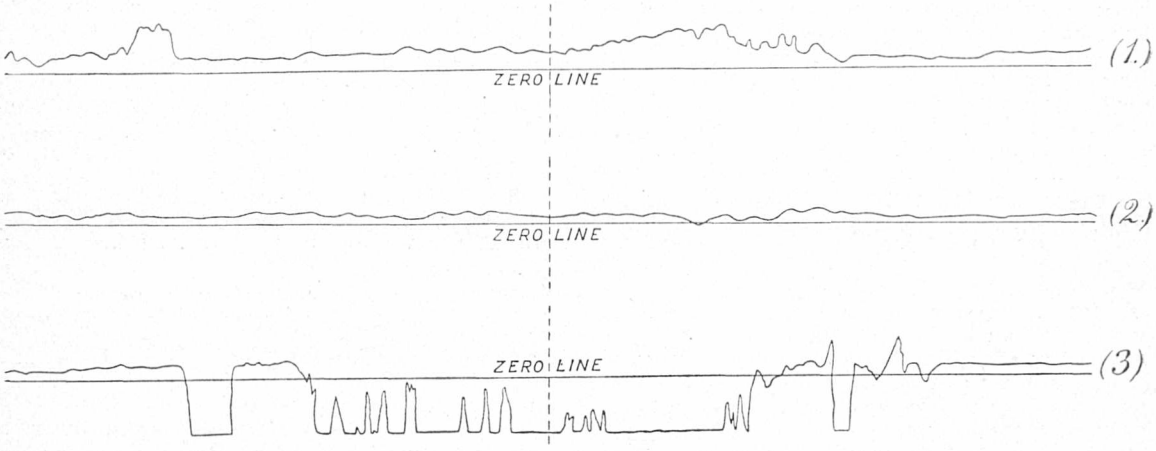
[1] *South African Journal of Science*; Proc. Roy. Soc. South Africa.

and distances measured above give positive values, and those below negative. The extreme range of the scale is equivalent to a gradient of 380 volts per metre.

Fig. 2 gives the record for a dust-storm which lasted the greater part of the day. In this figure it may be seen that the positive value never goes beyond 70 volts per metre, and on one occasion even becomes slightly negative.

Fig. 3 records a severe dust-storm which lasted from 4 a.m. until 8 p.m. The maximum value of the negative gradient cannot be inferred from the curve because the electrometer needle was deflected as far as it could go, and the horizontal portions of the curve indicate that the potential gradient was higher than the maximum which could be recorded. It will be shown presently that the gradient may reach the value of 5000 to 10,000 volts per metre when the dust is blowing thickly.

The writer has shown (*Phil. Mag.*, May, 1912) that during a dust-storm the charge upon the dust (if siliceous) is positive, while that upon the air at the same time is negative, and he was led from this to devise an electrical machine by means of which charges of both positive and negative electricity might be obtained during a dust-storm. The essential parts are :—(1) A small insulated disc coated with radium attached to a wooden rod about two metres in height; (2) a large hollow vessel with a fine wire gauze bottom; and (3) a pair of insulated spheres to serve as dischargers. The hollow vessel generally used was a five-gallon petrol tin supported upon an insulated rod at a distance of about 20 cm. above the ground, and directed with the open end towards the onrushing dust. Much of this dust is carried through, but a considerable portion is retained, and any charge it may possess is given up to the vessel. *This charge was invariably positive.*



(1) Normal fine weather record (2) a mild dust-storm ; (3) a severe dust-storm.

The radium-coated conductor, however, took the negative potential of the current of air blowing past it, so that the two balls acquired opposite charges, and a torrent of sparks as continuous as that furnished by an induction coil passed between them. On some occasions the sparks reached a length of 1·5 cm., showing that the potential difference between the conductors must have been at least 40,000 volts when the apparatus was set up on the open veld.

An ordinary vacuum tube having a radium-tipped wire attached to an electrode, the other electrode being earthed, will light up brilliantly during the passage of a dust-storm. A brush discharge is seen to proceed from the electrode and the shape of the brush makes it quite clear that positive electricity is escaping from the earth into the atmosphere.

W. A. DOUGLAS RUDGE.

Induced Cell-reproduction in the Protozoa.

IN the interesting letter by Mr. A. H. Drew, under the above heading, in NATURE, February 20, it is suggested in the last paragraph that certain substances called auxetics which caused the development of spores in the case of new species of Polytoma, may be necessary for cell-reproduction under natural conditions in ponds, &c., where such substances would probably occur owing to the putrefaction of organic matter.

In the course of an investigation which I have recently carried out on the process of excystation in the ciliated infusorian, *Colpoda cucullus*, from its resting cysts, I have found that this organism can emerge from its cysts when the latter are incubated in 1 per cent. hay infusion (alkaline or acid in reaction) and in pure distilled water—media quite free from auxetics. The real agent which is instrumental in causing excystation is an enzyme which digests the endocyst, and thus allows the organism to swim out into the surrounding medium. As is well known, *Colpoda cucullus* is an organism of wide distribution and of common occurrence in ponds and in infusions of hay, &c. It can frequently be found among rotting grass and decaying vegetation; situations in which the products of organic decomposition and bacterial putrefaction would be plentiful, yet the cysts of this organism can be caused to rupture and yield their contents in active condition when incubated in pure water.

I would therefore suggest that it is unsafe to infer that because auxetics may serve to induce cell-reproduction in certain cases, they may be necessary in all.

The winter spores of Polytoma and the resting (dauer) cysts of Colpoda are not perhaps quite comparable, but I may point out that Colpoda most frequently encysts in the condition of the resting cyst, and that therefore if auxetics are necessary at all they ought to be required for excystation from this condition.

An account of my investigations on this subject will shortly be published. T. GOODEY.

Rothamsted Experimental Station, Harpenden, Herts, March 4.

The Spectra of Neon, Hydrogen, and Helium.

IN a letter published in NATURE of March 6, Prof. Fowler pointed out that a series of "parallelisms" that we gave of lines in the spectra of neon and hydrogen were probably coincidences, and could not be taken as evidence of identity. We are sorry that we did not make our meaning plainer, in our letter in NATURE for February 27, for we did not mean that the lines we compared in the two spectra were

identical. The numbers we used were by Watson, and both spectra were measured from plates produced by the same instrument, and, of course, measured by the same person; thus experimental error was eliminated so far as possible. We were, however, in hope that possibly some similarity in atomic complexity might be argued from this "parallelism." But on talking the matter over with Prof. Fowler, whose knowledge of the subject is far greater than ours, we see that the evidence is not sufficient to justify any such assumption of similarity in the atomic complexity of these two elements, and we must therefore with regret abandon the idea.

J. NORMAN COLLIE.
HUBERT S. PATTERSON.

Mountain Stream Tadpoles in Natal.

SOME readers of NATURE will be interested to learn that tadpoles with large suctorial oral discs, enabling their possessors to adhere firmly to the rocks and boulders of mountain streams, have recently been discovered at Krantzkloop, in Natal, at an elevation of about 1500 to 1600 ft. They were found by the Rev. Fr. P. Boneberg, of Mariannhill, who kept them alive for some time, and observed their peculiar leech-like habit of sticking to one's fingers or to the sides of the vessel in which they were contained. Similar tadpoles have long been known from mountain streams in Borneo and other parts of the East, but so far as I can ascertain have not previously been recorded from Africa. However, the Natal tadpole belongs to the family Cystignathidæ (genus Heleophryne), whereas those of the Oriental region belong to the family Ranidæ, so that the adaptations are no doubt quite independently evolved. A description of this tadpole will be given in the next issue of the Annals of the Natal Museum. JOHN HEWITT.

Albany Museum, Grahamstown, South Africa,
February 1.

[IN his recently published account of the Batrachia of the Abor expedition, Dr. Nelson Annandale directs attention to some of the tadpoles (from Himalayan streams) which adhere to stones at the bottom or sides, and even in the vicinity of waterfalls. The majority adhere by their lips, which may be monstrously developed. In some other species a sucker, quite separate from the lips, and not homologous with the sucker that many young Batrachian larvæ possess, is found on the ventral surface, doubtless for the same purpose. It is interesting to note that some fishes have similar adaptations for adhesion.—ED. NATURE.]

INTERNATIONAL TIME AND WEATHER RADIO-TELEGRAPHIC SIGNALS.

IT is to the French Government that the world is indebted for the institution of an international conference on the radio-telegraphic distribution of time and weather signals. So long ago as 1908 the Bureau des Longitudes suggested a series of hourly signals from the Eiffel Tower for the determination of longitudes, and this service was brought into active operation in 1910. The great success which the service met with called for a more universal use of it, and to this end the French Government invited a certain number of foreign Governments to send delegates who had studied the problem of radio-telegraphy from the point of view of time and the determination of longitudes.

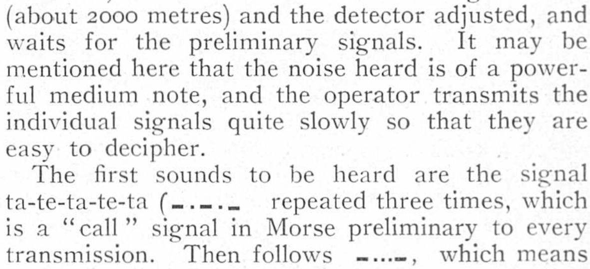
In October of last year such a conference was assembled, and programmes were formulated and resolutions passed with the object of preparing the way for the distribution of time and weather signals at stated hours from numerous selected stations suitably situated over the globe.

The outcome of this, the first international conference convened for this purpose, was a series of very important resolutions, but reference will only be made here to those that deal with the international time and weather signals. It may be of interest briefly to describe in the first instance samples of two signals that are being daily distributed at the present time, in order that the reader may compare them with the full international system which will be brought into operation on July 1 next.

Our purpose will be served if those sent out from the Eiffel Tower, Paris, and from Norddeich-Wilhelmshaven be alone considered, as these will show the different procedures adopted. To take the French signals first as recorded by a receiver in London. From this station morning and evening signals are transmitted, and at each transmission three separate "minute" signals are sent. Thus in the morning the observer can hear the tap from the pendulum clock in Paris at 10h. 45m. os., 10h. 47m. os., and 10h. 49m. os., and in the evening at 23h. 45m. os., 23h. 47m. os., and 23h. 49m. os., the clock indicating Greenwich mean time. In order to warn those who intend to receive the signals wherever they may be, a certain procedure is adopted which is the same for both morning and evening transmissions. This procedure is as follows:—

Let us suppose that we wish to correct our watch and therefore require to hear the morning signals. At about 10h. 40m. one sits by the receiving apparatus with the telephone fixed on the head, the coils set for the wave-length in use (about 2000 metres) and the detector adjusted, and waits for the preliminary signals. It may be mentioned here that the noise heard is of a powerful medium note, and the operator transmits the individual signals quite slowly so that they are easy to decipher.

The first sounds to be heard are the signal ta-te-ta-te-ta (—.—.— repeated three times, which is a "call" signal in Morse preliminary to every transmission. Then follows —...—, which means (=), a signal to separate the "call" from that which follows. The operator transmitting then sends out the following in Morse:—



The last four signals indicate "wait," repeated four times.

The foregoing announcement is the preamble preliminary to the time signals.

At 10h. 44m. 0s. a series of longs or – – – –, &c., are transmitted, ceasing at 10h. 44m. 55s.; then there is silence for some seconds, and *exactly* at 10h. 45m. 0s. a single "short" is heard.

A whole minute is then allowed to elapse with no signal at all, but at 10h. 46m. 0s. a new series of signals is commenced –·· –·· –··, &c., until 10h. 46m. 55s. is reached, when again there is silence for a few seconds, and then a short tap at *exactly* 10h. 47m. 0s. Another minute of silence is then allowed to pass, and at 10h. 48m. 0s. a different series of signals is commenced –···· –···· –····, &c., terminating about 10h. 48m. 55s., when after a few seconds' silence the single tap that follows indicates *exactly* 10h. 49m. 0s.

Thus it will be observed that the hearer has not only three opportunities of correcting his time-piece, but if by chance he missed the first signal at 10h. 45m. 0s. he can identify the other minutes by the different signals which precede them.

In the case of the German signals transmitted from Norddeich-Wilhelmshaven, at about 12 o'clock midday and 10 o'clock in the evening, the procedure is quite different. The first notification is the transmission of a series of V's thus, ···– ···– ···–, &c., to give the hearers a chance to tune their instruments to the wave-length in use (about 1750 metres) if not already in adjustment. The "call" signal –·–·– is then sent out, followed by the "call signal" of the station transmitting, namely, Norddeich, thus –·· –· –·· K N D. The fact that Greenwich mean time is being sent is given in the next signal in the form –– ––· ––·· M G Z, where MGZ indicate Mittel Greenwich Zeit. At 11h. 58m. 38s. the signal –·–·– or attention is repeated, and then follows the following series of signals:

Commencing at 11h. 58m. 46s., a tap is heard at *every second* until 11h. 58m. 50s. is reached; then a short pause is made, and another series of taps from 11h. 58m. 56s. to 11h. 59m. 0s.; again another pause, and a third series from 11h. 59m. 6s. to 11h. 59m. 10s. Then follows a longer pause, and a similar series of taps is heard for each of the intervals 11h. 59m. 36s. to 11h. 59m. 40s., 11h. 59m. 46s. to 11h. 59m. 50s., and 11h. 59m. 56s. to 12h. 0m. 0s. A few seconds after the last tap the signal –·–· indicating the end of transmission is given.

The above two examples show what very different systems are in use for the distribution of time by radio-telegraphy. They serve further to indicate that unless some international scheme is at once brought into operation, many other different systems may be added.

The Paris International Conference has thus stepped into the breach at the right moment and brought out a scheme which will be universally adopted and commenced on July 1 of the present year.

It is proposed for the international scheme that Greenwich time should be used throughout, and that the time signals should be transmitted at exact hours. It was further arranged that there should be no overlapping, *i.e.* that no two stations should send out signals at the same hour, and that the same wave-length (about 2500 metres) should be universally adopted.

A preliminary list of stations that will be in active operation by July 1 is as follows, and the times at which they will transmit their signals are added:

	Greenwich civil time. Hours	
Paris	0	(midnight).
San Fernando (Brazil)	2	
Arlington (U.S.A.)	3	
Manilla	4	(provisionally).
Mogadiscio (Italian Somaliland)	4	
Timbuctu	6	
Paris	10	
Norddeich-Wilhelmshaven ...	12	(midday).
San Fernando (Brazil)	16	
Arlington (U.S.A.)	17	
Massowah (Erythrea)	18	
San Francisco	20	
Norddeich-Wilhelmshaven ...	22	

Since September 1, 1912, radio-telegraphic time signals have been daily sent out from Chōshi, on the eastern shore of Japan. They are transmitted at 9 p.m. Japanese standard time, *i.e.* at Greenwich noon. This station will no doubt adopt the international scheme.

An important part of the scheme that is desired, and will ultimately no doubt be accomplished, is that both a day and a night signal can be received at any point on the globe.

Now as to the method which will be adopted for distributing the exact time at all transmitting stations.

To make the system quite clear, the accompanying figure (Fig. 1), taken from the report of the conference as recorded in the *Comptes rendus* (November 4, 1912, No. 19, vol. clv., p. 872), is shown. The reader is supposed to commence the time reckoning from the innermost portion of the spiral.

At three minutes before the hour—that is, at any hour at which the signals are intended to distribute the time—the transmitting operator sends out a series of successive similar preliminary signals, a repetition of the letter X in Morse –··– –··– –··–, &c. These commence at the beginning of the 57th minute, and continue until 57m. 50s. has been reached. Then, beginning at the 55th second, three longs are given at intervals of one second, each long *lasting one second*. In the 58th minute a short (lasting for a *quarter* of a second), preceded by a long commencing two seconds before, heralds every tenth second, and at the 55th second three longs as before are signalled. During the 59th minute two longs, preceding the quarter-second tap at every tenth second, are transmitted, and this minute concludes as before with the three longs at seconds intervals.

By following the spiral outwards and noting the positions of the longs and shorts in relation to

the divisions in seconds on the outer circle, the system can be easily understood.

It will thus be seen that each short signal or tap will give the receiver a chance of comparing his clock, and the dissimilar preliminary signals will inform him whether the minute involved is the 58th or 59th.

When all stations bring this excellent and very simple system into operation, it will be most easy for anyone unacquainted even with the Morse alphabet to check their clocks correctly.

Now while the above arrangements as regards the distribution of time will come into force on July 1 next, the questions as regards the type of weather messages, which will be transmitted directly after the time signals have been sent out, are not yet settled.

There is little doubt, however, that each transmitting station will send out a general description of the air movements over a wide area of which the station is about a centre, and also some definite data as regards certain specified stations useful for that area.

At the present time both Paris and Norddeich send out such messages, and it may be of interest to describe the procedure now followed at the former station, for it is probable that little, if any, change will be made with regard to the system there in vogue.

Let us suppose that the time signals at 10h. 45m. os., 10h. 47m. os., and 10h. 49m. os. have just been transmitted from the Eiffel Tower, then there follow immediately after them the weather signals. It may be mentioned again that the signals are sent through quite slowly, so that with a little practice they can be easily recorded and deciphered.

A typical message received in London on January 28, 1913, ran as follows:

(*a*) =BCM=R.51000=V.491424=O.551633=
C.621812=H.653043=S.46207=
Pression basse ouest Europe élevée nord==

(*b*) R.51000=V.491424=O.551633=
C.621812=H.653043=S.46207=
Pression basse ouest Europe élevée nord=

(*c*) Paris=vent 9 mètres stationnaire sud croît pression 758 stationnaire ciel couvert==

(*d*) V. 9 m ss sud cc pp 758 ss ciel couvert

Then follow the signals:

-.-.-. (end of transmission).

..-. .-.. (FL repeated several times, which denote Eiffel Tower).

And lastly

.....- (end of work).

The above message has been divided into four sections and marked (*a*) (*b*) (*c*) (*d*), in order to show that (*b*) is simply a repetition of (*a*), and that (*d*) is a repetition of (*c*), only sent in brief, *i.e.* "V" corresponds to "vent," "m" to "mètres," "ss" to "stationnaire," &c.

In deciphering the message only (*a*) has to be considered, because (*c*) explains itself, being the general weather conditions at Paris stating the velocity of the wind in metres per second, direction of wind, pressure in millimetres, and state of sky. At 3 p.m. each afternoon a similar message stating the meteorological conditions at Paris is transmitted from the Eiffel Tower.

With reference to (*a*), then, the message contains information relating to (1) atmospheric pressure, (2) wind direction and force, (3) the state of the sea, *in code* from the following six stations: Reykjavik (R), Valencia (V), Ushant (Ouessant) (O), Corunna (C), Horta (H) (Azores), for 7 a.m.; and for St. Pierre (S) (Miquelon, Newfoundland) for the preceding 8 a.m. (see Fig. 2).

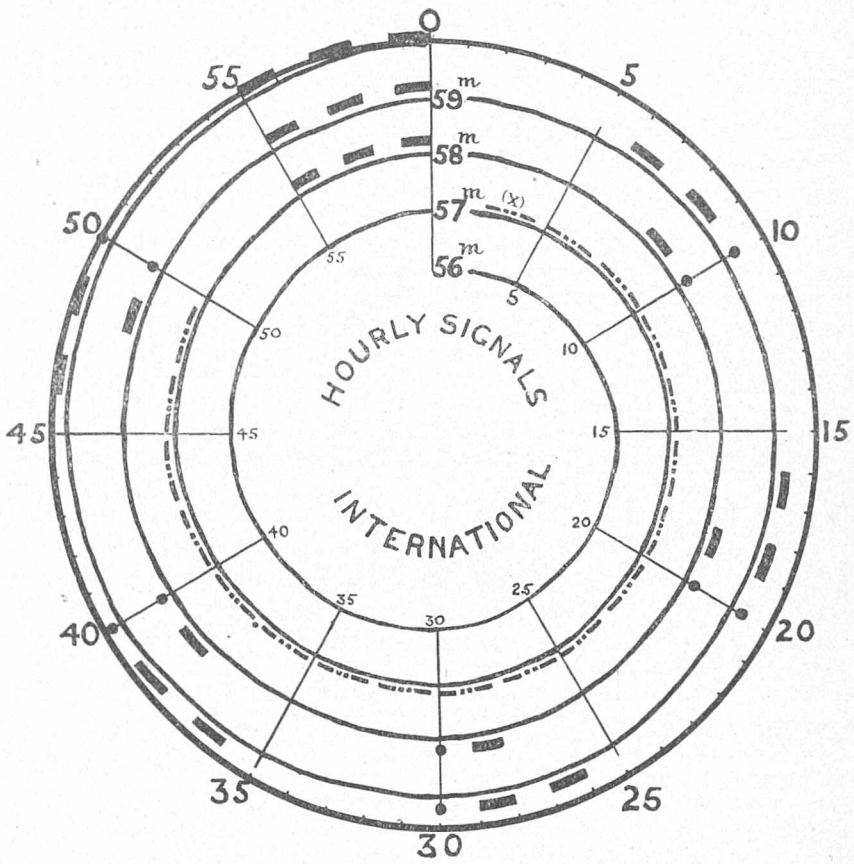


FIG. 1.—Diagram to illustrate the international system of radio-telegraphic time signals which will come into operation on July 1 of this year.

The coded part of the message is given in seven groups. The first group, BCM, stands for the Bureau Central Météorologique, and indicates the source of the information. The above-named stations are indicated by the single letters printed in brackets above.

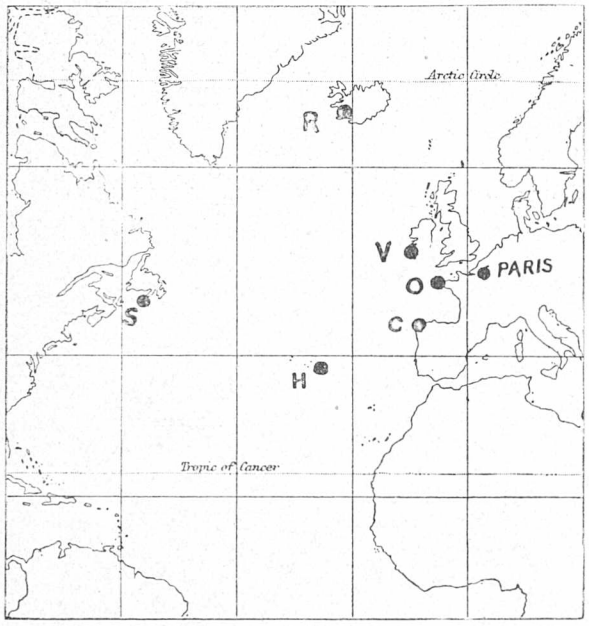


FIG. 2.—Chart showing the positions of the stations neighbouring the North Atlantic, the meteorological conditions at which are daily transmitted by radio-telegraphy from the Eiffel Tower. (See text for names of stations indicated.)

The first two figures in each group indicate the barometric pressure in millimetres, it being understood that 700 mm. should be added. The next two figures represent the wind direction in points of the compass as follows :—

Bureau Central Météorologique.

Letter	Station	Barometer		Wind			Sea
			mm	Direction		Force Scale 0-9	Scale 0-9
R	Reykjavik	51	751	00	N	0	—
V	Valencia	49	749	14	SSE	2	4
O	Ouessant (Ushant)	55	755	16	S	3	3
C	Corunna	62	762	18	SSW	1	2
H	Horta (Azores)	65	765	30	NNW	4	3
S	St. Pierre	46	746	20	SW	7	—

Low pressure west Europe high to the north.

It is impossible to overestimate the great value such messages can be to outward and homeward bound ships that receive them, for instead of having to gauge the approaching weather conditions from their own isolated observations they can form a far more accurate judgment by the deductions from the radio-telegraphic data.

While the distribution of time and weather signals will be of general utility, perhaps its most important value will be felt by sailors. Cut off from all shore communication with the exception of wireless, they will be put on nearly the same equality as land stations when the international system is in full swing.

WILLIAM J. S. LOCKYER.

Code No.	32	02	04	06	08	10	12	14	16	18	20	22	24	26	28	30
Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW

The fifth figure denotes the wind force on a scale ranging from 0, a calm, to 9, a hurricane. The sixth and last figure shows the state of the sea, a "calm" being denoted by 0 and "tremendous" by 9.

In the case of Reykjavik and St. Pierre, the sixth figure is omitted, no reports for transmission being available.

It sometimes happens that when the messages are being sent out from the Eiffel Tower, some of the data for some of the stations have not been received by the Bureau Central Météorologique, and therefore cannot be transmitted. In these cases the signal -..- or X is substituted for any unknown figure.

The following statement gives a full translation of the message marked (*a*) given previously, the code letters and figures being given in the first, third, fifth, seventh, and eighth columns.

NOTES.

IN the King's Speech at the opening of Parliament on Monday reference was made to the following matters, among others, to be brought forward during the session :—A guarantee from the Imperial Exchequer of a loan by the Government of the Sudan for the development therein of the industry of cotton-growing; proposals for the better care and control of the feeble-minded and for the further restriction of the industrial employment of children; proposals for the development of a national system of education. In the course of his comments upon the last-named subject, Lord Crewe remarked, in the House of Lords, that it is not the intention of the Government to endeavour to force through Parliament in this session a vast measure dealing with national education. "But in view of what has fallen from the Prime Minister, and also in view of the observations made by the noble and learned lord on the Woolsack at Manchester in the beginning of January, which were the sequel to a close inquiry into the subject, we think it is quite proper to place the country in possession of the general lines of our intentions during the coming session, although I do not suppose that we shall be able to proceed very far towards getting them

carried into law. We have not embarked on the consideration of the question without counting the cost or without realising that it will be necessary to provide more than is provided at present out of national funds towards the cost of education."

DR. DUGALD CLERK, F.R.S., has been elected a member of the Athenæum Club under the provisions of the rule which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public services."

THE Trustees of the Indian Museum have appointed Dr. N. Annandale as their representative at the International Congress of Zoology, to be held at Monaco this month.

THE ninth International Physiological Congress will be held at Groningen on September 2–6 next, under the presidency of Prof. H. J. Hamburger, professor of physiology in the University of Groningen.

MR. DAVID S. PRENTICE, superintending inspector, has been promoted to the post of chief inspector of the veterinary branch of the Department of Agriculture and Technical Instruction for Ireland.

THE death is announced at Paris, at sixty-nine years of age, of M. A. M. Picard, vice-president of the Council of State and an honorary member of the Institution of Civil Engineers. M. Picard was the author of several works on engineering subjects, and many comprehensive reports upon the achievements of arts and industry at the close of the nineteenth century and after.

AT a meeting of the council of the British Association, held on March 7, a vote of condolence with Lady White on the death of Sir William White, president-elect of the association, was passed. The presidency for the forthcoming meeting in Birmingham was considered, and subject, under the rules, to ratification at an extraordinary meeting of the council, to be held on April 4, Sir Oliver Lodge, F.R.S., will be nominated as president. There will be a meeting of the general committee on the same day to make the election.

AMERICA has lost a bacteriologist of great promise by the death, in his forty-fifth year, of Dr. P. H. Hiss, jun. After graduating in arts at Johns Hopkins and in medicine at Columbia, he was appointed in 1895 assistant in bacteriology at the College of Physicians and Surgeons at Columbia University. From that post he was promoted successively to an instructorship, adjunct professorship, and, in 1906, to the full professorship in that subject. Dr. Hiss was joint author of a widely used text-book of bacteriology, and had also published a series of technical studies. He was best known by his methods of detecting typhoid bacilli, and by his use of the leucocyte as a cure for pneumonia and erysipelas.

A MARBLE bust of the late Mr. Brian Houghton Hodgson, executed by Thornycroft in 1844, has been presented by his widow to the British Museum (Natural History). The bust, of which a photograph is given in Sir W. W. Hunter's "Life of Hodgson," represents Hodgson, who died in 1894, at the age of forty-four. By the gift of his natural history and anthropological collections made while British Resident at Khatmandu, in the first half of last century, and subsequently while living privately at Darjiling, Hodgson greatly enriched the museum, and it is therefore appropriate that his bust should find a home in the building, where it is to be placed, we believe, alongside that of Dr. Gray, at the entrance to the Upper Mammal Gallery.

THE Franklin Institute, Philadelphia, acting through its committee on science and the arts, recently made the following awards of the Elliott Cresson gold medal, the highest in the gift of the institute:—Dr. C. P. Steinmetz, of Schenectady, New York, in recognition of successful application of analytical method to the solution of numerous problems of first practical importance in the field of electrical engineering; Emile Berliner, of Washington, D.C., in recognition of important contributions to telephony and to the science and art of sound-reproduction; Dr. I. Randolph, of Chicago, Ill., in recognition of distinguished achievement in the field of civil engineering; Lord Rayleigh, O.M., in recognition of extended researches of signal importance in physical science; Sir William Ramsay, K.C.B., in recognition of numerous discoveries of far-reaching importance in the science of chemistry; Prof. Emil Fischer, of Berlin, in recognition of numerous contributions of fundamental importance to the science of organic and biological chemistry.

ONE of the largest of the great scientific and industrial congresses is to be held in London in the early part of June, 1915. This is the sixth International Congress of Mining, Metallurgy, Applied Mechanics, and Practical Geology. These congresses take place at intervals of five years, and the last, which was brilliantly successful, was held at Düsseldorf in 1910, previous congresses having been held in Paris and Liége. The attendance at the Düsseldorf Congress was more than 2000, and it is anticipated that the attendance in London in 1915 will be equally large. An influential committee has been formed to make the necessary arrangements, and the movement is being actively supported by the University of London, Imperial College of Science and Technology, Geological Society of London, Institution of Mechanical Engineers, Iron and Steel Institute, Society of Chemical Industry, Institution of Mining Engineers, Institution of Mining and Metallurgy, Institute of Metals, South Wales Institute of Engineers, Cleveland Institution of Mining Engineers, West of Scotland Iron and Steel Institute, Staffordshire Iron and Steel Institute, Sheffield Society of Engineers and Metallurgists, and by numerous firms interested in the various industries represented.

THE winter, as comprised in the period for the thirteen weeks ended March 1, is shown by the Meteorological Office to have been mild, wet, and somewhat sunless over the entire area of the United Kingdom. The excess of temperature was greatest in

the south-east of England, where the mean for the period was 3° above the average. In the Midland Counties and in the east of England the mean temperature was 2·5° above the average. The heaviest rainfall for the winter was 14·90 in. in the west of Scotland, which was followed by 14·70 in. in the south of Ireland, and 14·58 in. in the south-west of England. The greatest excess of rain was 32 per cent. above the average in the south-west of England, and about 25 per cent. in excess in the Midland Counties, the south-east of England, and in the north and south of Ireland. The sunshine for the winter was sixty hours deficient in the east and west of Scotland, but only about twenty hours deficient in the south-east of England. The temperature for the winter of 1911–12 was about equally in excess to that of the recent winter. The excess of the rainfall was everywhere greater except in the north of Scotland, where in 1911–12 there was a deficiency. In the south-west of England the aggregate rainfall in the winter of 1911–12 was 16·36 in., which was 5·29 in. more than the average. The duration of bright sunshine was also everywhere deficient in the winter of 1911–12, except in the north of Scotland. The characteristics of the last two winters were very similar over nearly the whole of the United Kingdom.

THE ninth International Zoological Congress will be held at Monaco, under the presidency of H.S.H. the Prince of Monaco, from Tuesday, March 25, to Saturday, March 29. The congress this year appears to be specially attractive, there being up to the present time above 500 members who have enrolled. Besides special communications which are to be made in the seven sections of the congress, questions of general interest will be discussed at the early meetings. One point the zoologists are specially asked to discuss, and in some way agree upon, is concerning the use of generic and specific names, as to whether in all cases zoological nomenclature should be given absolutely to the original generic and specific name, or whether exception should be made in certain time-honoured generic and specific names which are thoroughly familiar to every zoologist. No lengthy excursions are arranged, but there will be receptions held at the Oceanographical Museum, at the palace, and in other places in the principality. Included in the programme is a fête performance at the opera. The fee for attendance is 25 francs, and application should be made at an early date for particulars regarding hotel accommodation, &c., to the secretary, whose address until March 15 is Prof. Joubin, Oceanographical Institute, 195 Rue Saint-Jacques, Paris, and afterwards the Oceanographical Museum, Monaco.

IN the February issue of *Man* Messrs. M. Longworth Dames and T. A. Joyce describe a remarkable steatite relief acquired by the British Museum from the Swat Valley, on the north-west Indian frontier. It represents in a most artistic way the famous story of King Sivi, who saved a pigeon from a hawk, and to compensate the pursuer cut off pieces of his own flesh equal in weight to the bird. This is the only known representation of the story, and the acquisition of the relief is particularly interesting because, according to the Chinese Buddhist pilgrim, Hiouen Tsang, Asoka built a stupa in the land of Udyāna, the modern Swat Valley, to commemorate this incident. The discovery of the relief will now probably give a hint as to the position of the stupa. The writers point out that this story is also localised in the Indus Valley, and, being imported into Europe, was possibly the origin of the legend which formed the basis of "The Merchant of Venice."

REFERRING to Prof. R. T. Hewlett's article on the pasteurisation of milk, published in our issue for February 6 last (vol. xc., p. 623), "Paterfamilias" sends an account of a method of preserving milk he has found successful. The plan, which Prof. Hewlett considers very good, was to put the milk in an earthenware bottle with narrow neck, and to keep the bottle in a boiling water bath for twenty or thirty minutes, according to the size of the bottle. While still in the bath, a rubber stopper with a thistle funnel stuffed with cotton-wool was inserted in the neck and the bottle removed. As pointed out, however, in Prof. Hewlett's article, even with the precautions adopted by "Paterfamilias," in hot weather, unless *cooled* after treatment, the milk is liable to undergo very undesirable changes.

WE have been favoured with a cutting from *The Daily Malta Chronicle* of February 17, in which Mr. N. Tagliaferro, who has for some time been collecting fossil bones from a rock-fissure at Corradino, records the discovery of a large series of remains of giant land-tortoises. Most of these, it is stated, are referable to *Testudo robusta,* and the smaller *T. spratti* of Leith Adams. One of the specimens is, however, asserted to indicate a tortoise nearly half as large again as the biggest described example of the former, and may, it is suggested, represent a third species. These and other remains have been deposited in the museum at Valletta, and will, no doubt, be fully described in due course.

IT is announced in the Proceedings of the Philadelphia Academy for December, 1912, that the work of rendering the library and museum fireproof, which was undertaken through the aid of the Commonwealth of Pennsylvania, has at length been completed. As the library of natural history works is stated to be the largest in America, while the museum is particularly rich in type specimens, the importance of the achievement can scarcely be overrated. New quarters have been prepared for the entomological department, which are stated to meet all the requirements of workers; the department is devoting special attention to the economic aspects of entomology and the etiology of diseases due to insects.

IN the *Naturwissenschaftliche Wochenschrift* (xii., 5, February 2, pp. 65–69) Mr. H. Nachtsheim gives a valuable summary of observations and experimental work on the reproductive cycle of Rotifers. Most of the work has been done on *Hydatina senta,* and the greater part of his paper deals with this species. He reviews the earlier work of Maupas and Nussbaum, shortly summarises that of Punnett, and then dis-

cusses at greater length the experiments of Whitney and A. F. Shull, who have sought to determine what are the intrinsic and extrinsic factors which bring into existence male-producing and female-producing parthenogenetic females. It is concluded that while in many Rotifers, as Lauterborn has shown, there is a fairly regular cycle, in Hydatina external conditions, especially the chemical condition of the water, have much greater effect, perhaps because Hydatina lives in small pools which are more readily affected by environmental factors. Little is said about cytological observations, and the work of Lenssen, which is probably only in apparent contradiction of the later observations of Whitney, is not mentioned. Otherwise it appears to be a very complete and compact summary of our present knowledge of the subject.

PROF. G. KLEBS has forwarded a reprint of his recent important paper (*Verhandl. d. nat.-med. Ver.*, Heidelberg, 1912) on the morphology and phylogeny of the Peridineæ, a group of Protista which has in recent years received a vast amount of attention on account of the important part which these organisms play in the phytoplankton of both salt and fresh water. In this paper the author describes a number of new genera which are of remarkable interest as connecting up the typical Peridineæ with the Flagellate group Cryptomonadina, and showing also that on the other hand the Peridineæ have apparently given rise to Alga-like forms characterised by gradual loss of motility, and the development of resting colonies showing vegetative cell-division. He also discusses the possible affinities between the Peridineæ and certain groups of Algæ (Diatomeæ, &c.), and of Protozoa (*Infusoria ciliata* and Radiolaria), and represents his views in a diagrammatic "family tree."

THE last number of the Bulletin of the Seismological Society of America contains two short accounts by Mr. G. A. Clark and Mr. A. G. McAdie of the eruption of the Katmai volcano in Alaska last June (vol. ii., pp. 226–229, 236–242). The volcano is a rather insignificant peak, less than 5000 ft. in height, and, before last June, was supposed to be extinct. The eruption began on June 6 at about 4 p.m., and was seen by several observers on the island of Kodiak, at a distance of seventy-five miles. A heavy fall of ashes took place during June 6 and two following days, but ceased about three days later. The town of Katmai, which was explored on June 14, was found to be buried in ashes to a depth of three or four feet, and on Kodiak island the thickness of the layer of ashes was more than a foot. Further eruptions occurred during each of the next four months, those of August 19 and October 25 being of some violence.

THE useful report on the state of the ice in the Arctic seas during 1912, published by the Danish Meteorological Institute, is of more than usual interest in view of the abnormal conditions which obtained in the North Atlantic in that year. It includes, as before, monthly summaries prepared from all reports received, and charts showing the condition of the ice during each of the months April–August. The winter of 1911–12 was on the whole mild in the region of Bering Strait and in Greenland, but cold in the European Arctic seas; in the White Sea there was much ice until the first half of June, and the Kara Sea seems to have been unapproachable all through the summer. In Barents Sea the edge of the ice throughout the summer was more westerly and southerly than usual. The coast of Iceland was quite free during the year, but the edge of the ice was not far off the northern shore. Vessels were able to put into Angmagsalik (East Greenland) about the third week in July, owing to there being no great drift southward of the vast masses of ice further north; a possible result may be a heavy drift this year. The conditions along the west coast of Greenland were about normal. Only few reports from Bering Sea and Strait were received, and none from the Beaufort Sea. On this account the institute makes an impressive appeal for more cooperation in its important work; during the year in question the available information was almost entirely received from Norwegian and Danish sources. The proposed publication by the Meteorological Office in its *Weekly Weather Report* of observations respecting the state of the ice off the east coast of North America during this season, received by wireless messages from the whaler *Scotia*, which has been chartered by the Board of Trade in conjunction with the North Atlantic steamship lines, will be an important step in the direction of the appeal of the Danish Meteorological Institute.

FROM the *Rendiconti* of the Royal Lombardy Institution we learn that the prize for airships, which was founded by the late Dr. Cagnola long before the days of aërial navigation, has again been unawarded, as has, indeed, been the case during practically the whole period of development of modern airships and dirigibles. The report of the referees on the work submitted by the solitary competitor, coupled with the absence of other competitors, seems to indicate that Italian aëronauts, as well as others competent to submit Italian, French, or Latin accounts of their successful experiments, are deterred from making any serious effort to compete for the prize, and this for some reason or other which is doubtless well known to them. The object which Dr. Cagnola had in view has been attained quite independently of his benefaction, and it is surely unfortunate that the latter has signally failed to further this end.

POSTAGE stamps do not often afford material for scientific discussion, but an interesting point is mentioned by Mr. Sam S. Buckley in his book on the marginal varieties of the Edwardian stamps of Great Britain (published by Oswald Marsh, London), in connection with a change that was initiated in the autumn of 1911 in the mode of perforating the new English issues. Until then the horizontal and vertical perforations were at the same distance apart, namely 14 in 2 centimetres. It was found, however, that the stamps would not tear well along the horizontal lines, and the explanation was that in machine-made paper the fibres have a tendency to lie in certain directions, thus making the resistance to tearing unequal in

different directions. A remarkable result of these experiments was the conclusion that the resistances could be equalised by using fifteen perforations horizontally to fourteen vertically, the extra perforation making all the difference.

WE have received a copy of a new illustrated catalogue of physical apparatus issued by Messrs. F. E. Becker and Co., Hatton Wall, E.C. It is a substantial quarto volume of more than a thousand pages, and covers most of the apparatus, from millimetre scales to electric motors, likely to be used in a physical laboratory, while the requirements of the engineer and miner are not forgotten. Some of the newer apparatus is described in detail, and instructions as to its use are given, as, for instance, in the case of the Bunsen ice calorimeter on p. 950, and of the stereo pyrometer on p. 1013.

THE first number of *Scientia* for 1913 contains two articles which throw doubt on the validity of the recently discovered sun-spot periods of five and eight years, and on the principle of relativity which has taken so prominent a place in recent theory. The first article is by Mr. E. W. Maunder, of Greenwich. The second article, by Prof. M. Brillouin, of the Collège de France, points out the slenderness of the foundation on which the theory of relativity has been reared, and maintains that the impossibility of detecting a relative motion of ether and matter, which forms the basis of the theory, is merely an experimental difficulty of the present time, and ought not to be elevated into a universal principle. Prof. Brillouin also takes exception to some of the more recent propositions stated by Prof. Einstein, as, for example, that energy has inertia and weight, and concludes that the principle of relativity introduces more difficulties than it solves.

THE *Verhandlungen* of the German Physical Society for January 15 include a short *résumé* by Dr. F. Reiche of the results he has obtained for the distribution of intensity in a fine spectrum line under various conditions. He considers a thin layer of a luminous gas the electron systems attached to the atoms of which are oscillating owing to the impact on them of electrons or atoms. The breadth of the line emitted is produced partly by damping due to radiation, and to inter-atomic forces, and partly to the motion of the emitting centres themselves in accordance with the kinetic theory of gases. As a result, he finds that the distribution of intensity is to a great extent determined by a parameter, which, if small, gives the distribution found previously by Lord Rayleigh; if large, a distribution the author proposes to call the "dispersion distribution." In the former case, increase of density of the gas or of thickness of the layer of gas leads to only a small amount of widening of the line, in the latter to a considerable widening. These theoretical conclusions have been verified experimentally.

A YEAR ago reference was made in NATURE to the elegant proof given by Willstätter and Escher that lutein, the yellow pigment of yolk of egg, was similar to, if not the same as, the xanthophyll present in leaves. In the interval other animal pigments have been investigated, and Dr. Escher now announces that the yellow pigment of the *Corpus luteum* is identical with carrotene, such as is present in carrots and leaves, and closely allied to lycopin, the colouring matter of tomatoes. Carrotene has been shown by Monier-Williams to form the yellow colouring matter of wheaten flour, and it is of interest to note that Escher states he has preliminary evidence that the yellow pigment of fat is similar in composition. Carrotene is an unsaturated hydrocarbon, $C_{40}H_{56}$, whereas xanthophyll has the formula $C_{40}H_{56}O_2$. The two classes of pigments are separated by shaking with a mixture of alcohol and light petroleum. The liquid forms two layers, the upper one of petroleum ether containing the carrotene, and the lower alcoholic layer containing the xanthophyll. The ovaries of no fewer than 10,000 cattle were required for the investigation, and yielded less than half a gram of pigment.

FIVE recent additions to the "Cambridge Manuals of Science and Literature" have been received from the Cambridge University Press. One volume, by Prof. J. H. Poynting, has on its cover, "The Earth," but an examination of the title-page shows that its shape, size, weight, and spin only are dealt with. In Mr. A. J. Berry's book, "The Atmosphere," the subject-matter has been restricted to the more purely chemical and physical phenomena, meteorology being omitted. Dr. Alex. Wood writes on "The Physical Basis of Music," and provides an elementary account of the principles of the subject. In "The Story of a Loaf of Bread," Prof. T. B. Wood gives a popular account of the subject so far as farming, milling, and baking are concerned. Mr. E. L. Attwood, writing from the naval architect's point of view, contributes a volume on "The Modern Warship." The volumes, which are each sold at 1*s.* net, appear to be addressed to the general reader, but it is to be feared that few such readers will be prepared to give the sustained attention which the treatment of the subject in most of the volumes demand. In accuracy and authoritativeness the books leave nothing to be desired, and as introductions to more advanced treatises the series may be recommended unreservedly.

A BRIEF account of the thirteenth meeting of the Australasian Association for the Advancement of Science, held in January, 1911, at Sydney, appeared in the issue of NATURE for February 23, 1911 (vol. lxxxv., p. 558). We have now received the official report of this meeting, edited by the permanent honorary secretary, Mr. J. H. Maiden, assisted by the secretaries of sections. It is an imposing volume of 766 pages, and is well and profusely illustrated with forty-eight plates, in addition to the illustrations in the text. The report provides excellent evidence of the industry and enthusiasm of Australasian men of science, and of this record of a year's work the association may well be proud.

OUR ASTRONOMICAL COLUMN.

THE USE OF A PLANE GRATING IN STELLAR SPECTROSCOPY.—In No. 5, vol. vi., of the Journal of the Royal Astronomical Society (Canada) there is an interesting note describing some preliminary tests, made at the Dominion Observatory, Ottawa, of a plane grating used as the dispersion piece of a stellar spectrograph. The grating used is one ruled by Dr. J. A. Anderson, who is now regularly ruling excellent gratings at the Johns Hopkins University, and has a ruled surface of $2\frac{7}{8} \times 3\frac{3}{4}$ in., with 15,000 lines to the inch. It was employed in the Littrow form of spectrograph, giving a linear dispersion of 17·5 Angströms per millimetre, and gave excellent definition over a nearly flat field extending from λ4800 to λ3500. The photographs secured show a much more uniform intensity over a wide range than do those taken with a three-prism spectrograph, and for this reason will be especially useful. In the red, where the prismatic spectrum is so compressed, and in the violet and ultra-violet, where it suffers considerable absorption, the grating spectrograph will prove very advantageous, and the results of the further experiments to be made will be awaited with interest.

OBSERVATIONS OF THE ZODIACAL LIGHT.—The February number of *L'Astronomie* contains two striking drawings of the zodiacal light as seen by Lieut.-Col. Pachine at Essentouki (Caucasus) on January 28, 1911. This observer has seen the phenomena many times, and in various countries, but had never before seen it so bright. At 6h. 30m. p.m., the base of the luminosity extended along the western horizon for a distance of some 30° from α Piscis Austr. towards Aquila, and the cone reached upwards to a point a little to the south of α Arietis, the brightness from the base to γ Pegasi being more than twice that of the Milky Way in its brightest parts. Many curious fluctuations took place, and at 9h. 40m. the apex of the cone enveloped the Pleiades. The colour of the light generally was from a pale-yellow to a bluish-grey.

ASTRONOMICAL TIME-INSTALLATIONS.—A brochure published by the Royal Observatory of Belgium contains a very detailed and well-illustrated account of the installations employed for the time-service in that observatory, written by MM. Philippot and Delporte. The various means employed to secure the necessary constancy of pressure and temperature in the underground chamber containing the installation are very interesting, as are also the various devices for automatic regulation and registration, and it would appear that the Belgian authorities have established an ideal installation for their time-service.

Amateur astronomers will find a useful note, by M. Jonckheere, in the January number of *L'Astronomie*, describing a device he employs for keeping his sidereal clock at constant temperature. The clock is placed in a double case, and should a change of temperature occur, a current is sent automatically through a heating circuit (an incandescent lamp bulb) until equilibrium is restored. With this apparatus M. Jonckheer keeps the temperature constant within 0·25° C.

ORNITHOLOGICAL NOTES.

IN the fifth part (vol. i.) of *The Austral Avian Record* the editor executes a complete *volte face* in the matter of the classification of Australian birds. Hitherto he has used generic terms in a wide and comprehensive sense; he now employs them in a much more restricted signification, and accordingly proposes no fewer than forty-eight new genera in this issue. Whether such changes be expedient or not (there is no right or wrong in the matter), they have the great disadvantage of rendering standard works, like Sharpe's "Hand-list of Birds," more or less obsolete.

In *The Zoologist* for December, 1912, Mr. F. J. Stubbs gives reasons for regarding migration as a cosmical function, which plays an important part in regulating the present balance of life on the globe. The prevalence of continuous sunlight during the Arctic summer and its absence in winter is regarded as the primary controlling factor of the phenomenon.

Bird-migration in Lindisfarne forms the subject of an editorial article in *British Birds* for December, 1912. Rather more than a hundred kinds of birds were observed on the island, of which not more than thirty seemed to be resident. Although no great inrush of birds was noticed, migration was going on during twenty-six out of the forty days of the visit. Bird-life in the south-west of Ireland and the recovery of birds marked in 1912 form two of the chief items in the January issue of the same journal.

Bird-marking in the Netherlands forms the subject of an article by Dr. E. D. Van Oort in Notes Leyden Mus., vol. xxxiv., p. 243. The number of birds marked in 1912 was considerably greater than in the preceding year. The record includes such birds of both years as have been recovered up to date, but the returns from correspondents were not complete when the article was written.

In the course of a narrative of a trip through South America, including a visit to Tierra del Fuego, which deals chiefly with ornithology, Mr. F. W. Blaauw (Notes Leyden Mus., vol. xxxv., No. 1) describes the nestling plumage of the so-called Coscoroba swan (*Coscoroba candida*), and its bearing on the affinities of the genus. The colour-pattern is intermediate between those of sheldrake and tree-duck chicks, the head-markings approximating to, and the body-markings being almost identical with, those of the latter. This tends in some degree to confirm the author's view that Coscorobas are practically overgrown tree-ducks.

It is satisfactory to learn, from a report by Mr. G. Bolam on the natural history of Hornsea Mere, published in the January number of *The Naturalist*, that the local birds are most efficiently protected by the keeper, who has occupied his post for thirty-two years. It may be noted that in 1911 fourteen bearded tits were introduced, some of which have nested and reared young.

In a long article on the "Hand-list of British Birds," by Dr. Hartert and others, published by Messrs. Witherby, *The Field* of March 8 strongly condemns the great changes in familiar nomenclature which form one of the most striking features in that work, referring especially to the inconvenience caused by transferring names long associated with well-known species to others. At the conclusion of the article it is suggested that those "who may be in doubt whether to accept or reject the list now under consideration will do well to await the appearance of a new edition of the B.O.U. List, which, we understand, is in active preparation. The simplest way out of the difficulty, as it seems to us, is to ignore the new list."

Last year schedules were distributed throughout the country with the object of obtaining data with regard to the alleged decrease during the last few years in the numbers of certain migratory species which regularly visit the British Islands. Although the returns are not so full or so numerous as is desirable, they afford a considerable amount of in-

formation in respect to England, which is summarised by Mr. M. Vaughan in the March number of *British Birds*. As the result of the inquiry it seems practically certain that a decrease—and this not merely local—has taken place in the case of several species, notably the whitethroat, the redstart, the marten, the swallow, and the wryneck. No attempt is made to explain the diminution in numbers, which we have heard attributed, at least in the case of some species, to shooting and netting on the Continent.

In the February number of *The Zoologist* Mr. J. M. Dewar records further observations on the manner in which oyster-catchers open mussels and other bivalves. Mussels seldom open their shells wide enough to enable the bird to introduce its beak, except by the way of the gap for the byssus, and when this is not accessible, the oyster-catcher resorts to careful tapping, which causes the mollusc to rotate one valve on the other, and thus afford an entrance for the beak. Small mussels are frequently hammered to pieces by repeated blows with the beak.

Nos. 6 and 7 of *The Austral Avian Record* are devoted to a list of the species of Australian birds named by John Gould, and the present location of the type specimens, drawn up by Messrs. Witmer Stone and Mathews. The Gould Australian collection was sold in 1847 to Dr. T. B. (not J., as has been stated) Wilson, of Philadelphia. The type specimens are for the most part in the museum of the Philadelphia Academy; although the greater part of those of species named by Gould subsequently to the 1847 sale are in the British Museum. Gould named 426 or 427 Australian birds (both numbers are given at the end of the list) of which 341 stand, either as species or subspecies. The list will be valuable to systematic ornithologists.

In his presidential address to the Royal Australasian Ornithologists' Union, as reported in *The Emu* of January, Mr. J. M. Mellor emphasised the necessity of continued bird protection and the working of the present Act. A serious defect in this is the opportunity afforded by merely partial protection for a heavy destruction of certain species during the Christmas holidays.

In *Science* of February 27, Dr. R. W. Shufeldt announces a forthcoming memoir on the Pleistocene avifauna of the Oregon desert, in which three extinct species will be described. R. L.

FORTHCOMING BOOKS OF SCIENCE.

AGRICULTURE.

Crosby Lockwood and Son.—Agricultural Arithmetic: An Elementary Handbook for Farmers and Farm Students, containing Important Data and Calculations bearing upon the Science and Practice of Agriculture, with Special Reference to Dairying, J. C. Newsham and T. V. Philpott. *John Murray.*—A Pilgrimage of British Farming, A. D. Hall, illustrated. *T. Fisher Unwin.*—Mozambique: its Agricultural Development, R. N. Lyne, illustrated. *John Wiley and Sons (New York).*—Agricultural Drafting, C. B. Howe; Exercises on Dairying, Prof. C. Larsen.

ANTHROPOLOGY.

John Bale, Sons, and Danielsson, Ltd.—Some Austral-African Notes and Anecdotes, Major A. J. N. Tremearne, illustrated. *The Cambridge University Press.*—Folk Song and Dance, Miss Neal and F. Kidson; Brands Used by the Chief Camel-owning Tribes of Kordofán: a Supplement to the Tribes of Northern and Central Kordofán, H. A. MacMichael, illustrated. *W. Heinemann.*—Pedagogic Anthropology, S. M. Montessori. *G. Fischer (Jena).*—Die Anthropologie in ihren Beziehungen zur Ethnologie und Prähistorie, Prof. O. Schlaginhaufen. *Macmillan and Co., Ltd.*—The Golden Bough: a Study in Magic and Religion, Prof. J. G. Frazer, third edition, revised and enlarged; Part vi., The Scapegoat; Part vii., Balder the Beautiful; The Belief in Immortality and the Worship of the Dead, Prof. J. G. Frazer: Vol. i., The Belief among the Aborigines of Australia, the Torres Straits Islands, New Guinea, and Melanesia, the Gifford Lectures, St. Andrews, 1911–12. *Methuen and Co., Ltd.*—The Ancient History of the Near East from the Earliest Period to the Persian Invasion of Greece, H. R. Hall, illustrated. *Oliver and Boyd (Edinburgh).*—The Antiquity of Man in Europe, being the Munro Lectures on Anthropology and Prehistoric Archæology in connection with the University of Edinburgh.

BIOLOGY.

D. Appleton and Co.—Colour Key to North American Birds, F. M. Chapman, new edition, illustrated. *A. and C. Black.*—First Principles of Evolution, Dr. S. Herbert, illustrated; The Naturalist at the Sea Shore, R. Elmhurst, illustrated; Reptiles and Amphibians, A. N. Simpson, illustrated; Pond Life, Rev. C. A. Hall, illustrated; British Moths, A. M. Stewart, illustrated; British Beetles, Rev. C. A. Hall, illustrated. *W. Blackwood and Sons.*—Text-Book of Agricultural Zoology, F. V. Theobald, new edition. *The Cambridge University Press.*—Vegetation of the Peak District, Dr. C. E. Moss; The Land of the Blue Poppy; Wanderings of a Botanist in Tibet, F. K. Ward, illustrated; Bees and Wasps, O. H. Latter; The Wanderings of Animals, Dr. H. Gadow. *Cassell and Co., Ltd.*—Flowerless Plants: How and Where they Grow, S. L. Bastin, illustrated; Botany For All, H. J. Jeffery, illustrated; Baby Birds at Home, R. Kearton, illustrated; Garden Work for Every Day, H. H. Thomas, illustrated; Cassell's Dictionary of Practical Gardening, edited by W. P. Wright, illustrated. *J. M. Dent and Sons, Ltd.*—The Geography of Plants, G. S. Boulger, Part i., A comprehensive history of the scientific study of the geographical distribution of plants, as far as possible in the actual words of the successive workers; Part ii., A reasoned exposition of the present principles of the science and phytogeography (including ecology); Part iii., A description of the vegetation of the different botanical regions and provinces of the globe; The Sea-shore I know, W. P. Westell and H. E. Turner, illustrated. *Duckworth and Co.*—Life and Evolution, F. W. Headley, new edition, illustrated. *G. Fischer (Jena).*—Die Fauna Südwest-Australiens, edited by Drs. W. Michaelsen and R. Hartmeyer, Band iv., Lieferung 1–4, illustrated; Metamorphose der Muraenoiden, Prof. B. Grassi, illustrated; Handbuch der Entomologie, edited by Prof. C. Schröder, Band i., Lieferung 2 and 3, illustrated; Moderne Probleme der Biologie, Prof C. S. Minot, illustrated; Einführung in die botanische Mikrotechnik, H. Sieben, illustrated. *R. Friedländer und Sohn (Berlin).*—Das Tierreich, edited by Prof. F. E. Schulze, Turbellaria II.: Rhabdocœla and Allocœla, L. v. Graff; Pteropoda, T. T. Tesch; Amphibia, F. Nieden; Cumaoca, T. R. Stebbing. *Hodder and Stoughton.*—Every Man His Own Gardener, J. Halsham, new edition, illustrated; Every Man's Book of Garden Difficulties, W. F. Rowle, new edition, illustrated; Every Man's Book of Garden Flowers, J. Halsham, illustrated; The "Open-air" Series: Field and Lane, River and Pond, Sea and Cliff, Hill

and Vale. *T. C. and E. C. Jack.*—Insects: their Life-histories and Habits, H. Bastin, illustrated; The British Bird Book, Sections 11 and 12, illustrated; Present-day Gardening: Climbing Plants, W. Watson, illustrated. *H. Jenkins, Ltd.*—Wild Birds through the Year, G. A. B. Dewar, illustrated. *C. H. Kelly.*—Common British Birds and How to Identify Them, R. H. W. Hodges, illustrated. *Longmans and Co.*—British Diving Ducks, J. G. Millais, 2 vols., illustrated; A Text-book of Practical Bacteriology and Microbiology, Dr. A. Besson, translated from the fifth French edition, and adapted by Prof. H. J. Hutchens. *Macmillan and Co., Ltd.*—A Treatise on Embryology, edited by W. Heape, vol. i., Invertebrata, Prof. E. W. Macbride, illustrated; Physiological Plant Anatomy, Prof. G. Haberlandt, translated by J. M. F. Drummond, illustrated; Cocoa, Dr. C. J. J. van Hall. *A. Melrose.*—The Wonder of Life, Prof. J. A. Thomson, illustrated. *Methuen and Co., Ltd.*—Some Secrets of Nature (Studies in Field and Wood), Junior, illustrated; The Romance of Nature (Studies of the Earth and its Life), Senior, illustrated. *Milner and Co.*—Bird Life, W. P. Westell, illustrated. *John Murray.*—The Genus Rosa, E. Willmott, drawings by A. Parsons, Part 25; The Reduction of Domestic Flies, E. L. Ross, illustrated. *The Oxford University Press.*—The Works of Aristotle, translated into English, by L. Dowdall, E. S. Forster, H. H. Joachim, and T. Loveday, vol. vi., Opuscula; The Problems of Genetics, Prof. W. Bateson. *Bernard Quaritch.*—Illustrations of Conifers, H. Clinton-Baker, vol. iii. *Lovell Reeve and Co., Ltd.*—The Coleoptera of the British Islands, Rev. Canon W. W. Fowler and H. St. John Donisthorpe, vol. vi., illustrated. *The Religious Tract Society.*—Wild Flowers of the Year, Rev. Prof. G. Henslow, illustrated. *G. Routledge and Sons, Ltd., and Kegan Paul and Co., Ltd.*—The Gardener's Dictionary, edited by A. Hemsley and J. Fraser, illustrated; General Biology, Father H. Muckermannn, translated from the German under the author's supervision. *Simpkin, Marshall and Co., Ltd.*—Twentieth Century Gardening, J. Weathers, illustrated. *John Wiley and Sons (New York).*—Laboratory and Field Studies of Trees, J. J. Levison; Logging: Some of the Problems relating to, and the Methods of, Harvesting Major and Certain Minor Forest Products in the United States of America, Prof. R. C. Bryant; Theory and Practice of Working Plans (Forest Organisation), Prof. A. B. Recknegel. *Witherby and Co.*—A Dictionary of English and Folk-Names of British Birds, H. K. Swann.

CHEMISTRY.

Edward Arnold.—Service Chemistry, Prof. V. B. Lewes and J. S. S. Brame, new edition, illustrated; Organic Chemistry, Prof. J. B. Cohen, Part ii.; Industrial Poisonings ("Gewerbliche Vergiftungen"), Dr. J. Rambousek, translated by Dr. T. M. Legge, illustrated. *Constable and Co.*—Outlines of Industrial Chemistry, edited by Dr. G. D. Bengough: Leather Trades, H. G. Bennett; Concrete, Cement, and Bricks; Dairy Trades; Alkali and Sulphuric Acid; Photographic Industries. *Gurney and Jackson.*—Chemical Monographs: The Chemistry of Dyeing, Dr. J. K. Wood; The Chemistry of Rubber, B. D. Porritt; The Fixation of Atmospheric Nitrogen, Dr. J. Knox; A Text-book of Quantitive Chemical Analysis, Drs. C. Cumming and S. A. Kay. *Longmans and Co.*—Photochemistry, Dr. S. E. Sheppard; Osmotic Pressure, Dr. Alexander Findlay. *The University Tutorial Press, Ltd.*—Senior Volumetric Analysis, Dr. Wm. Briggs and H. W. Bausor; Preliminary Chemistry, H. W. Bausor.

ENGINEERING.

Cassell and Co., Ltd.—Structural Engineering, Dr. A. W. Brightmore, new edition, illustrated; Railway Wonders of the World, F. A. Talbot, illustrated. *Chapman and Hall, Ltd.*—Continuous Beams in Reinforced Concrete, B. Geen; Further Points in the Theory and Design of Structures, E. S. Andrews. *Constable and Co., Ltd.*—Surveying, J. Williamson; Foundations, W. Simpson; Earthwork, by W. A. Kemp; Railway Permanent Way, W. A. Messer; Bridge Work; Gas Engineering; Equipment of Docks; Caisson Construction; Materials of Construction; Tunnelling; Materials of Construction; A Handbook of Testing, Prof. C. A. Smith, ii., Prime Movers. *Crosby Lockwood and Son.*—Fire Protection in Buildings: a Practical Treatise for Engineers, Architects, Surveyors, and Property Owners, H. G. Holt, illus-Engine: a Practical Treatise on the Design and Construction of the Diesel Engine for the Use of Draughtsmen, Students, and others, G. J. Wells and A. J. Wallis-Tayler. *Longmans and Co.*—Heating Systems: Design of Hot Water and Steam Heating Apparatus, F. W. Rayners, illustrated. *G. Routledge and Sons, Ltd., and Kegan Paul and Co., Ltd.*—The Control of Water for Power Irrigation and Town Water-Supply Purposes, P. à M. Parker, illustrated. *John Wiley and Sons (New York).*—Text-Book on Highway Engineering, Prof. A. H. Blanchard and H. B. Browne; Suspension Bridges: Arch, Rib, and Cantilever, Prof. W. H. Burr; Earthwork Haul and Overhaul, Prof. J. C. L. Fish; Gas Power, Prof. C. F. Hirshfeld and T. C. Ulbricht; Working Drawings of Machinery, W. H. James and M. C. Mackenzie; Computation for Marine Engines, Prof. C. H. Peabody; Catskill Water Supply, L. White.

GEOGRAPHY AND TRAVEL.

G. W. Bacon and Co., Ltd.—Contour Map of Wales with Names in Welsh, T. Lewis, scale 1 : 278,784, size 30 in. by 40 in.; Four-sheet Contour Map of United States, scale 1 : 3,200,000, size 58 in. by 46 in.; Contour Map of the Ancient World, showing Routes of Alexander the Great, St. Paul, &c., scale 1 : 6,063,552; A Physical Atlas containing Orographical Rainfall, Temperature, &c., Maps of the Continents; Contour Map of England and Wales, scale 1 : 760,000. *The Cambridge University Press.*—Cambridge County Geographies: Herefordshire, A. C. Bradley, illustrated; Lincolnshire, E. M. Sympson, illustrated. *Cassell and Co., Ltd.*—Mexico and Her People of To-day, N. O. Winter, illustrated. *Duckworth and Co.*—From the Congo to the Niger and the Nile, Adolf Friedrich Duke of Mecklenburg, 2 vols., illustrated. *Macmillan and Co., Ltd.*—Trans-Himalaya: Discoveries and Adventures in Tibet, Sven Hedin, vol. iii., illustrated. *John Murray.*—The Big Game of Central and Western China, being an Account of a Journey from Shanghai to London Overland Across the Gobi Desert, H. F. Wallace, illustrated. *T. Fisher Unwin.*—A Naturalist in Cannibal-Land, A. S. Meek, with an introduction by the Hon. Walter Rothschild, illustrated.

GEOLOGY.

The Cambridge University Press.—Submerged Forests, C. Reid. *Harper and Brothers.*—The Age of the Earth, A. Holmes. *G. Fischer (Jena).*—Geologische Heimatkunde von Thüringen, Prof. J. Walther, new edition, illustrated. *Macmillan and Co., Ltd.*—Text-Book of Palæontology, Prof. Karl A. von Zittel, a new edition, thoroughly revised, enlarged, and to some extent re-written, translated and edited by Dr. C. R. Eastman, vol. i. *Oliver and Boyd (Edinburgh).*—Mountains, their Origin, Growth, and Decay, Prof. J. Geikie, illustrated.

MATHEMATICAL AND PHYSICAL SCIENCE.

The Cambridge University Press.—Matrices and Determinoids (University of Calcutta Readership Lectures), Prof. C. E. Cullis; Mathematical Tripos Paper, 1908–12; Beyond the Atom, Prof. J. Cox; Wireless Telegraphy, Prof. C. I. Fortescue; Proceedings of the Fifth International Congress of Mathematicians (Cambridge, August 22 to 28, 1912), edited by the General Secretaries of the Congress, Profs. E. W. Hobson and A. E. H. Love; Principia Mathematica, A. N. Whitehead and B. Russell, vol. 3; Cambridge Tracts in Mathematics and Mathematical Physics: Volume and Surface Integrals Used in Physics, J. G. Leathem, new edition, with two additional sections. *Cassell and Co., Ltd.*—Electricity in the Service of Man, Dr. R. M. Walmsley, vol. iii., section 1, illustrated. *G. Fischer (Jena).*—Einführung in die höhere Mathematik für Naturforscher und Aerzte, Dr. J. Salpeter, illustrated. *Harper and Brothers.*—The Planets Inhabited? E. W. Maunder. *Longmans and Co.*—An Introduction to the Mathematical Theory of Attraction, Dr. F. A. Tarleton, vol. ii. *Milner and Co.*—Astronomy, E. Hawkes, illustrated. *R. Mückenberger (Berlin).*—Anleitung zu den wichtigsten physikalischen Schulversuchen, Dr. W. Volkmann, illustrated. *The Oxford University Press.*—The Algebra of Quantics, E. B. Elliott, new edition; Stellar Motions, W. W. Campbell. *The University Tutorial Press, Ltd.*—Mathematical Physics, C. W. C. Barlow, vol. i., Magnetism and Electricity; Preliminary Arithmetic, A. Barraclough. *John Wiley and Sons (New York).*—Applied Mechanics, Profs. C. E. Fuller and W. A. Johnston, vol. i., Statics and Kinetics; vol. ii., Strength of Materials.

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RECENT ADVANCES IN SCIENTIFIC STEEL METALLURGY.[1]

TO render clear the exact nature of certain modern scientific advances in steel metallurgy it is necessary briefly to consider what is known of the past history of steel, more particularly with reference to cutting implements, whether for the purposes of peace or war. That steel (or, to be more accurate, probably steely-wrought iron) was known to the ancients, say, 3000 years ago, seems to be proved by a passage translated by Pope from the ninth book of Homer's "Odyssey":—

> "And as when armourers temper in the ford
> The keen-edged pole-axe, or the shining sword,
> The red-hot metal hisses in the lake
> So in his eyeballs hissed the plunging stake."

As has been truly remarked by Roscoe and Schorlemmer, the above description can be applied only to steel—that is to say, to iron containing a very considerable percentage of carbon.

So far as definite records are concerned, the story of early British steel metallurgy is wrapped in profound obscurity, and its history can be only indirectly surmised from collateral historical evidence. About A.D. 60 a great British army under the command of Queen Boadicea stormed the Roman camp at Colchester and annihilated the Ninth Legion. She then marched on St. Albans and London, and in both places put the garrisons and the Roman colonists to the sword, the stake, or the cross. Tacitus, the Roman historian, records that the losses of the Romans and their allies in these battles reached the startling total of 70,000 people. In the subsequent campaign, which ended in the defeat and death of the heroic British Queen, the same historian states that the British lost 80,000 persons.

It is evident, therefore, that Boadicea must have commanded at least 100,000 British troops, or she could never have undertaken such extensive and formidable military operations. It is also clear that these troops were armed with swords and spears, to say nothing of the scythes attached to the axles of their war chariots. There is no reason to suppose that these weapons were not of native manufacture. They would partly be made of bronze and partly of steely-iron, since the country had been for a century occupied by Roman soldiers and artisans. It is therefore almost certain that in the first century the manufacture of steely-iron weapons and implements would be on a fairly large scale, and would doubtless mainly be concentrated in iron ore and charcoal-producing districts, such as Sussex and the Forest of Dean.

In connection with Sheffield—now the greatest British steel centre—the earliest written record refers to the twelfth century, and states that in 1160 the monks of Kirkstead Abbey had somewhat extensive works at Kimberworth, near Sheffield, manufacturing wrought-, and, no doubt, steely-irons. In 1386 Chaucer, in "The Reve's Tale," in describing a miller of the time of Edward III., wrote, "A Shefeld thywtel bare he in his hose." Since 1386 Sheffield steel in the form of table knives has been in almost everybody's mouth. In 1590 Peter Bales, "The Writing Schoolmaster," recommends Sheffield razors and penknives for the cutting of quill pens. It is obvious that for this purpose fine steel carrying a perfect cutting edge is necessary, and was being made at Sheffield prior to 1590. Hunter states that in 1615 Sheffield workmen could make armour only fit for the common man-at-arms. The armour for knights was imported from Spain and Italy. Scott, in "Ivanhoe," embodies this fact in his description of the siege of "Torquilstone":—

"Thrice did Locksley bend his shaft against De Bracy, and thrice did his arrow bound back from the Knight's armour of proof. 'Curse on thy Spanish steel coat,' said Locksley. 'Had English smith forged it, these arrows had gone through an as if it had been silk or sendal.'"

The opening scene in "Ivanhoe" was near Woodhouse (five miles east of Sheffield), where, until quite recently, wrought-iron was manufactured at the Rotherwood Iron Works.

In 1760 Horace Walpole, writing to George Montague, remarks: "I passed through Sheffield, which is one of the foulest towns in England in the most charming situation. There are two-and-twenty thousand inhabitants making knives and scissors. They remit eleven thousand pounds a week to London. One man there has discovered the art of plating copper with silver. I bought a pair of candlesticks for two guineas, that are quite pretty."

Antiquarians express the opinion that the remarkable concentration of the cutting-steel industry round Sheffield was due to the juxtaposition of coal and iron ore in the district. This reason, however, is quite unconvincing to metallurgists; first, because charcoal and not coal was used, and, secondly, because the local ore produces an iron high in phosphorus, from which it is practically impossible to make cutting implements of fine steel. There is little doubt that the main factor which originally determined the location of the chief British steel industry at Sheffield was the unique situation of the town in a hollow near the confluence of four rivulets into the Don. Along these streams, running down the valleys of the Sheaf, the Porter, the Rivelin, and the Locksley, the old Sheffield steel-workers could, by the construction of numerous dams, get water-power for their forging hammers and grinding wheels at a small cost, and waterwheels worked by some of these dams are still in operation along these valleys, that of the Don itself actuating tilt-hammers and grindstones.[2] The latter are made from the carboniferous sandstones of the district. There is proof positive that the basis metal, consisting of nearly pure iron, from which the best Sheffield cutting steels are still made, was being imported into the town in the sixteenth century from abroad.

Among entries in the accounts of the Sheffield Church burgesses for the year 1557 is the following:—

"Paid to Robert More for one stone and quarter of Danske Yron XXIId. Paid to ye same Robt. for X lib of Spanysche Yron XV."

In modern money the cost of this raw material works out to at least 60*l.* per ton, or 3*l.* per cwt.[3] The Danish (Danske) iron was probably Swedish, just as at present much of the Danish butter imported comes from Swedish dairies.

In connection with the early importation of pure Swedish or Spanish iron for a basis metal, it is significant that in 1442 Sheffield obtained a Royal warrant to construct towpaths to make the River Don navigable. This river runs into the Humber at Goole, and there is little doubt that so early as the fifteenth century Sheffield steel-makers were endeavouring to replace the costly packhorse transit of foreign raw

[1] Discourse delivered before the Royal Institution on Friday, January 24, by Prof. J. O. Arnold, F.R.S.

[2] There is evidence in old documents that the name Sheffield may be a corruption of "Escafeld," meaning "the field of waters."

[3] Prof. Thorold Rogers in his Oxford lectures, 1888–9, stated that about 1685, using a multiplier of 2, the value in modern money of English wrought-iron was about 73*l.* per ton. The Sheffield record, however, proves beyond doubt that in 1557, *or more than a century and a quarter earlier*, the imported and superior Spanish and Swedish irons were commanding in Sheffield, retail, not more than 14*l.* per ton, which, using a multiplier of 4.5, is equivalent in present money to 63*l.* per ton.

materials by cheaper water carriage from the Humber.

It is next of interest to consider how, during the fourteenth, fifteenth, sixteenth, seventeenth, and half the eighteenth centuries, Sheffield made all its fine steel. It seems almost certain that the nearly pure imported Swedish or Spanish irons were carburised "in the dry way," by cementation in charcoal at a yellow heat. The highly ductile bar iron and the blistered and brittle steel resulting from its cementation-carburisation were described. The blister bar was then made into what for perhaps two hundred and fifty years has been known as "shear steel."

(The method of producing from blister bar both single and double shear steel was then described.) The origin of the name "shear steel" was due to the fact that British cloth-workers insisted on having this fine quality of steel for their cloth-cutting shears, and this material is still branded with rude representations of clothiers' shears. One pair of shears signifies single shear and two pairs double shear steel. The chemical composition of this steel, which is the purest made, is as follows:—Carbon 1·00 per cent; silicon, 0·03 per cent.; manganese, 0·07 per cent.; sulphur, 0·01 per cent.; phosphorus, 0·015 per cent. With its high reputation built up during centuries this material has naturally had its name branded on inferior kinds of steel. Indeed, bars of steel up to 6 in. in diameter have been sold as "shear steel" at 18*s*. per cwt., the price of the raw material from which shear steel is manufactured. Probably a bar $1\frac{1}{2}$ in. in diameter marks the advisable limit of size for genuine shear steel, and its average market price is about 45*s*. per cwt.

The year 1740 marked for Sheffield, and indeed for the world, the beginning of an epoch of great metallurgical importance. Benjamin Huntsman, a well-known clockmaker of Doncaster, found that shear steel, on account of its sometimes varying temper and of its weld-lines, often presented uneven hardness and exasperating flaws when made into clock springs. He consequently determined to make a steel even in texture and free from weld flaws. He experimented successfully, and worked out a method for the production of sound steel ingots by the fluid or crucible process, and so founded in Sheffield an industry, destined to become world-wide, which soon extended the fame of Sheffield steel throughout the civilised world.'

(A composition typical of crucible cast-steel was then given. It is less pure than shear steel, but sounder, being free from weld-lines. It is said that the famous American, General Sherman, when asked to "spare the good Indians," replied that the only good Indians he had ever met were dead Indians. Be this as it may, it is certain that no steel can be good unless it is properly "killed," or, in other words, "dead melted."

Fig. 1 shows two crucible steel ingots of identical composition and weight when poured in a "lively" and in a "killed" condition. Ignoring the "pipe," or central contraction cavity, the killed steel is quite solid, whilst the unkilled metal is riddled from end to end with gas cavities or "blowholes," containing, under pressure, hydrogen, carbonic oxide, and nitrogen gases, evolved in the plastic steel during solidification, and thus rendering the ingot commercially worthless. The sound and hence apparently much smaller ingot has been "killed" by the presence of a trace (say 0·01 per cent.) of metallic aluminium. The scientific explanation of this, the most remarkable phenomenon in the whole range of steel metallurgy, may be found in text-books or in reports of metallurgical lectures, but the present lecturer must confess that he is no nearer a convincing solution of this problem than when he began his researches twenty-five years ago.

It is next necessary to correlate the chemical and micrographic analyses of the plain carbon steel upon which the world depended for its cutting implements from the time of Homer to 1870.

The structure of pure Swedish iron is usually contaminated with a little slag. Ignoring this, the mass consists of white allotrimorphic crystals of iron with optically black boundaries.

In a micrograph of nearly pure iron containing about 0·4 per cent. of carbon, almost half the mass consists of the dark-etching compound constituent pearlite.

The structure of nearly pure iron containing 0·89 per cent. of carbon consists entirely of pearlite, a mechanical mixture of 87 per cent. of iron with 13 per cent. of normal carbide of iron, Fe_3C. The mass abrasion hardness of normal pearlite is about 4·5—that is, between fluorspar and apatite on Moh's mineral scale.

We have next to consider the phenomena known as the hardening and tempering of steel.

Figs. 2 and 3 show very clearly the beginning, the progression and end of the hardening of steel—that is to say, the transformation (during a thermal amplitude of perhaps 3° C.) of the compound constituent pearlite ($21Fe+Fe_3C$) to the micrographically amorphous constituent hardenite, which corresponds to the empirical figures $Fe_{24}C$, in which the carbide of iron, owing to the quenching, is trapped in some molecular association with the whole of the iron. The constituent hardenite has a hardness of 7 on Mohr's mineral scale—that is to say, it is as hard as quartz, flint, or rock crystal.

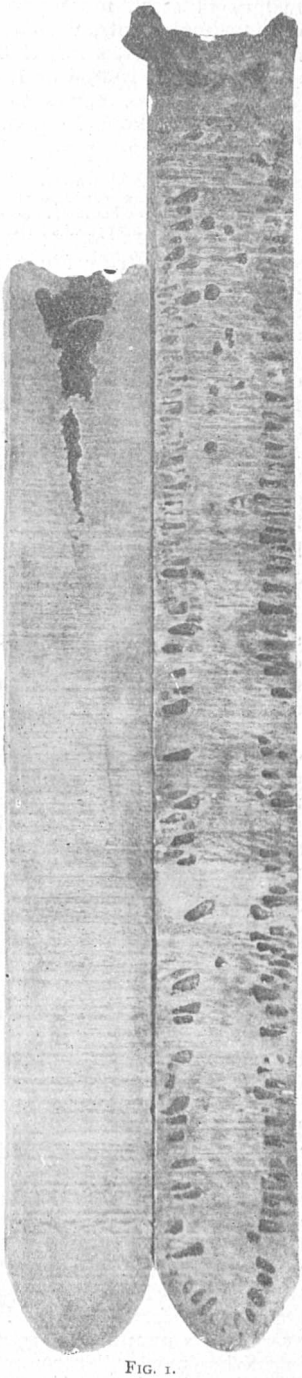


FIG. 1.

It is a little difficult to realise how much the thermal capability of the mineral pearlite (with a hardness of 4·5) to transform itself into the igneous rock hardenite (with a hardness of 7) has contributed to the advance of civilisation and to the material well-being of the human race. But unfortunately it was

found that hardenite was thermally very unstable, and that its cutting powers were greatly limited by the fact that the heat of friction in turning operations caused the hardenite to revert largely to relatively soft pearlite at a blue heat, say, 300° C. This property naturally limited the operations of engineers as to speed, as to traverse, and as to depth of cut, and consequently as to the cost and rate of output of all the engines and appliances necessary to our modern civilisation.

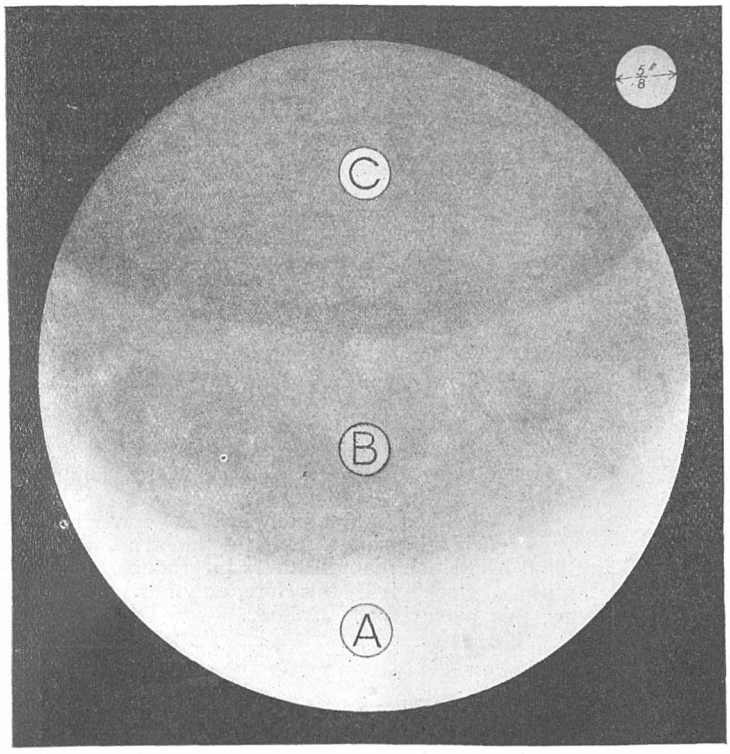
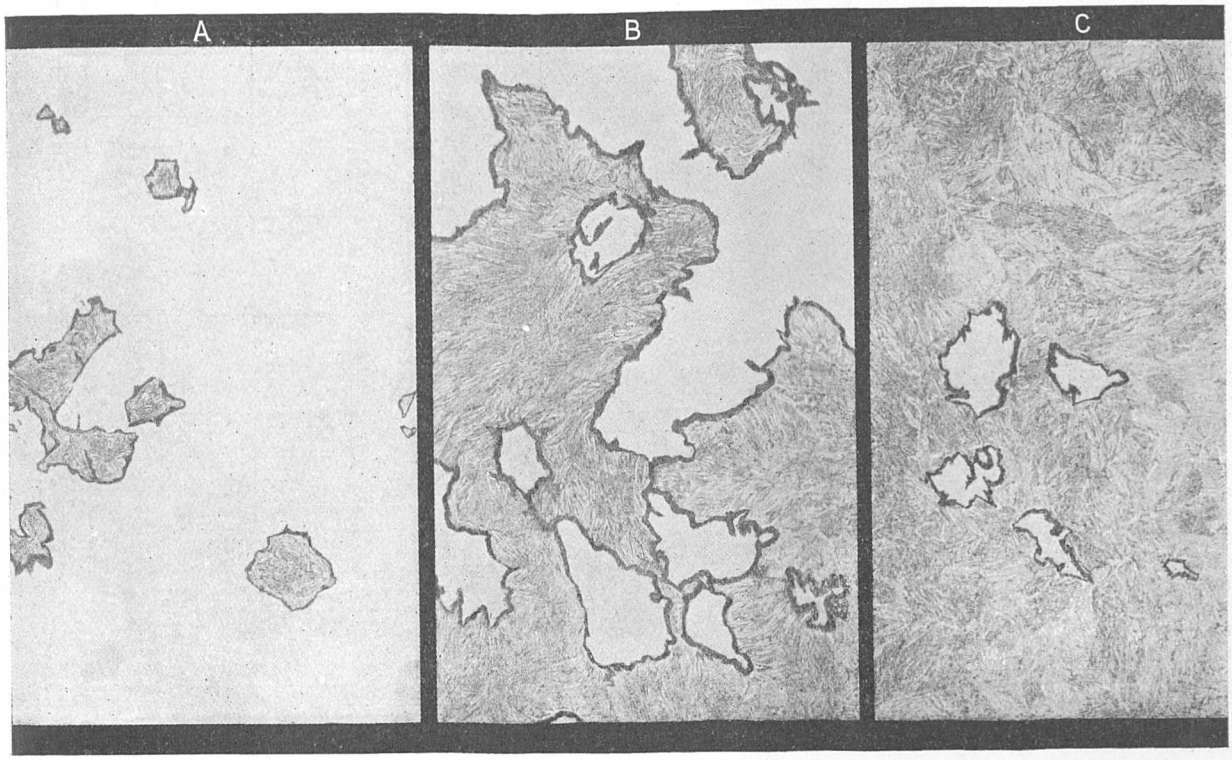


FIG. 2.—Carbon 0·89 per cent. The edge A was quartz-hard, stripping file teeth. The edge C was quite soft to the file. Etched ⅝ in. diameter disc. Magnified about 12 diameters after differential heating and rapid quenching. For high-power magnification see Fig. 3.

(A tempering diagram was then explained in which the black areas show the evolution of the latent heat of hardening, and consequently the transformation of the quartz-like hardenite to soft pearlite. This change at about 250° C. acquires a marked increase in velocity which reaches a maximum at about 300° C. Here the soft pearlite becomes the predominant partner, and the cutting power of the mass has practically vanished.)

About the year 1870 marked the first beginnings of an epoch in cutting-steel metallurgy, which may be called the tungsten-chrome era. Robert Forrester Mushet, at the Clyde Works, Sheffield, began to manufacture on a considerable scale his "self-hardening steel." Mushet had practically discovered that when carbon steel was alloyed with a large percentage of tungsten, it, when cooled from a yellow heat in a draught of air, was not only sufficiently hardened, but, owing to the fortifying action of the tungsten on the carbon, the hardenite was thermally considerably more stable than that of plain carbon steel.

It is probable that in Mushet's early steels the "letting-down" point



Transformation nearly completed. Temperature about 730° C. Transformation half completed. Temperature about 729° C. Transformation beginning. Temperature about 728° C.

FIG. 3.—Pale areas, hardenite. Laminated areas, normal pearlite. Dark borders, troostitic pearlite. Carbon 0·89 per cent. Magnified about 450 diameter

of the hardenite was raised to a temperature of perhaps 400° C., thus enabling engineers to take bigger cuts and work at higher speeds. Later, about 1880, Mushet still further fortified his hardenite by the addition of relatively small percentages of chromium, and between 1880 and 1900 self- or air-hardening steels were produced by many steel manufacturers in considerable variety.

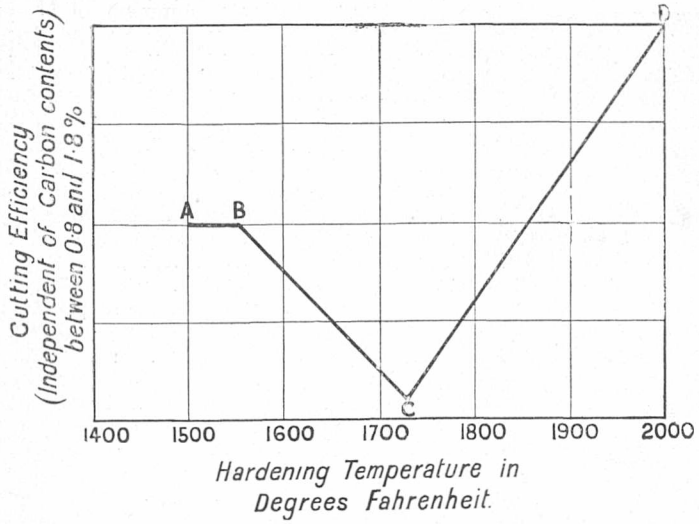


FIG. 4.—Physical diagram claimed by Messrs. Taylor and White for tungsten-chrome steels

In connection with cutting steels, a profound sensation was made throughout the steel world when, at the Paris Exhibition in 1900, the Bethlehem Steel Co. of America showed turning tools made under the alleged patent of Messrs. Taylor and White, cutting very mild steel at a speed which rendered the nose of the tool red-hot. It was obvious that in these tools the thermal stability of the hardenite had been raised to perhaps 600° C. The chemical compositions in the patent embodied nothing which had not been included in the Mushet type of steel for a period of about twenty years prior to the date of the American patent. In fact, what Taylor and White had really done was to show that this type of steel was capable of retaining its cutting edge at a much higher temperature than most engineers and metallurgists had realised. For this demonstration every credit is due to the Bethlehem Company.

Sheffield steel-makers, realising future possibilities, made from the year 1900 and onwards a series of experimental researches which eventually gave to engineers that astounding material known as high-speed steel, in which the thermal stability of the fortified hardenite was raised to about 700° C., and the striking difference in chemical composition between Mushet's and high-speed steels was shown; nevertheless, the latter are merely a progressive experimental development of the former.

The claims of the Taylor-White patent were the subject of a protracted lawsuit, the costs of which were about 50,000*l*. In the end, Mr. Justice Cross, of the United States Circuit Court, in a lengthy and luminous judgment, pronounced the Taylor-White patent to be absolutely invalid. Nevertheless, it is still claimed that the patent in suit was utilised by British manufacturers in producing modern high-speed steel. It is, therefore, only fair to consider what this patent really claimed.

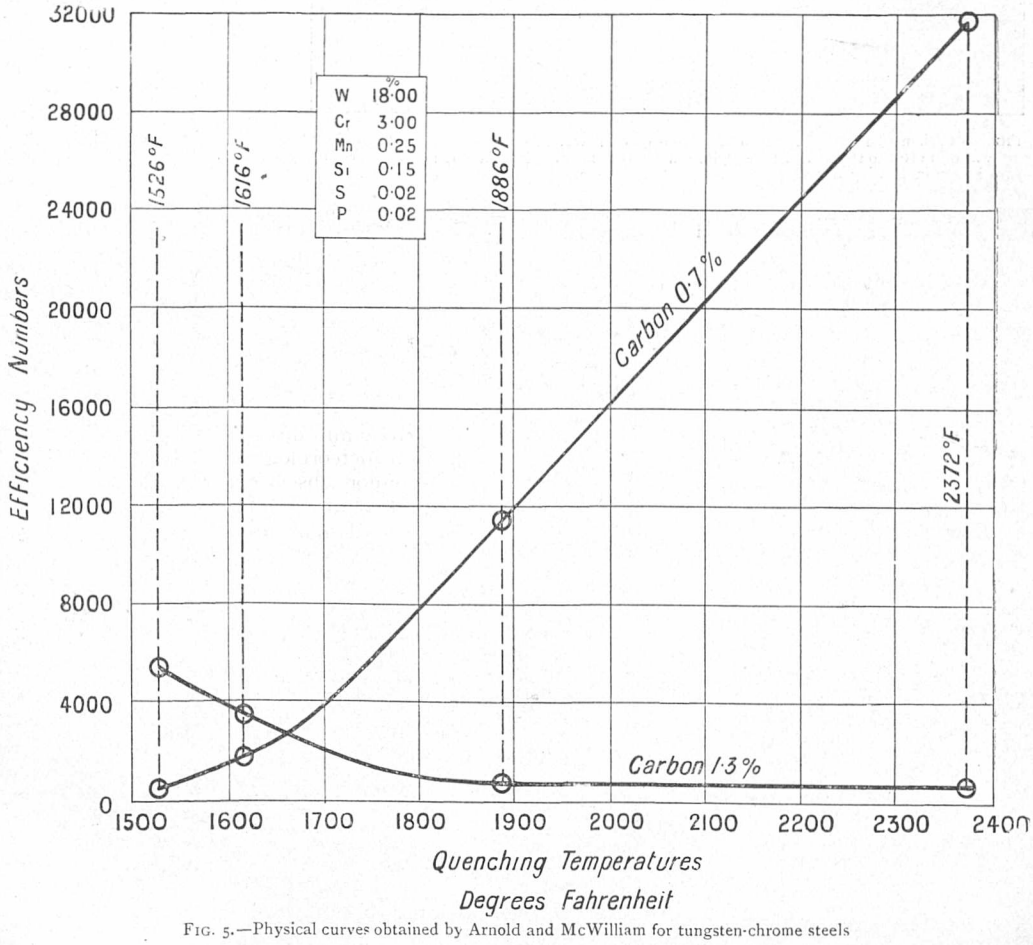


FIG. 5.—Physical curves obtained by Arnold and McWilliam for tungsten-chrome steels

Fig. 4 shows a physical curve of tungsten-chrome steels which the patentees claimed to have discovered. The coordinates are vertically the

cutting efficiencies of tungsten-chrome steels with any carbon from 0·8 to 1·8 per cent. (the amount being a matter of indifference), and horizontally the hardening temperatures in degrees Fahrenheit. The short horizontal line "A–B" between 1500° and 1550° F. was alleged to be the range in which, prior to the patent, all tungsten-chrome air-hardening steel had been hardened. The falling line "B–C" between 1550° and 1725° F. was stated to be the breaking-down range discovered by the patentees, along which the cutting power of the steel steadily deteriorated. Then along the rising line "C–D," from 1725° to 2000° F (the maximum temperature specified in the patent), the quality of the steel improved as the temperature of hardening rose, until in the higher part of this range the turning tools had an efficiency never before achieved in the art, and in effect (to use the words of Coleridge's "Ancient Mariner") the patentees claimed :—

We were the first that ever burst
Into that silent sea.

My late colleague, Dr. A. McWilliam, and I were commissioned to investigate at Sheffield University the accuracy or otherwise of the curve specified in the patent. The results are embodied in Fig. 5. The coordinates are, horizontally hardening temperatures in degrees F., and vertically cutting efficiency numbers obtained by the approximate and relative formula $e=t\times s^2$, where e is an efficiency number, t the time endurance in minutes, and s the cutting speed, *caeteris paribus*, in feet per minute. It will be seen that with a steel containing about 17 per cent. of tungsten, 3 per cent. of chromium, and 1·3 per cent. of carbon, the maximum efficiency number of about 5000 is obtained at the lowest temperature, 830° C., after which the higher the hardening temperature the less the efficiency number, which at 1300° C. or 2400° F. has fallen to 500, or only twice the efficiency of plain carbon steel. In a similar steel, containing, however, only 0·7 per cent. of carbon, the efficiency number at 830° C. is only about 500, but the efficiency steadily rises with the hardening temperature, until at 1300° C. or 2400° F. it reaches the astounding number of about 32,000. In a word, there is no breaking-down range, and so far from the percentage of carbon being immaterial the cutting efficiency is actually a function of the carbon and hardening temperatures.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—The council, in accepting the resignation by Prof. J. H. Poynting of the office of dean of the faculty of science, has passed the following resolution :—"That this council deeply regret the illness which has deprived them of the greatly valued and long-continued services of their former colleague, Dr. Poynting, at their meetings, and earnestly trust that his health, now happily restored, may be preserved for many years."

Prof. Barling has resigned the chair of surgery on his election as Vice-Chancellor.

Dr. Alfred H. Carter has resigned the chair of medicine, and the following resolution has been passed by the council :—"That the council accepts with great regret the resignation of Dr. A. H. Carter of his appointment as professor of medicine in this University. It desires to thank him for his valuable services not only as teacher during the past twenty years, but also for the great assistance he rendered in promoting the union of the medical faculty of Queen's College with Mason College, a step which materially advanced medical education and the University idea in Birmingham."

CAMBRIDGE.—The following is a summary of benefactions received by the University during the year ended December 31, 1912 :—

	£	s.	d.
Gonville and Caius College, towards the maintenance of the new buildings for physiology and experimental psychology	500	0	0
Dr. J. B. Hurry, St. John's College, for the endowment of a research studentship in physiology to be called the Michael Foster research studentship	1100	0	0
Anonymous, for the endowment of the Arthur Balfour professorship of genetics	20,000	0	0
Balfour Library Endowment Fund, subscribers to	2302	3	2
Col. W. Harding, for the endowment of a lectureship in zoology	1100	0	0
St. John's College, towards the equipment of the Solar Physics Laboratory on its installation at Cambridge ...	500	0	0
Anonymous, for the purpose of increasing the stipend of the director of the Fitzwilliam Museum	100	0	0
	£25,602	3	2

In addition, sums amounting to about 10,000*l.* have been presented to the University. These include 5000*l.* from Mr. Otto Beit, 1000*l.* from the Mercers' Company, 1000*l.* from Messrs. Rothschild and Son, and 200*l.* from Mr. Almeric Paget, M.P., for the new school of physiology.

The Vice-Chancellor gives notice that he has appointed Saturday, April 19, as the day for the election to the Plumian professorship of astronomy and experimental philosophy vacant by the death of Sir George Darwin. Candidates for the professorship are requested to send their names to the Vice-Chancellor on or before Friday, April 11.

The director of the Solar Physics Observatory has, with the consent of the Vice-Chancellor, appointed the following to be members of the staff of the Solar Physics Observatory :—F. J. M. Stratton, to be assistant director; C. T. R. Wilson, to be observer in meteorological physics; F. E. Baxandall, to be first senior observer; C. P. Butler, to be second senior observer; W. E. Rolston, to be first junior observer; W. Moss, to be second junior observer.

LEEDS.—Arrangements are being made for the establishment of a Yorkshire Summer School of Geography to be organised in alternate years by the Universities of Leeds and Sheffield. The course for 1913 will be held at Whitby, from August 4–25, under the auspices of the University of Leeds. The aims of the course are to provide instruction which shall equip students for attacking problems in the regional geography of any area, and to discuss and elucidate problems connected with the teaching of geography. The work of the school will include field work, laboratory work, and lectures on geological, meteorological, economic, and historical aspects of the geography of Yorkshire. The agricultural, mining, textile, and metallurgical industries will be dealt with, as well as questions connected with language and place-names. Further information will be available in June, on application to the secretary, Summer School of Geography, the University, Leeds.

In September next Prof. H. R. Procter will retire

from the chair of applied chemistry (chemistry of leather manufacture) which he has held for the past twenty-two years. Prof. Procter is prepared and desirous to continue in an honorary capacity the researches into the chemistry of the tanning process and the behaviour of colloids, on which he has been engaged. To commemorate the great services he has rendered to leather industries it is therefore proposed to erect and equip an International Research Laboratory, of which he will be honorary director so long as he desires to continue his investigations. The laboratory will be open, without charge, to competent students from every part of the world. The council of the University has provided a site, and an influential committee, representing the scientific and commercial sides of the leather industry, has been formed to appeal for subscriptions. The sum desired is 4000*l.* for the establishment of the laboratory, and 300*l.* a year for current expenses and assistance. The honorary treasurer of the committee is Mr. W. J. Rivington, *The Leather Trades Review*, 24 Mark Lane, London, E.C.

The University is to receive a grant of 1000*l.* a year through the Board of Agriculture from the Development Fund for investigations into the subject of animal nutrition. The work is to be carried out in consultation with the existing Research Institution at Cambridge, so that there shall be no unnecessary overlapping between the two schemes.

Science announces that gifts amounting to more than 100,000*l.* to Washington and Lee University, Lexington, Va., are provided for in the will of Mr. R. P. Doremus, who died on February 1.

THE council of the University of Bristol has been informed that the late Mr. Augustus Nash has bequeathed the residue of his estate in trust to pay a near relative the income during life, and afterwards to pay the capital sum to the University in the hope that it may be used to advance natural sciences, particularly chemistry. The sum will be about 18,000*l.*

IT will be remembered that, in 1909, the Goldsmiths Company gave 50,000*l.* towards the extension of the engineering department in the Central Technical College. The company has now offered to pay the entire cost of the new building, which means an added gift of 37,000*l.* The Goldsmiths' Company has attached the condition that the portion of the capital belonging to the Imperial College of Science and Technology which will be thus set free shall be added to the endowment fund, the income being used for higher educational and research work.

A MEMORIAL signed by a large number of educationists and others has been presented to the Prime Minister urging the need for an immediate reform of our national education. The petition states that the memorialists "are of opinion that this country has been slow, as compared with some other nations, in recognising how greatly education increases national strength when it permeates every class of the community and makes for the unity of the nation. They, therefore, urge that adequate provision for education in all grades, from the primary school to the university, be made in every defined area of the population; that the artificial barriers between grade and grade should be, so far as possible, broken down, and facilities given to every child, whatever his birth or creed, to proceed unhindered to his appropriate development and towards a national ideal of intellectual, spiritual, and vocational efficiency." The petition urges the Government to undertake forthwith "a comprehensive reform of the national education, making for the good of the nation as a whole.

THE Admiralty has issued a circular detailing the steps it is proposed to take to supplement the supply of officers for the Navy. The new requirements of the Air and Submarine Services, the establishment of the Dominion Navies, and other causes all make an increased number of naval officers necessary. This greatly augmented demand will be met in part by promotions from the lower deck, by absorption of officers from the R.N.R., and in other ways, but to provide officers available for service in 1920 a new policy is to be adopted in addition to existing plans. The special entry is proposed of a limited number of cadets of about the age of eighteen, who have completed their general education. A number of such cadets not exceeding thirty annually will be admitted by competitive examination of selected candidates. They will be sent to a naval establishment for a course of professional training before being distributed as midshipmen in the fleet. The same subsequent career will be open to them as to officers who have entered through Osborne. They will be free to volunteer for service in any one of the special branches. The entrance examination will be such as to attract candidates who have received at school a good grounding in mathematics, mechanics, and physics. The subjects of examination will be nearly identical with those prescribed for entry to Woolwich, but some weight will be assigned to an elementary knowledge of engineering science in addition to the usual Woolwich subjects. The course of training which these cadets will undergo after admission will consist largely of instruction of a practical kind in naval engineering and in the service applications of electricity. The first special entry under these conditions will take place by competitive examination in June next. An Admiralty Committee will interview each candidate and examine credentials furnished by the headmaster of the school he is attending or last attended. On the report of this committee it will be determined whether the candidate shall be admitted to compete.

DURING the International Kinematograph Exhibition, to be held at Olympia on March 22–29, there will be an educational conference, at which the use and value of the kinematograph as an aid to instruction will be discussed. It would, of course, be absurd to suggest that direct observation, or mental work requiring the individual activity of the pupil, can be replaced as educational factors by the more or less passive contemplation of moving pictures; nevertheless, there are many subjects, which can be illustrated more effectively by the kinematograph than by any other means. Moving pictures representing the peoples, industries, and characteristics of many lands give more accurate impressions than many pages of a geographical reading book; the dry bones of history may be made to live in the minds of pupils by means of some of the historical films available; animals may be seen in their natural haunts; the stages of development of an animal or plant can be followed in quick and orderly sequence; the nature of disease and the value of preventive medicine can be illustrated; and many other points not easily explained can be presented in the most striking manner. At the forthcoming conference the application of the kinematograph to instruction in various branches of the curriculum, and to education generally, will be discussed. Among the speakers will be Dr. Lyttelton (headmaster of Eton), Mr. Stephen Paget, Miss Von Wyss (president of the Nature Study Union), Dr. Walmsley, Mr. F. W. Sanderson (headmaster of Oundle School), Mr. A. P. Graves (late H.M. Chief Inspector of Schools). Messrs. Pathé Freres will show many of their educational films during the conference in illustration of the various subjects brought forward. The

kinematograph may be made such an effective educational instrument that encouragement should be given to all who are endeavouring to discover its best uses and to produce pictures above the penny-dreadful type which is now too common.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 6.—Sir Alfred Kempe, vice-president and treasurer, in the chair.—Prof. J. C. **Bose**: An automatic method for the investigation of the velocity of transmission of excitation in Mimosa. The research was undertaken to decide the question whether in *Mimosa pudica* stimulus gives rise to a mere passage of hydro-mechanical disturbance or a transmission of true excitation. The results obtained warrant the conclusion that there is transmission of true excitation.—W. K. **Spencer**: The Evolution of the Cretaceous Asteroidea. An endeavour is made to trace the evolution of the starfish through the whole of the Cretaceous deposits. At the first sight the material appeared to be unpromising, for complete or even fragmentary specimens are rare. It has been found possible, however, to use the isolated marginal plates which are found fairly commonly on weathered chalk surfaces. It is shown that these marginal plates have a shape and ornament characteristic of each distinct species. The species may be arranged in lineages, and the examination of large collections made by English and Continental workers make it feasible to trace the life-history of most of the lineages.—Dr. E. A. Newell **Arber**: A preliminary note on the fossil plants of the Mount Potts Beds, New Zealand, collected by Mr. D. G. Lillie, biologist to Capt. Scott's Antarctic Expedition in the *Terra Nova*, in 1911. The communication briefly discusses the first results, which have reached this country, of the late Capt. Scott's second Antarctic Expedition. In the winter months of the last two years the *Terra Nova* has been at work in New Zealand waters. During these periods Mr. D. G. Lillie, one of the biologists of the expedition who has been attached throughout to the *Terra Nova*, has been endeavouring to clear up on the evidence of the fossil floras some of the many points which remain unsolved with regard to the stratigraphical geology of New Zealand. In particular, he has made large collections from the Mount Potts Beds, in Ashburton County, Canterbury. Whether these beds contain Glossopteris, as asserted by Hector and others, has long been a matter of dispute, for the whole question whether New Zealand formed part of the great southern Permo-Carboniferous continent of "Gondwanaland" depends entirely on the character and age of the flora of these beds. As it proves, the flora of these beds is thoroughly Mesozoic. The flora as a whole consists chiefly of Rhætic plants, though a few Jurassic types also occur, and thus the age of the beds is either Rhætic or Lower Jurassic. The Mount Potts beds are admittedly the oldest plant-bearing series, in a geological sense, as yet discovered in New Zealand. No Palæozoic plants are known from these islands, and there is thus no evidence that they formed part of "Gondwanaland" in Permo-Carboniferous times.—Sir D. **Bruce**, Majors D. **Harvey** and A. E. **Hamerton**, Dr. J. B. **Davey**, and Lady **Bruce**: (1) Trypanosomes found in the blood of wild animals living in the sleeping sickness area, Nyasaland. (2) Trypanosome diseases of domestic animals in Nyasaland. II., *Trypanosoma Caprae* (Kleine). (3) Morphology of various strains of the trypanosome causing disease in man in Nyasaland. I., The human strain.

Linnean Society, February 20.—Prof. E. B. Poulton, F.R.S. president, in the chair.—Roland H. **Deakin**: Anatomy of the larva of *Phryganea stricta*.—W. Botting **Hemsley**: The genera Radamæa, Benth., and Nesogenes, A. DC. *Radamaea montana* is a shrub from Madagascar, and some imperfect specimens of a similar plant were referred to his *R. prostrata*. On comparing these specimens with some collected on the *Sealark* expedition by Prof. J. Stanley Gardiner and Mr. J. C. F. Fryer, the author found it had to be transferred to its proper genus, Nesogenes. Four species of the latter genus are now known, including a new one from Aldabra, named *N. Dupontii*, Hemsl., after the discoverer.—Prof. R. J. Harvey **Gibson** and Margaret **Knight**: Marine Algæ collected by Mr. Cyril Crossland in the Red Sea. Part ii. was mainly a list of species, forty-six in number, thirty-five of which are additions to the former list. The authors have observed sexual and asexual organs, not merely on the same plant, but on the same branch, in several species, and consider the phenomenon to be by no means exceptional.

BOOKS RECEIVED.

Problems of Life and Reproduction. By Prof. M. Hartog. Pp. xx+362. (London: J. Murray.) 7*s*. 6*d*. net.

Geschichte der deutschen Naturphilosophie. By Dr. C. Siegel. Pp. xv+390. (Leipzig: Akademische Verlagsgesellschaft m.b.H.) 10 marks.

A Foundation Course in Chemistry for Students of Agriculture and Technology. By J. W. Dodgson and J. A. Murray. Pp. x+244. (London: Longmans and Co.) 3*s*. 6*d*. net.

An Introduction to Metaphysics. By Prof. H. Bergson. Authorised translation by T. E. Hulme. Pp. vi+79. (London: Macmillan and Co., Ltd.) 2*s*. net.

The Development of Mathematics in China and Japan. By Y. Mikami. Pp. x+347. (Leipzig: B. G. Teubner; London: Williams and Norgate.) 18 marks.

The Elements of Heating and Ventilation. By Prof. A. M. Greene, jun. Pp. vi+324. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd.) 10*s*. 6*d*. net.

Vertebrate Embryology. By Dr. J. W. Jenkinson. Pp. 267. (Oxford: Clarendon Press.) 12*s*. 6*d*. net.

Development and Purpose: an Essay towards a Philosophy of Evolution. By Prof. L. T. Hobhouse. Pp. xxix+383. (London: Macmillan and Co., Ltd.) 10*s*. net.

Aristarchus of Samos. The Ancient Copernicus. A History of Greek Astronomy to Aristarchus, together with Aristarchus's Treatise on the Sizes and Distances of the Sun and Moon. A New Greek Text, with Translation and Notes. By Sir T. Heath. Pp. viii+425. (Oxford: Clarendon Press.) 18*s*. net.

Materialien für eine wissenschaftliche Biographie von Gauss. By F. Klien and M. Brendel. Heft 2/3. Pp. 143. (Leipzig: B. G. Teubner.) 4.40 marks.

Report of the Thirteenth Meeting of the Australasian Association for the Advancement of Science, held at Sydney, 1911. Pp xciii+766+48 plates. (Sydney.)

Chloride of Lime in Sanitation. By A. H. Hooker. Pp. v+231. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd.)

The Trades School in the Transvaal. By W. J. Horne. Pp. viii+96. (Johannesburg: Argus Printing and Publishing Co., Ltd.)

Union of South Africa. Department of Agriculture. Report with Appendices for the period May

31, 1910, to December 31, 1911. Pp. iv+663+plates. (Cape Town: *Cape Times*, Ltd.)

L.M.B.C. Memoirs of Typical British Marine Plants and Animals. xxi., Eupaguans. By Dr. G. Jackson. Pp. viii+79+vi plates. (London: Williams and Norgate.) 2*s*. 6*d*.

Philips's Panama Canal Route Globe. (London: G. Philip and Son, Ltd.) 2*s*. 6*d*. net.

The Economics of Everyday Life: a First Book of Economic Study. Part i. By T. H. Penson. Pp. xiv+174. (Cambridge University Press.) 3*s*. net.

The Manufacture of Sulphuric Acid and Alkali with the Collateral Branches. By Prof. G. Lunge. Fourth edition. Vol. i., part i. Pp. xxiv+582. Part ii. Pp. xii+583–1078. Part iii. Pp. xii+1079–1617. (London: Gurney and Jackson.) 3*l*. 3*s*. net.

Verhandlungen des Naturhistorischen Vereins der preussischen Rheinlande und Westfalens. Neunundsechzigster Jahrgang, 1912. Erste Hälfte. Pp. lv+223+plates. (Bonn: F. Cohen.)

Technical School Organisation and Teaching. By C. Hamilton. Pp. xii+178. (London: G. Routledge and Sons, Ltd.) 2*s*. 6*d*. net.

Anleitung zur Kultur der Mikroorganismen. By Dr. E. Küster. Zweite Auflage. Pp. v+218. (Leipzig and Berlin: B. G. Teubner.) 8 marks.

The Organometallic Compounds of Zinc and Magnesium. By Dr. H. Wren. Pp. viii+100. (Chemical Monographs.) (London: Gurney and Jackson.) 1*s*. 6*d*. net.

La Télégraphie et la Téléphonie Simultanées et la Téléphonie Multiple. By K. Berger. Pp. 134. (Paris: Gauthier-Villars.) 4.50 francs.

Les Appareils D'Intégration. By H. de Morin. Pp. 208. (Paris: Gauthier-Villars.) 5 francs.

Aus Natur und Geisteswelt. Band 393, Die Dampfmaschine. By Prof. R. Vater. Dritte Auflage. Pp. vi+104. (Leipzig and Berlin: B. G. Teubner.) 1.25 marks.

First-Year Course in General Science. By E. A. Gardiner. Pp. vi+113. (London: W. Heinemann.) 2*s*. 6*d*. net.

DIARY OF SOCIETIES.

THURSDAY, MARCH 13.

ROYAL SOCIETY, at 4.30.—A Simple Method of Finding the Approximate Period of Stable Systems: A. Mallock.—The Motion of Electrons in Gases: Prof. J. S. Townsend and H. T. Tizard.—The Self Inductance of Circular Coils of Rectangular Section: Prof. T. R. Lyle.—Ammonium Ferrous Sulphate and its Alkali-Metal Isomorphs: Dr. A. E. H. Tutton.—The Recombination of the Ions produced by Röntgen Rays in Gases and Vapours: H. Thirkill.—Optical Investigation of Solidified Gases. III. The Crystal-properties of Chlorine and Bromide: Dr. W. Wahl.

ROYAL INSTITUTION, at 3.—Surface Energy: W. B. Hardy.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Power Supply on the Rand: A. E. Hadley.

CONCRETE INSTITUTE, at 7.30.—The Strength of Cement: H. C. Johnson.

INSTITUTION OF MINING AND METALLURGY, at 8.—Annual General Meeting.

MATHEMATICAL SOCIETY, at 8.—Some Cases of Tidal Motion of Rotating Sheets of Water: J. Proudman.—Indeterminate Equations of the Third and Fourth Degree: L. J. Mordell.

SOCIETY OF DYERS AND COLOURISTS, at 8.—Stripping Agents for Garment Dyers: F. G. Newbury.—A Few Notes on Fur Dyeing: M. C. Lamb.

FRIDAY, MARCH 14.

ROYAL INSTITUTION, at 9.—Great Advance in Crystallography: Dr. A. E. H. Tutton.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Some Effects of Superheating and Feed-water Heating on Locomotive Working: F. H. Trevithick and P. J. Cowan.

PHYSICAL SOCIETY (University College, Gower Street), at 5.—Demonstration of Spark Photographs: W. B. Haines.—(1) Some Oscillograms of Condenser Discharges and a Simple Theory of Coupled Circuits; (2) Exhibition of Braun Kathode-Ray Tubes and an Electrostatic Machine for Working them, used as á High-frequency Oscillograph: Prof. J. A. Fleming.—The Stretching and Breaking of Sodium and Potassium: B. B. Baker.—The Latent Heat of Evaporation of Aqueous Salt Solutions: R. G. Lunnor.—Some Flame Spectra: Dr. E. N. da C. Andrade.

ROYAL ASTRONOMICAL SOCIETY, at 5.—The Sounds Alleged to Accompany Flights of Meteors: A. King.—Note on the Possibility of Refraction by the Sun's Atmosphere. Papers of the I.U.S.R. No. VIII.: R. S. Capon.—Observations of Gale's Comet: Sydney Observatory.—A Family of Oscillating Orbits of Short Period; H. R. Willard.—Note on the Nebula HI Cassiopeiæ: Mrs. Isaac Roberts.—Notes on Fireballs and Shooting Stars: W. F. Denning.—The Variable Star R Cygni: E. E. Barnard.—A Formula for Correcting Statistics for the Effects of a Known Probable Error of Observation: A. S. Eddington.—*Probable Papers:* Observations made with the Durham Almucantar during 1912: E. H. Hills and F. C. H. Carpenter.—Enhanced Lines in the Early Spectrum of Nova Geminorum No. 2: H. F. Newall and F. J. M. Stratton.—The Distribution in Space of the Stars of Carrington's Circumpolar Catalogue: F. W. Dyson.—The Distribution in Space of the Bright Stars: A. S. Eddington.—Report on the Expedition to Passu Quatro, Brazil, to observe the Total Solar Eclipse of 1912 (October 10): A. S. Eddington and C. Davidson.

SATURDAY, MARCH 15.

ROYAL INSTITUTION, at 3.—The Properties and Constitution of the Atom: Sir J. J. Thomson, O.M.

MONDAY, MARCH 17.

VICTORIA INSTITUTE, at 4.30.—The Bearing of Archæological and Historical Research on the New Testament: Rev. Parke P. Flournoy.

TUESDAY, MARCH 18.

ROYAL STATISTICAL SOCIETY, at 5.—Some Statistical Problems suggested by the Sickness and Mortality Data of Certain of the Large Friendly Societies: Dr. E. C. Snow.

ZOOLOGICAL SOCIETY, at 8.30.—Remarks on the Relationship of the Big Game of Africa to the Spreading of Sleeping Sickness: Dr. W. Yorke.—Variations in the Skeleton of the Pectoral Fins of Polypterus: Edith E. Bamford.—A Descriptive Study of an Oligochæte Worm of the Family Enchytræidæ: H. H. Stirrup.—(1) A Collection of Fishes made by Prof. Francisco Fuentes at Easter Island; (2) A Revision of the Fishes of the Genus Kuhlia: C. Tate Regan.—The Polyzoa of Waterworks: Dr. S. F. Harmer.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further Discussion:* Notes on City Passenger-Transportation in the United States: G. D. Snyder.

WEDNESDAY, MARCH 19.

ENTOMOLOGICAL SOCIETY, at 8.—The Classification of the British Crabronidæ (Hymenoptera): Dr. R. C. L. Perkins.

GEOLOGICAL SOCIETY, at 8.—The Geology of Northern Peru: Tertiary and Quaternary Birds: Beeby Thompson.—The Internal Cranial Elements and Foramina of *Dapedius Granulatus:* G. Allan Frost.

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