THURSDAY, DECEMBER 28, 1916.

THE LIFE-WORK OF DR. E. K. MUSPRATT.

My Life and Work. By Dr. E. K. Muspratt. Pp. xi+320. (London: John Lane, 1917.) Price 7s. 6d. net.

THE author of this autobiography comes of a family which has exercised a marked influence on the industrial development of South Lancashire. Its members, moreover, have played no inconsiderable part in the social and intellectual life of Liverpool. To his father, James Muspratt, belongs the credit of founding the alkali manufacture in Lancashire. His life is one of the romances of chemical industry. Born in Dublin, of English parents, in 1793, he was apprenticed, when fourteen years of age, to a wholesale druggist in that city, but losing both his parents when he was scarcely eighteen, he broke his indentures and embarked for Spain in the hope of obtaining a cornetcy in a cavalry regiment in Wellington's army. A youth of fine physique and of a splendid constitution, Muspratt had all the physical qualifications for a successful soldier, but unfortunately he had no social influence, and in those days commissions in mounted regiments were reserved for those favoured in high quarters. Still, he had some experience of the Peninsular campaign, was stricken with fever in Madrid, and was in Hill's retreat down the valley of the Tagus. He then joined the Navy, and as a midshipman in the *Impetueux* took part in the blockade of Brest and in one or two frigate actions. He soon threw up this career, and making his way back to Dublin, started chemical manufacturing with the aid of a small inheritance which had been saved from the results of a Chancery action.

On the abolition of the salt duty in 1823, Muspratt saw his opportunity, and, moving to Liverpool, established, in the face of difficulties that would have crushed a weaker man, the manufacture of soda by the Leblanc process. He rapidly acquired wealth, and eventually built Seaforth Hall, a fine large house in the classical style, and a prominent landmark in what was then a remote suburban district among the sandhills at the mouth of the Mersey. He died at the age of ninety-three, after a vigorous, active life, full of excitement and incident. He had a large family, one of whom, Dr. Sheridan Muspratt, the well-known editor of the "Dictionary of Chemistry," a work which had a considerable vogue in its day, founded the Liverpool College of Chemistry.

The author of this memoir was the youngest son of the father of the alkali trade. He was born in 1833—the same year as his friend, the late Sir Henry Roscoe, with whom he went to school at Gateacre. When young Muspratt was about four years old the British Association happened to meet at Liverpool, an event which was destined to have a considerable influence on his after-life. Among the distinguished foreign visitors was Justus Liebig, the chemist, then a comparatively young man of thirty-five, but already almost at the summit of his fame. With him the elder Muspratt, now an acknowledged leader of English chemical technology, and a man of social influence in Liverpool, contracted a firm friendship which eventually included both their families.

After a good school training on Pestalozzi's system young Muspratt was sent in his seventeenth year to Giessen to study chemistry under Liebig and Will, and physics and mathematics under Buff and Zamminer. "When I first arrived at Giessen," writes our author, "Liebig, who was only about fifty or fifty-one years of age, appeared an old and broken-down man. When he entered the lecture-room he could hardly walk firmly, but glided in and appeared exhausted with the effort. In a few minutes all was changed, when he became inspired by the subject of his lecture."

Liebig, shortly afterwards, was invited to a far less strenuous position in the University of Munich, a circumstance which, no doubt, prolonged his life, and Dr. Muspratt elected to follow him, not so much with the view of studying chemistry as of studying medicine, to which at that time he had some inclination. He and the other members of his family who from time to time joined him at Munich were now on terms of close intimacy with the Liebigs, and were, in fact, part of their social and home life. This section of Dr. Muspratt's reminiscences constitutes, indeed, one of the most interesting features of his book, and in a few graphic touches, done with the artlessness which conceals art, we gain a vivid impression of German university life and of the condition of German society in the early fifties of last century. It is not without its lights and shades. Nothing could be more striking, for example, than the contrast between the drab and humdrum life at Giessen, its atmosphere of strenuous study, its simple, homely pleasures, and the social whirl and political excitements of the gay and light-hearted Bavarian capital. We trace the influences already at work of which we see the outcome in this later time. The "foreigners," as the North Germans, who had been invited to Munich by Maximilian, at the instigation of his Prussian tutor, von Dönniges, were called, were never really popular in the city of their adoption. Their influence from the outset was, and with good cause, dreaded by the Ultramontanes, and there can be little doubt that it was used to promote Bavaria's adhesion to the North German Confederation, and, ultimately, to bring about its absorption into the German Empire. The potential political value of professors, of which we hear so much to-day, is no new thing in Germany.

The space at our disposal, unfortunately, does not permit us to follow Dr. Muspratt at greater length through the many episodes of his long and varied career. But before we leave his account of his Munich life it may be of interest to note it was the circumstance that his sister, Miss Emma Muspratt, afterwards Mrs. Harley, was attacked with typhoid fever when on a visit to the Liebigs that indirectly led to the invention of the world-famous "extract of meat."

The growing anxieties of a large and complex business at length compelled Dr. Muspratt to leave Germany in order to assist his father, and henceforth most of his life and energies were spent in his native city and its neighbourhood, varied only by not infrequent interludes of foreign travel, accounts of which form a considerable portion of his narrative.

But in spite of the constant demands upon his time and activities, owing to the changing and progressive character of manufacturing chemistry during the last few decades, Dr. Muspratt has found abundant opportunity to associate himself with the social, political, municipal, and intellectual development of Liverpool, and there have been few public movements of any importance in that city with which he has not been connected in greater or less measure. All this he sets out, with a pardonable pride, in this autobiographical record. His has been a singularly full, active, and useful life, of many and varied interests, fruitful in achievement and in unselfish personal service. The book is written in a simple, unaffected manner, with no pretensions to literary style. It has suffered in a very slight degree from the fact that the author's failing eyesight compelled him to seek the aid of an amanuensis. This doubtless accounts for the occasional misspelling of proper names and certain lapses in expression which ought not to have escaped the attention of the proof-reader.

T. E. THORPE.

STUDIES OF THE RESPIRATORY EXCHANGE.

The Respiratory Exchange of Animals and Man. By Dr. A. Krogh. Pp. viii + 173. (London: Longmans, Green and Co., 1916.) Price 6*s.* net.

THE fact that Dr. August Krogh is perhaps better known in this country than any other foreign contemporary physiologist is chiefly owing to the attention which was attracted by his researches on the mechanism of the respiratory exchange. A treatment of the subject from this point of view might have been expected of one whose own work has been of such fundamental importance in this direction; such expectation is, however, not realised in the volume before us, for it contains no reference to this department of the author's labours.

The study of the respiratory exchange has now grown to be a large subject divisible into subsidiary branches, and the monograph deals only with a limited aspect of one of these, namely, the quantitative aspect of the material and energy exchanges of the body as judged by the criterion of the total respiratory exchanges. The influences of functional activity are not considered.

The work opens with a short, clear account of the significance of the respiratory exchanges, and of the principles involved in direct and indirect calorimetry. The methods used in the investigation of the respiratory exchanges are described, and then follows the chief subject-matter of the volume. Great stress is laid throughout on the importance of referring all determinations of total respiratory exchange to a "standard metabolism," *i.e.* the metabolism of the organism when in a state of minimal functional activity, and the author ruthlessly sets aside the results of many admittedly interesting series of observations where this essential has not been observed.

The influences of various intrinsic factors and of chemical and physical factors are discussed, and then follows one of the most interesting chapters in the book, that on the variations in standard metabolism during the life-cycle. The sections of this chapter which deal with hibernation and that treating of the pupal life of insects are of first importance.

Some of the author's own work in this direction is highly interesting; for instance, he shows that by raising the temperature the duration of pupal life may be shortened even by two-thirds, yet in all cases the carbon dioxide produced during pupal life by unit weight of chrysalides is the same. The most diverse forms of animal life, from sea-urchin eggs to brooding pythons, are introduced to illustrate specific points, or to indicate useful lines for future work, the outlook being essentially biological.

The final chapter, which deals with the respiratory exchange in different animals of the same and of different species, shows careful treatment of results which are still very far from complete; the portion dealing with the relation of metabolism to surface and weight is logically dealt with. The bibliography is carefully chosen so as to present the pith of the very voluminous literature on the subject.

GNOMONICS AND CELESTIAL MOVEMENTS.

(1) *Gnomonica: L'Orologio Solare a Tempo Vero nella sua Moderna Applicazione.* By G. Bottino Barzizza. Pp. viii + 199. (Milano: Ulrico Hoepli, 1915.) Price 2.50 lire.

(2) *Lezioni di Cosmografia.* By Prof. Giovanni Boccardi. Pp. x + 233. (Milano: Ulrico Hoepli, 1916.) Price 3 lire.

(1) THIS is a short text-book on gnomonics, and is not intended for people who merely want to put up a nice sun-dial as an ornament in their garden or grounds. There is not a single picture of an article of that kind: only geometrical diagrams. The aim of the author is a much higher one, and has been well accomplished by showing how in careful hands a sun-dial may be used to control a clock sufficiently well for ordinary purposes. After explaining the diurnal and annual motion of the sun, the necessary formulæ are developed for tracing the hour-lines on horizontal and vertical dials and for correcting their indications for errors of adjustment. Convenient auxiliary tables are also given of the various

trigonometrical functions, the equation of time, and the declination of the sun.

(2) The author of this little book on the rudiments of astronomy has endeavoured to avoid dealing with matter already treated in other books of the Hoepli series (entitled "Astronomy," "Gravitation," etc.) by explaining mainly the apparent phenomena on the celestial sphere. The word cosmography is thus used in a sense which is scarcely the usual one, as descriptive astronomy, astrophysics, and the orbits of the planets are omitted altogether; but phenomena like the libration of the moon and the tides are briefly described. Beginning with the figure of the earth and its daily rotation, the author passes on to the apparent annual motion of the sun, defines parallax, both daily and annual, and gives a table of twenty-seven stars the annual parallaxes of which are supposed to be best known, ranging from α Centauri with 0·76″ down to Polaris with 0·07″. The motion of the earth comes next, after which precession and nutation are briefly alluded to, and aberration more fully. The distances and periods of the satellites of the planets (including the recently discovered ones) are given in tabular form, but the motion of the moon and the effects of its principal perturbations are described in greater detail. The treatment of every subject throughout the book is concise; the explanations are given in simple and unadorned language, and ought to give beginners a clear idea of the principal phenomena of the heavens within the limits the author has set for himself.

OUR BOOKSHELF.

British and Foreign Marbles and other Ornamental Stones: a Descriptive Catalogue of the Specimens in the Sedgwick Museum, Cambridge. By J. Watson. Pp. x+485. (Cambridge: At the University Press, 1916.) Price 5*s.* net.

THE Sedgwick Museum, Cambridge, is indebted to the industry of Mr. Watson for its useful exhibit of polished marbles. This volume, which is supplementary to the one by the same author on "Building Stones," is essentially a descriptive guide to the marbles and other ornamental stones in the collection, about eight hundred in number. The specimens have been assembled from many parts of the world, and a number of well-known varieties are represented, as well as some that will be less familiar.

The geological arrangement adopted in the companion book has been wisely discarded in favour of a geographical one, but a short account of the distribution and geology of the marbles prefaces the detailed catalogue of each country's products.

As a handbook to the collection this volume is admirable; the descriptions are clear and, on the whole, adequate, and the remarks on the examples to be found in buildings have been prepared with care, but the major title is rather misleading, for as a work of reference its utility is lessened by the circumstance that it deals only with specimens which happen to have been acquired by the museum. Thus steatite is represented only from Central Africa and India, and while there is a considerable amount of space devoted to fluorspar and jade, there is no reference to chalcedony. Again, dolerites and felsites are represented by only a single sample of each, from India, and only two porphyries are mentioned. In view of the fact that so many of the igneous rocks are used primarily as ornamental stones, the inclusion of these few examples serves merely to emphasise the omission of the others.

Here and there statements of doubtful accuracy appear, as in the suggested coral origin of Rosewood marble; and some of the information is a trifle stale—for example, the remarks on the popularity of Derbyshire black marble.

The index is good and greatly enhances the value of the book for general use, but for practical purposes a list of the marbles grouped according to their prevailing colour should be added in another edition.

The Rain-children. A Fairy-tale in Physics. By T. H. Orpen. With seven illustrations by C. E. Brock. Pp. vi+112. (London: Society for Promoting Christian Knowledge, n.d.) Price 2*s.* 6*d.*

IN designing the plan of this book the author seems to have thought of the nursery expedient of administering a medicinal powder in a spoonful of jam. His object appears to be to explain to children the formation and uses of the forms of water, but, having doubts of the intrinsic interest of the subject for his readers, he creates characters like Aunt Cold, Aunt Heat, Colonel Lightning, Sergeant Thunder, and Rain-children to describe to a little heroine he has created how natural phenomena can be explained. The result is a tale which little girls may like, but we believe boys usually prefer to keep their lessons and stories for separate occasions.

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.]*

University Doctorates.

I SEE from an announcement in the *Times* of December 22 that facilities are to be offered to advanced students of other universities by the University of Oxford in order to allow them to take the degree of Doctor of Science or of Doctor of Letters under new conditions.

It is to be hoped that, before any such scheme is discussed, a serious attempt may be made to introduce something like a uniform standard of attainment among our own universities for the doctorate, which is at present awarded for very different degrees of attainment and under very different conditions. When that uniformity has been adopted, any scheme offering facilities for the doctorate to graduates of the United

States and other universities should be framed by joint representatives of all our universities.

It would be a misfortune if anything in the nature of competitive schemes for attracting students were to be evolved independently by different university authorities. J. B. COHEN.

Leeds, December 23.

The Deterioration of the Atmosphere in the Swiss Alps.

DR. MAURER, Director of the Swiss Federal Meteorological Service, sends a further communication about the deterioration of the atmosphere of the Swiss Alps, referring to Prof. Riccò's letter in NATURE of November 9 on the occurrence of an eruption at Stromboli. I am forwarding a translation for your information.

NAPIER SHAW.

Meteorological Office, South Kensington, London, S.W., December 11.

This remarkable optical deterioration of the atmosphere was visible here (Zurich) until about the middle of November. The thin, cirrus-like layer could be seen on clear mornings just before sunrise at a height of about 14–15 km. above the earth's surface, according to our reckoning—that is to say, it was situated considerably above the usual cirrus region. It consisted of thin horizontal bands, extremely delicate and soft, which soon disappeared after sunrise. A curious fact was that no appreciable effect, either actinometric or photometric, was produced by this thin, mist-like layer. The impression made was that of a most delicate, comet-like veil of mist, yet not dimming the starlight. After sunrise absolutely nothing was to be seen of the phenomenon, in spite of the keenest observation through field-glasses of a weak magnifying power. Synchronising with this remarkable phenomenon, the sun had a large aureole with a diameter of 100°. Here and there the extreme outer edge of this ring was of a pale brown colour. So far we have not been able to offer any explanation as to the cause.

During the period of maximum visibility of the thin veil (twilight cirrus), such a conspicuous layer was to be seen in the eastern sky, shortly before sunrise and at a height of 40°, that even an unskilled observer would have noticed it at once. The structure of the layer was often so regular and definite in its remarkable horizontal stratification that it looked as though an artist with a coarse brush had coloured the whole eastern sky with long horizontal strokes not too neatly laid on.

Each time this peculiar veil of "twilight cirrus" reached a maximum of intensity we had a colourless morning twilight with interrupted "purple light." What can be the cause of all these remarkable phenomena?

Winter Thunderstorms.

A YEAR ago (December 16, 1915) I asked readers of NATURE if they would let me know when they observed thunder or lightning during the first three months of the year. I made a similar request to the observers of the British Rainfall Organisation. The number of replies I received amounted to nearly one thousand, and the rather remarkable fact came to light that during the period in question thunder or lightning occurred somewhere in the British Isles on sixty-four out of the ninety-one days. So numerous were the replies received that I was unable to answer each one personally, but I wish to thank those correspondents who kindly sent information, and to assure them that every report was of value.

The information obtained last winter was so remarkable, and the number of days on which thunder or lightning occurred so unexpected, that I am anxious to collect information again. Readers of NATURE could assist if they would send me a note by postcard or letter if they observe thunder or lightning between January 1 and March 31, 1917. The following points are of interest:—(1) Time when storm was nearest or overhead; (2) direction of storm when first observed, and time; (3) direction when last observed, and time; (4) note if there was a change of wind during the storm and if there was a drop in temperature; (5) any other information as to heavy rain, hail, snow, or any remarkable feature; (6) if an observer has accurate time, a list of the times of occurrence of flashes would be useful.

Many observers may not have the time or opportunity to record all these points, but I should be grateful for information on even one of them; No. 1 is the most important. The information is of real value, and every record, however short, is of use.

C. J. P. CAVE.

Meteorological Office, South Farnborough, December 20.

GRAVITATION AND THE PRINCIPLE OF RELATIVITY.

ACCORDING to the principle of relativity in its most extended sense, the space and time of physics are merely a mental scaffolding in which for our own convenience we locate the observable phenomena of Nature. Phenomena are conditioned by other phenomena according to certain laws, but not by the space-time scaffolding, which does not exist outside our brains. As usually expressed, the laws of motion and of electrodynamics presuppose some particular measurement of space and time; but, if the principle is true, the real laws connecting phenomena must be independent of our framework of reference—the same for all systems of co-ordinates. Of course, it may be that phenomena are conditioned by something outside observation—a substantial æther which plays the part of an absolute frame of reference. But the following considerations may show that the ideal of relativity is not unreasonable. Every observation consists of a determination of coincidence in space or time. This is suffcently obvious in laboratory experiments; and even the crudest visual observation resolves itself into the coincidence of a light-wave with an element of the human retina. If, then, we trace the path of adventure of a material particle, it intersects in succession the paths of other particles or light-waves, and these intersections or coincidences constitute the observable phenomena. We can represent the course of Nature by drawing the paths of the different particles—on a sheet of paper in a two-dimensional case. The essential part of the diagram is the order of the intersections; the paths between the intersections are outside observation altogether, and are merely interpolated. The sequence of phenomena will not be altered if the paper is made elastic and deformed in any way, because the serial order of the intersections is preserved. This deformation of the paper corresponds to a mathematical transformation of the space in which for convenience we have located the phenomena.

Until recently the application of the principle of relativity was limited to one particular transformation, namely, a uniform translation of the axes. In this case there is a wide range of experimental evidence in support of the principle. In 1915 Prof. A. Einstein[1] finally succeeded in developing the complete theory by which the postulate of relativity can be satisfied for all transformations of the co-ordinates. Gravitation plays a part of great importance in the new theory, and therein lies much of the practical interest of Einstein's work.

No attempt is made to explain the cause of gravitation—as a kink in space or anything of that nature. But the extended law of gravitation is determined, to which Newton's law is an approximation under ordinary conditions. It has long been suspected that there must be some modification of the law when the bodies concerned are in rapid relative motion; moreover, the "mass" of a moving body no longer has a unique meaning, so that a further definition, if not extension, of Newton's law is clearly needed. Now, although we do not seek a *cause* of gravitation in the properties of space, it may well happen that the *law* of gravitation is determined by these properties. The inverse-square law represents the natural weakening of an effect through spreading out in three dimensions; we may say that it is determined by the properties of Euclidean space. There is, therefore, nothing unreasonable in proceeding, as Einstein does, to examine whether a more extended law is suggested by the properties of generalised space—that is, by geometry.

The way in which gravitation enters into the discussion may be seen from the following example. Suppose an observer is in a closed lift; let the supports break and the lift fall freely. To the observer everything in the lift will now appear to be without weight; gravity has been suddenly annihilated. The acceleration of his frame of reference (the lift) is equivalent to an alteration of the gravitational field. Now an acceleration of the axes is one of the transformations contemplated by the general principle of relativity, and it is therefore necessary to allow that the gravitational field depends on the choice of co-ordinates. There is a "local" gravity, just as there is a "local" time or magnetic field depending on the co-ordinates selected.

We can now take a brief survey of Einstein's procedure. Suppose that space and time are measured by a system of co-ordinates x_1, x_2, x_3, x_4; x_4 is the time, but there is no need to discriminate between it and the others. If there is a gravitational field at any point, it can be abolished (as in the example of the lift) by choosing new co-ordinates x_1', x_2', x_3', x_4' accelerated with respect to the old. The necessary transformation could be specified in various ways; the way chosen involves the element of length ds, measured by coincidences with a standard scale, and therefore independent of the choice of co-ordinates. Since in the x' co-ordinates there is no gravitation to complicate matters, we can safely use the usual formula,

$$ds^2 = dx_1'^2 + dx_2'^2 + \ldots$$

and this when transformed to the old co-ordinates takes the most general form,

$$ds^2 = g_{11}dx_1^2 + g_{22}dx_2^2 + \ldots + 2g_{12}dx_1dx_2 + 2g_{13}dx_1dx_3 + \ldots$$

The ten g's depend on the transformation, and can be used to specify it. But they do more than that; they define the original gravitational field, since they specify how it can be got rid of. They usually vary from point to point, because a different transformation is needed to eliminate gravity at different points. In the new theory the g's are regarded as ten gravitational potentials specifying the field; and, in fact, one of them, g_{44}, is approximately the same as the Newtonian potential ϕ, except for a factor.

The inverse-square law can be expressed by the well-known differential equation $\nabla^2\phi = 0$. Evidently the new law of gravitation must be a generalisation of this—an equation, or set of equations, involving the ten potentials instead of one. Also, to conform to relativity, the new equations must be unaltered by a change of co-ordinates. If new co-ordinates are used the g's will be different, but the relations between the new g's and new co-ordinates must be the same as those between the old g's and old co-ordinates. The possible sets of relations which satisfy this are very limited in number. This subject, known as the theory of tensors, has been worked out very fully by Riemann, Christoffel, and others, and the possible sets of equations can be classified and enumerated. From this limited choice we have further to pick out a set of equations which will reduce to $\nabla^2 g_{44} = 0$ as a first approximation, and that is found to leave only one possibility. There is just one set of ten differential equations (of which, however, only six are independent) which satisfy both conditions. Einstein takes these as expressing his generalised law of gravitation. It is important to notice exactly how much of this is geometry. Geometry shows that *if* the equations hold for a particular set of co-ordinates, they hold for every set. We abolish the "if," and so assert a new law of Nature.

It is further necessary to consider what must be the generalised equivalent of Poisson's equation $\nabla^2\phi = -4\pi\rho$, which supplants Laplace's equation when matter is present. The extension is not difficult, since it is found that the ten equations above mentioned are the expression of a generalised principle of least action as applied to gravitational energy. Now mass is considered to be simply electromagnetic energy, and since there is no reason to believe that electromagnetic energy will behave differently from gravitational energy in regard to least action, we have only to include both forms of energy together in the equations, treating them as equivalent. It is not possible to write down here these final equations, since a very elaborate notation is needed for their expression.

[1] Einstein, "Die Grundlage der allgemeinen Relativitätstheorie." (Leipzig: J. A. Barth, 1916.) A detailed account appears in *Monthly Notices*, 1916, No. 9, by Prof. W. de Sitter, giving the astronomical applications. See also an article by de Sitter in the *Observatory*, October, 1916.

Though highly complicated in form, they can be applied without excessive labour to the more simple problems.

One or two of the more elementary consequences of this theory were given by Einstein some years ago. A ray of light must be bent in passing through an intense field of gravitation; thus a star seen close to the limb of the sun during an eclipse should appear displaced 1·7″ from its usual position. The vibrations of an atom must be slower in an intense field, so that the lines of the solar spectrum should be displaced slightly to the red as compared with terrestrial spectra. It has not yet been possible to put these predictions to a satisfactory test, and it has been left to the completed theory to furnish the first opportunity of an appeal to observation. In this the new theory has scored a most signal success, for it has cleared up the most celebrated case of discordance in gravitational astronomy.

From his generalised law of gravitation Einstein has deduced that the elliptic orbit of a planet will rotate in the direction of motion at the rate of

$$\frac{24\pi^3}{V^2}\frac{a^2}{T^2(1-e^2)} \text{ radians per revolution of the planet.}$$

Here V is the velocity of light, and a, T, e are the semiaxis, period, and eccentricity of the orbit. If v is the velocity of the planet, the amount is practically $6\pi v^2/V^2$ radians per revolution. For Mercury this works out at 43″ per century—just the amount of the outstanding discordance between observation and theory. The theory also gives rotations for Venus and the earth, but their orbits are so nearly circular that the effect is imperceptible to observation. For Mars, with its strongly elliptic orbit, the correction is more important, and sensibly improves the accordance between theory and observation.[2]

It is rather difficult to grasp the fact that the same laws of Nature may hold when some bizarre system of co-ordinates is chosen. Suppose an observer A uses rectangular co-ordinates, and B, through some kink in his mind, uses polar co-ordinates without realising that he is doing anything unusual. For A a ray of light can travel along the straight line x=constant; but evidently it cannot travel along the circle r=constant, which is B's idea of a straight line. The answer is that B through his peculiar system of measurement will suppose that he is in an intense gravitational field; he will calculate the curvature in the ray of light produced by this field; and, making allowance for it, he will find that the light actually travels along its theoretical curve (*i.e.* curve for B, but straight line for A). Thus the same general laws of Nature are satisfied for B as well as for A; and it might be difficult to decide which of them had got hold of the absolute rectangular co-ordinates.

A. S. EDDINGTON.

[2] The discordance of the perihelion of Mercury (now removed) was nearly 30 times its probable error. Of the sixteen secular variations of the four inner planets, all are now accordant, except the node of Venus, which deviates by 4½ times its probable error. Among sixteen residuals we should expect to find one of three times the probable error, so that the evidence for the remaining discordance is not very strong. There are besides unexplained variations of the longitudes of the moon and planets, but these are in a different category.

PLANTS IN HEALTH AND DISEASE.[1]

PROF. WEISS and his colleagues have done well in publishing in book-form abstracts of their lectures on Plants in Health and Disease. The lectures were delivered at the University of Manchester during 1915-16, and had for their object the giving of botanical guidance to the many small gardeners and allotment-holders who were, and are, endeavouring by the cultivation of their several plots to add to the food supplies of the country.

Although only its friends recognise the fact, science in this country suffers from the virtue of modesty. Accompanying that quality—as is so often the case—is often a certain hauteur. Hence it is that those who—only too rarely, it must be confessed—come seeking guidance from science are often sent empty away. It would be well for science, and also for the country, if this attitude of aloof detachment were to cease to be habitual. It is true that biological science has at present not overmuch to offer to horticulturists; but that is an added reason why closer relations should be established between those who cultivate the land and those who study the science of biology. It is by such means as those adopted by Prof. Weiss and his colleagues that this contact may be best established.

It is no adverse criticism on this little book to say that if and when science and practice go hand in hand a thoroughly good botany for gardeners will make its appearance, and not before. One of the results of such a book will be to teach the gardener to do scientifically and better what he now does empirically and well. The day of publication of that perfect book is far off, and botany will have not only to grow but to be pruned very heavily before it is written. The science will have to cast off the pseudo-encyclopædic habit, woven in Germany, which it wears. For example, when talking to gardeners of the importance of restricting water supply in order to provoke flower and fruit formation (p. 2), why not give an account of the current method of tomato-growing instead of citing examples from "tropical climes"? In the cultivation of the tomato the check imposed after the first truss of fruit is set, the pinching-out of side-shoots, the stopping of the leader, and the reduction of leaf surface, all have for their purpose the regulation of the water supply and the reduction of vigour of vegetative growth. Apart, however, from the fact that those who are habitually engaged in gardening might not infrequently suggest more cogent illustrations of botanical principles, the general account given in these lectures of the life of a plant is admirable. Occasionally we discover a lapse, as, for example (p. 7), the omission to mention the chief virtue of the hoe, namely, that by its use water is conserved in the soil.

The less difficult parts of the book, those which

[1] "Plants in Health and Disease: being an Abstract of a Course of Lectures delivered in the University of Manchester (1915-16)." By Prof. F. E. Weiss, Dr. A. D. Imms, and Wilfrid Robinson. Pp. 143. (Manchester: At the University Press; London: Longmans, Green and Co. 1916.) Price 1s. 6d. net.

deal with disease, are no less excellent than the account of the normal life of the plant. In the chapters devoted to fungi such diseases as finger-and-toe, black scab, late blight, rust, and mildews are described. It is curious that no reference appears to be made to the fact that many varieties of potato are now known to resist attack by black

then in Gower Street. His duties in this connection were too onerous to allow him much time for the practical pursuit of astronomy, in which science he always took a deep interest; but so early as 1860 he described, in "Recreative Science," vol. ii., p. 212, his detection of markings on the surface of Mars with an object-glass only $1\frac{1}{2}$ in. in diameter. In 1899 he presented to the Royal Astronomical Society a discussion of the colours of 4984 stars as described by various observers, with the special purpose of reducing such descriptions to a uniform scale; and in 1891 he described, before the British Astronomical Association, an instrument which he had devised—the star chromascope—for obtaining definite measures of star colours. But it is to his work in connection with the literature of astronomy that his colleagues in the science owe most to Mr. Levander. He was an original member of the British Astronomical Association, and in 1895, when the association had accumulated the nucleus of a library, he became librarian, and administered this

fall as good, but for more perfect measures we must look to future research, for at present they are unknown. To the reviewer at all events the absence of illustrations is no drawback; it may be, however, that the layman may find it difficult to see mentally the pests and processes without their aid. We trust not; for we hold the belief that pictures are overdone in popular books on science and in science teaching generally. F. K.

PROF. DANIEL OLIVER, F.R.S.

WITH deep regret we record the death at Kew on December 21, in his eighty-seventh year, of Emeritus Prof. Daniel Oliver. The eldest son of another Daniel Oliver, the deceased was born at Newcastle-upon-Tyne on February 6, 1830, and was educated partly in private schools, partly at the Friends' School, Brookfield, near Wigton. Attached from an early age to botanical study and a youthful member of a local scientific society, we find him in 1847 contributing to the *Phytologist* a list of rare plants from different geological formations, and in 1850 adding a new genus to the flora of the United Kingdom. In 1851 he became a fellow of the Edinburgh Botanical Society, and in 1853 of the Linnean Society. His reputation as a keen and critical worker, gained in the North of England, was already such as to prompt Sir William Hooker to invite him to assist his son in the heavy task of arranging and distributing the botanical collections accumulated by the East India Company and to induce him in 1858 to become an assistant in the herbarium at Kew. On settling there Oliver instituted in 1859 a course of lectures on botany, which he continued to conduct until 1874, for the benefit of the young gardeners. He proved so excellent a teacher that in 1861 he was appointed to the botanical chair which had been occupied by Lindley at University College, London. The extent and accuracy of his botanical knowledge led to his election to the Royal Society in 1863 and to his appointment, on the retirement of Mr. A. Black in 1864, to the keepership of the herbarium and library at Kew. The chair at University College, now held by his distinguished son, Oliver retained until 1888; the keepership at Kew he occupied until he retired from the public service in 1890. After his retirement he succeeded Sir Joseph Hooker as editor, on behalf of the Bentham Trustees, of the "Icones Plantarum." This duty he fulfilled for five years, so that his connection with the institution where he worked so long, and for which he did so much, was not finally severed until 1895.

The salient features of Oliver's contributions to botany, too numerous to be recounted here, are the accuracy of his observations, the soundness of his conclusions, and the combined fidelity and artistic skill of his illustrations. But his published works represent only a fraction of his botanical knowledge, so exact as to have earned the justifiable confidence of Sir Joseph Hooker and Mr. Bentham while engaged in preparing their great "Genera Plantarum," so wide that Darwin, when seeking the benefit of his great knowledge of flowering plants, spoke of him to Hooker, only half in play, as the "omniscient" Oliver. This wide knowledge, the outcome of the long and patient devotion to duty of a keen and active intellect, was readily placed at the disposal of all serious students who chose to consult him. If he never sought, neither did he avoid, the outside duties that devolve on men of his capacity; he served twice on the council of the Royal, twice on that of the Linnean Society. He did strive to avoid, but could not wholly escape, honours and distinctions. In 1882 the Edinburgh Botanical Society elected him, after thirty years of ordinary membership, one of their six British honorary fellows. In 1884 the Royal Society recommended him as the recipient of a Royal medal. In 1891 the University of Aberdeen conferred on him the degree of LL.D. In 1893 the Linnean Society awarded him its gold medal, and a number of friends arranged for the painting of his portrait by Mr. J. Wilson Foster for presentation to the herbarium at Kew. On his attaining his eightieth birthday in 1910 old colleagues united with the existing herbarium staff in offering him an address of congratulation.

After his definite retirement from botanical pursuits in 1895, Oliver devoted himself to his garden and to the further cultivation of that artistic gift to the possession of which his botanical illustrations testify, with such results as to warrant the belief that, had he chosen to make Art his mistress, he might well have merited in her service the eminence which his devotion to Botany deserved.

Oliver married in 1861 Miss Harriet Wall, of Sheffield, by whom, by his son, and by two daughters he is survived. Those whose privilege it is to have known Oliver mourn with them the loss of a true and highly gifted friend.

PROF. CLEVELAND ABBE.

THE death of Cleveland Abbe near Washington, D.C., on October 28, in the seventy-eighth year of his age, makes a gap of a special character in the ranks of meteorologists, and particularly among those who use the English language. From 1871 until August last, when he retired, Abbe was professor of meteorology in the United States Weather Bureau. That is the title which the bureau gives to the professional meteorologists on its staff. Born and educated in New York, he had been a teacher of mathematics in New York and of engineering at the State University, Ann Arbor, Michigan. From there he went to Harvard University, 1860–64, being at the same time aid in the U.S. Coast Survey under B. A. Gould; thence to the Central Observatory of the Russian Meteorological Service at Petrograd for two years; aid in the U.S. Naval Observatory, 1867–68, and director of the Cincinnati Observatory, 1868–73.

The work at the Weather Bureau for which he is best known is the editing of the *Monthly Weather Review*, which was in his charge from 1893 until his retirement, with a break of a few years from 1909, during which the Bulletin of Mount Weather Observatory took its place. Besides original papers, it includes the best monthly epitome of progress in meteorology in English, and ranks for that purpose with the *Meteorologische Zeitschrift*. This work gave Abbe an unrivalled knowledge of meteorological literature. He was a sort of college-tutor for the Weather Bureau, and with his encyclopædic knowledge he was to a large extent the force behind the organisation. He was a very keen advocate of the study of dynamical meteorology. Every student of the subject knows his collections of translations into English of classical papers in French and German which are published by the Smithsonian Institution. He founded a meteorological library at Johns Hopkins University and was professor of meteorology in the George Washington University of Washington. He was specially the promoter of meteorology. We owe to his instigation the installation by the Meteorological Office of the station now in operation at St. Helena. He wrote a large volume on the Maryland Weather Service, with a discourse upon aims and methods. That represents his interest. In an article in the "Encyclopædia Britannica" it is the observation of clouds at sea that claims attention. He took part in a number of scientific expeditions for eclipses and other purposes, and he started the reform in civil time, reckoning by even hours from the Greenwich meridian, a reform which in Europe has over-shot itself into "summer-time."

Abbe's services to meteorology were recognised by the Royal Meteorological Society by the award of the Symons Medal in 1912. He was a man of most genial disposition. His wife, the daughter of W. G. H. Percival, of St. Kitts, whom he married in 1909, survives him. One of the sons of his first marriage, Cleveland Abbe, junior, succeeds him as editor at the Weather Bureau.

NAPIER SHAW.

NOTES.

object the giving of botanical guidance to the many small gardeners and allotment-holders who were, and are, endeavouring by the cultivation of their several plots to add to the food supplies of the country.

Although only its friends recognise the fact, science in this country suffers from the virtue of modesty. Accompanying that quality—as is so often the case—is often a certain hauteur. Hence it is that those who—only too rarely, it must be confessed—come seeking guidance from science are often sent empty away. It would be well for science, and also for the country, if this attitude of aloof detachment were to cease to be habitual. It is true that biological science has at present not overmuch to offer to horticulturists; but that is an added reason why closer relations should be

AN interesting discussion took place in the House of Lords on Wednesday, December 20, on a motion by Lord Sudeley requesting H.M. Government to take the steps necessary to provide funds to enable the Imperial Institute to carry out its functions adequately and completely. Lord Sudeley pointed out that, although the institute's work is of great importance in connection with the war and with the development of the resources of the Empire, and though these services have been publicly acknowledged in various ways, yet the institute is greatly hampered in its work by want of funds. The motion was supported by Lord Rathcreedon, who gave some examples of the institute's work, and emphasised the need for more funds and more space in order that full advantage may be taken of the organisations which the institute has developed for the investigation of the resources of the Empire and the dissemination of information regarding them. Viscount Haldane, whilst in sympathy with the motion, pointed out that so far as research is concerned care must be taken to secure co-operation with the work of the Advisory Council for Scientific and Industrial Research, as otherwise confusion might arise. In his reply Lord Islington gave an account of the developments which have taken place at the Imperial Institute since the passing of the new Management Act eight months ago. Committees are being appointed by the various Dominions and Colonies to consider their needs and interests, and the special committee for India has been requested by the Government of India to undertake an important inquiry into the possibility of increasing the usage of Indian raw materials within the Empire. A number of technical committees has also been formed to advise with regard to investigations and other work on minerals, timbers, silk, rubber, etc. The Executive Council also hopes to work in close co-operation with the newly established Department of Scientific and Industrial Research, especially in those cases where more purely scientific investigation is needed. The question of funds is being carefully considered, and the Executive Council of the institute intends to approach the Government in due course with a statement of needs, in order that the work may be maintained and, as opportunity offers, developed. It is hoped that further support will be forthcoming from the Dominions, Colonies, and India, which already provide the larger part of the funds available to the institute.

BY the death of Mr. F. W. Levander the British Astronomical Association loses one of its most retiring and yet most useful members. Mr. Levander was for many years on the staff of University College School, then in Gower Street. His duties in this connection were too onerous to allow him much time for the practical pursuit of astronomy, in which science he always took a deep interest; but so early as 1860 he described, in "Recreative Science," vol. ii., p. 212, his detection of markings on the surface of Mars with an object-glass only 1½ in. in diameter. In 1899 he presented to the Royal Astronomical Society a discussion of the colours of 4984 stars as described by various observers, with the special purpose of reducing such descriptions to a uniform scale; and in 1891 he described, before the British Astronomical Association, an instrument which he had devised—the star chromascope—for obtaining definite measures of star colours. But it is to his work in connection with the literature of astronomy that his colleagues in the science owe most to Mr. Levander. He was an original member of the British Astronomical Association, and in 1895, when the association had accumulated the nucleus of a library, he became librarian, and administered this department for twelve years. In 1900 he was elected editor of the Journals and Memoirs of the association, a post that he fulfilled most efficiently until his death. While editor he drew up a complete index to the first eighteen volumes of the journal of the association, having some years earlier prepared a similar index to the volumes of the *Astronomical Register*. In 1906 he was elected president of the association, and held the chair for the customary period of two years. Mr. Levander died on December 20, after a very short illness, aged seventy-seven. He was interred at the Hampstead Cemetery, Fortune Green, on December 23.

THE attention given in the Press to the sudden death, on December 15, of Prof. Hugo Münsterberg is due much less to his scientific eminence than to his notorious activities as a pro-German propagandist in the United States. Born at Dantzig in 1863, he took his doctorate in philosophy at Leipzig and in medicine at Heidelberg, and began his teaching career as a *Privatdozent* at Freiburg-im-Breisgau. While engaged in this University he produced his first considerable work, "Die Willenshandlung" (1888), described by William James as "a little masterpiece," and commenced the publication of the "Beiträge zur experimentelle Psychologie," of which the "Grundzüge der Psychotechnik" may be regarded as the completion. In 1892 James, who admired the acuteness and vigour of "the irrepressible young Münsterberg," invited him to come to Harvard as first director of the psychological laboratory—the forerunner of institutions that have become specially characteristic of American universities. His success as a lecturer and publicist led him to write a series of English works dealing in a semi-popular way with the applications of psychology to law, medicine, education, and the problems of society and industry. The last books of this series were a "Business Psychology" (1915) and a study of the "Photoplay" (1916). While these works undoubtedly did much for the popularisation of psychology, and contain matter of considerable value, they have scarcely added to their author's reputation as a man of science. His last serious book in English, "Psychology, General and Applied" (1914), is an extremely interesting exposition of his psychological doctrine, in which the results of the modern experimental and the older philosophical methods were happily and ingeniously combined.

MR. R. PROTHERO, President of the Board of Agriculture, attended the first meeting of the War Emergency Committee of the Royal Agricultural Society of England, under the chairmanship of Mr. Adeane. He outlined the Government's proposals for increasing the production of food, and after his departure the committee passed the following resolutions, which are being forwarded to the Board of Agriculture:—(1) That this committee is of opinion that a price should not be fixed for any agricultural produce unless the cost of production is taken into consideration and unless the price of feeding stuffs, fertilisers, etc., is also fixed. The committee questions the wisdom of fixing prices, but in the event of the price of wheat being fixed at 60*s*. per quarter, the opinion of the committee is that the price of oats should be fixed at not less than 40*s*. per quarter. (2) The committee is of opinion that where spring sowing of wheat is undertaken care should be taken to ensure that the varieties used should be especially suitable for the purpose—such as Red Marvel, April Bearded, or, in districts where it is known to succeed, Red Fife. (3) The committee feels that the land of this country cannot be made to produce more food unless there be an increase in the supply and use of artificial manures. The manufacturer of these manures is dependent upon a larger amount of sulphuric acid being made available for the use of the makers of artificial manures, and the committee urges the Government to set free for the use of those manufacturers such acid as they may require. (4) The committee is of opinion that in view of the great difficulty experienced in obtaining artificial manures in this country, the Government be requested to prohibit the export of sulphate of ammonia and basic slag, except to our Colonies, until the requirements of agriculturists in this country have been met.

THE King has conferred the honour of knighthood upon the Very Rev. John Herkless, principal of the University of St. Andrews.

MR. F. J. H. MERRILL, State geologist of New York from 1890 to 1893, has died at Los Angeles at the age of fifty-five. For the last three years he had been field-assistant to the California State Mining Bureau.

DR. HJALMAR ÖHRVALL is retiring from the chair of physiology at Uppsala University, having entered his sixty-sixth year on December 15.

THE astronomical institute of Lund University has at last obtained the seismograph for which it prepared an underground chamber two years ago.

THE removal of the natural history collections from the building of the Swedish Academy of Science in Drottninggatan, Stockholm (see NATURE, November 30, p. 255), has afforded temporary accommodation therein for the ethnographical collections, which have long had wholly insufficient lodging. Prof. C. V. Hartman intends to make the most of the eight months' tenancy promised him. When the public sees a larger selection from these valuable stores it will surely insist on a suitable and permanent home for them.

IN this country, where many of our leaders in science have been amateurs, we do not always realise the rarity of such workers in some other countries or the difficulties met with by those who do exist. In Sweden, however, the number of serious amateur workers in biology has so greatly increased of late years that a proposal has emanated from the University of Lund to hold, in one or other place, a yearly meeting at which professional biologists may be brought into closer personal relations with their amateur colleagues. The proposal is also supported by Prof. Lönnberg and others.

IT is announced that a school of mothercraft will be opened in February. The scheme is intended for educated women wishing to complete their qualifications for posts as health visitors, superintendents of infant welfare centres, matrons of babies' homes, and the like. Mothers with babies will be resident, and students will have the care of them and be instructed in breast-feeding and in various methods of artificial feeding. The course will extend over nine months, of which the first five will be spent in routine nursery work, and the last four at infant welfare centres, home visiting, etc. The school, named the Marlborough School of Mothercraft, is under the presidency of the Duchess of Marlborough.

THE second meeting of the Society of Glass Technology was held on December 14, in the University of Sheffield, the president, Mr. W. F. J. Wood, in the chair. Dr. H. Frank Heath, secretary of the Department of Scientific and Industrial Research, addressed the meeting, pointing out the good services the society could render to the nation, and assuring it of the Government's interest and support. The remarkable developments that have taken place in the glass industry during the last two years were emphasised by an exhibition of various types of glass, including (1) scientific ware, (2) optical glass, (3) artistic glass, (4) miscellaneous exhibits. Many firms and private individuals sent collections for exhibition, and it was apparent that in chemical ware and other scientific glass there was no necessity to depend on German production in the future. Beautiful specimens of artistic glass, both ancient and modern, were shown, whilst there were several interesting and instructive exhibits of glasses illustrating the various effects met with in glass production.

A MEETING of makers and users of refractory materials was held in the Chemistry Theatre of the University of Manchester on Wednesday, December 13, and was well attended. Mr. A. Cliff occupied the chair, and practically all the important manufacturing centres were represented. The opinion was generally expressed that a technical society of some kind ought to be formed, and that it should emphasise the manufacturers' side and develop a close relationship with the users in the various industries, so that all may work together in harmony for the general good. After discussion, it was decided to form a special section of the Ceramic Society, which has its headquarters at Stoke-on-Trent. This section is to work independently of the parent body in electing its own officers and in the management of its own meetings, to be held in the different centres. A provisional committee was appointed, which met at Newcastle-upon-Tyne on Wednesday, December 20, to formulate a scheme for the election of officers, to consider what modifications of the rules of the Ceramic Society are necessary to suit the requirements of the new section, and to appoint a place for the next general meeting. It was decided to hold this meeting of the section at Leeds early in the new year, when Dr. J. W. Mellor, of Stoke-on-Trent, is to read a paper on "The Spalling of Magnesite Bricks."

A STUDY of the individual and sex differences resulting from fasting is reported by H. D. Marsh in the *Psychological Review* (vol. xxiii., No. 6). The writer and his wife undertook a fast of three weeks. During the first of the three weeks the food was gradually reduced from normal to very little; during the second no food was taken except about 600 c.c. of water daily; the third week reversed the procedure of the first week. The immediate effects of the fast, as shown by the tests, indicate a depletion of vitality and strength and to some extent a slowing down in the speed of activities, more for the motor than the mental. Some improvement in both sexes is shown in mental clearness and accuracy, and a most pronounced effect upon memory, disadvantageous for the masculine subject and advantageous for the feminine. It is certainly desirable that the ultimate effects of fasting upon both health and ability should be made the subject of definite study, and this article is interesting as an example stimulating to further inquiry. The sex differences found, though, may possibly prove to be individual rather than sexual.

THE Royal Anthropological Institute has been presented with a collection of fifty-nine photographs of Welsh Baptist ministers, dated about 1860–65. This collection was studied by the late Dr. John Beddoe, and notes have been made on each photograph with the view of determining the various types—Mediterranean, Kymric, Bronze, or Saxon—to which they belong. The question is discussed by Mr. H. J. Fleure in the December issue of *Man,* who pleads for contributions to a series which is likely to interest anthropologists.

IN spite of delay caused by the war and the loss of powerful supporters like Lord Ninian Crichton Stuart and Sir John Rhys, the National Museum of Wales is making steady progress, a considerable portion of the new buildings now approaching completion. The appeal of the court of governors for exhibits has been well responded to, but specimens are still much wanted to illustrate the geology and mineralogy of the Principality. The exhibition of Mr. E. Lovett's collection of dolls was very popular; the governors are now making arrangements for an exhibition to illustrate the methods of education adopted in bygone times, and an effort is being made to establish a collection of mining appliances, especially such as were used in the past, to illustrate the development of the Welsh mining industry. A special appeal is being made for assistance in carrying out these useful projects.

IN the Museum Journal of the University of Philadelphia for June, recently received, Mr. C. W. Bishop gives an account of his expedition to the Far East in search of specimens for the museum. In Japan he was permitted to inspect the Imperial treasury of the Shoshoin, a collection practically unknown to foreigners. It consists chiefly of the palace furniture of the Emperor Shomu, who reigned during the eighth century, when the capital of Japan was at Nara. The collection comprises a wide range of objects, many of Korean, Chinese, and even Persian or Roman-Syrian origin, and includes bows and arrows, swords, spears, javelins, a curious form of halberd with a blade shaped like a lambent flame—a type peculiar to this period—decorated boxes, collections of Buddhist *sutras,* masks used in sacred ceremonies, musical instruments, games, robes, shoes, banners, tapestries, jewelry, glassware, and many other articles of great artistic value. Nowhere else in the world does such a collection exist, in particular, containing objects of the T'ang and preceding Chinese dynasties. Early Korean art is nowhere represented with such completeness as in this plain log building in the quiet groves of Nara.

AN interesting paper "On Plotting the Inflections of the Voice," by Mr. B. Bradley, well known as a comparative philologist, appears in the University of California Publications in American Archæology and Ethnology (vol. xii., No. 5). Vocal sounds, and more especially words, appeal to the ear with various inflections, such as "high" or "low," "rising" or "falling," etc., and the inflection, both as regards "pitch" and "duration," often gives a certain character and meaning to the word. This is indicated in many languages by the use of "accents," as in Greek. Mr. Bradley has investigated the nature of such inflections by a new method, unlike the usual methods of the registration of sounds by those interested in phonetics. Recognising that an inflection is determined by pitch and duration, he registers vocal sounds by Rousselot's apparatus, and then he plots on co-ordinate paper, by an ingenious and most laborious method, the curve obtained by an examination of pitch and duration. The result is, to take an illustration from the Siamese language, with which Mr. Bradley is acquainted, that certain curves represent a rise, or a circumflex (rising and falling), or a more uniform mesial movement, or depression, or falling, all of which can be recognised by the ear. The remarkable thing, however, is that when such curves are studied with care, and with appropriate corrections, variations (often slight) may be observed in the wave-like movement which are not recognised by the ear, and the sound heard conveys a definite meaning, with a wave form different from that of the same word with different inflections. Thus, in Siamese, the syllable *nā*, with a rising inflection, means *thick*; with a circumflex, *uncle* or *aunt*; with a middle, *ricefield;* with a depressed, *indeed*; and with a falling, *face* or *front*. Tonal inflections or modulations "are essential features of every spoken word" in such languages as Chinese. The paper is accompanied by interesting curves.

IN 1879 Capt. Kirby, of Gloucester, while fishing for cod and hake south of Nantucket, brought up a new fish, which has been named *Lopholatilus chamaeleonticeps*. Since then, from time to time, other specimens of the fish, popularly known as the "tile-fish," have been obtained. In the *American Museum Journal* for November Mr. G. H. Sherwood describes an expedition in search of specimens. The flesh of the fish is said to resemble cod, and the remarkable discovery of a new edible fish seems likely to prove of some economic importance.

IN their third report on the improvement of indigo in Bihar (Agricultural Research Institute, Pusa, Bulletin 67, 1916) Mr. A. Howard and Mrs. Howard again insist that sound scientific cultivation is the first essential in the resuscitation of the natural indigo industry. Regarding "indigo wilt," they explain that, though cure be impossible, prevention, under intelligent treatment, is not difficult. The occurrence in the indigo plant of two "nitrogen cycles" makes the planter's task something more than the harvesting from a given area of a maximum crop, a given weight of leaf of which shall yield a maximum of indican. The chemical advice under which during recent years this, without due regard to the physiological characteristics of the plant, has been the grower's aim is unwittingly responsible for damage to the industry. Seed of single plants of a wild indigo, separately collected in Natal in 1913 for cultivation at Pusa, yielded a progeny more uniform than the Java indigo first introduced into Bihar in 1898. Colour, it is said, is thereby lent to the idea that Java indigo has arisen as a cross between the Natal plant introduced into Java three-quarters of a century ago and some species formerly cultivated in Java. The identity of the latter species is not suggested, nor is it stated where in Natal the seed imported in 1913 was gathered. When, shortly after 1898, attempts to import Natal seed into Bihar were first made, no dye-yielding indigo could be found in Natal; the seed then secured was that of the Zulu indigo plant. All those engaged in the natural indigo industry will welcome this report and look forward with interest to further information from its authors on this important subject.

THE only part of the British Empire that can be looked upon as a producer of thorium minerals in quantities of economic importance is the island of Ceylon, and a good account of their occurrence and distribution will be found in the September Bulletin of the Imperial Institute (vol. xiv., No. 3). The minerals in question are monazite and thorianite, the former containing about 8 per cent. and the latter about 55 per cent. of thoria. The most profitable sources of the former appear to be certain of the beach deposits, where the monazite, together with much black sand, mainly ilmenite, has been concentrated by the action of the sea, whilst the thorianite is obtained from alluvial deposits in the river valleys, being often met with as a by-product in gem-mining operations. Both these minerals have been traced to their parent rocks, their main source being apparently pegmatite veins or lenses in granite, granulite, and charnockite. Up to the present none of these primary occurrences have been found sufficiently important to be capable of economic exploitation; the minerals capable of being worked to advantage are all obtained from clastic deposits, resulting from the degradation of the primary deposits and the subsequent concentration by natural causes of the material thus broken down.

THE meteorological observatory at the South Orkneys, founded by Dr. W. S. Bruce in 1903, is still being maintained by the Argentine Government. Mr. R. C. Mossman, who was in charge of the observatory for the first two years of its existence, contributes some notes to *Symons's Meteorological Magazine* for November (vol. li., No. 610) on the observations during 1915. The year was a remarkably cold one at the South Orkneys, the mean temperature (20·6° F.) being the lowest on record at the islands, and 3·4° below the average. In February, the warmest month, the mean temperature was 31·3°. Mr. Mossman points out that abnormally low temperatures were not prevalent during 1915 in the southern hemisphere; many observatories in middle latitudes showed mean temperatures above the normal. Other departures from the average conditions at the South Orkneys were the low rainfall and cloud amount, while the mean annual wind velocity was the lowest on record. These observations for 1915 will be of great value in conjunction with Sir Ernest Shackleton's observations further south in the Weddell Sea at the same time.

THE Meteorological Institute of the Netherlands has published a revised edition of the oceanographical and meteorological observations in the Indian Ocean for the months of September, October, and November, which completes the series for the year. The observations embodied are for the years 1856–1914. Results published by the English and French Meteorological Offices have been incorporated, and have added much to the value of the discussion. The work has been carried out under the superintendence of M. E. Van Everdingen, chief director of the Netherlands Meteorological Institute. The discussion is comprised in letterpress of 240 pages, which give the mean values of the principal meteorological elements for each single-degree square over the Indian Ocean. In a separate volume charts are given for the several months of ocean currents and winds, also isobars and isotherms of air and sea, with routes, trajectories of cyclones, limits of fog, ice, and of the trade-winds and monsoons. For the charts the observations are in some cases grouped into 5° squares, and in others into 2° squares. The results are of a very high order owing to the large number of observations available over the greater part of the Indian Ocean, and the method of dealing with the observations is about all that could be wished. The data are limited solely to the sea, but probably in some cases land data might have been combined with advantage. In the pressure charts isobars are given for each 2·5 millimetres, There are numerous islands over the Indian Ocean at which long series of observations have been maintained; the entry and use of these stations would have enhanced the value of the work.

UNDER the joint auspices of the New York State Commission on Ventilation, the American Museum of Natural History, and the American Museum of Safety, an investigation of three of the best methods of determining the amount of dust in air has been carried out by Messrs. G. T. Palmer, L. V. Coleman, and H. C. Ward, and the results obtained are given in vol. vi. of the *American Journal of Public Health*. In the first of the methods investigated the dust-laden air is forced against a surface smeared with glycerine, and the number of dust particles caught by the glycerine on selected areas of the surface counted under the microscope. In the second method the air is drawn through syrup, which is afterwards diluted with water, a drop of which is placed in a shallow cell under the microscope, and a count made in the same way. In the third method the air is drawn through a spray or curtain of water, which is then examined under the microscope as in the second method. In the second and third methods a rough determination may be made by a comparison of the turbidity of the water with that of a series of prepared samples. The authors conclude that the water-spray method is the best and most convenient to use under normal conditions, and they give a number of directions as to the best way of carrying out the observations.

ACCORDING to the *Chemical Trade Journal* of December 9, the Secretary of the U.S.A. Department of Agriculture has decided to erect on the coast of southern California a Government plant for the production of potash from kelp. Unlike the private companies which are already manufacturing potash from this source, the Government is determined not only to produce the potash at the minimum cost, but also to conserve the nitrogen, iodine, and other by-products. In the Government plant the kelp will first be dried in a series of rotary driers. It will then be distilled in a modified coke-oven in such a way as to prevent the loss of the nitrogen, iodine, and other by-products. The potash salts will be dissolved with water out of the resulting charcoal, which may afterwards be used as fuel. The combustible gas obtained by the distillation may also be used as fuel. The U.S.A. Government experts hold that by such economical methods the process can be made to pay in ordinary times.

WE have received from Messrs. Dulau and Co., Ltd., their December catalogue of botanical and natural history works. It is classified under botany and horticulture; orchids and orchid culture; mammals, birds, and reptiles; entomology; mollusca, and periodical publications. Many rare and out-of-print books are included. We notice that a set of NATURE from 1869 to 1907 is listed at a low price.

OUR ASTRONOMICAL COLUMN.

MERCURY AN EVENING STAR.—Mercury will be at its greatest elongation east on the morning of January 3, and visible on several evenings before and after that date over the W.S.W. horizon about ¾h. or 1h. after sunset. The planet will be visible to the unaided eye should the atmosphere be very clear at the important time, though this apparition will not be so favourable as the one which will occur on April 24 next. Between about December 28 and January 10 next Mercury will set about 1½ hours after the sun, and, with good weather conditions, the ruddy, scintillating light it emits ought to be detected without difficulty, though it will be at a very low altitude.

TOTAL ECLIPSE OF THE MOON.—This phenomenon will take place on the morning of January 8, and the following are the astronomical times of its various stages:—

	January 7 h. m.
Moon enters penumbra	16 36
Moon enters shadow	17 50
Beginning of total eclipse ...	19 0
Middle of eclipse	19 45
End of total eclipse	20 29
Moon leaves shadow	21 39
Moon leaves penumbra	22 53

Magnitude of eclipse = 1·369 (moon's diameter = 1·0).

At Greenwich the moon sets at 20h. 10m., while the moon is totally eclipsed. The various phases of the event may therefore be watched until after the middle of the eclipse. It will be interesting to observe whether the earth's shadow proves a very dark or light one on this occasion. At some lunar eclipses the disc of our satellite has remained quite bright, at others it has been scarcely visible at all. It usually happens that, at the time of a lunar eclipse, the atmosphere is sufficiently favourable to allow successful observation.

LONG-PERIOD VARIABLE STARS.—A valuable contribution to the investigation of variable stars was recently made by the Rev. T. E. R. Phillips, in a presidential address to the British Astronomical Association (Journ. B.A.A., vol. xxvii., p. 2). Observational data for such stars have been much extended by the carefully determined light-curves of twenty-one long-period stars observed by the members of the Variable Star Section of the association, and by sixty-seven light-curves published in the Harvard Annals. Mr. Phillips has analysed the curves of eighty stars, and from a comparison of the phases of the second and third harmonics he finds that the long-period variables fall into two distinct groups. This grouping is supported by the evidence of the ranges of variation, and, in a somewhat less degree, by the coefficients, brightness, and periods. The general characteristics of the two classes are also shown in the light-curves. In Group I. the intervals from maximum to minimum, and from minimum to maximum, are not very unequal, and there is a tendency for the curve to show a pause on the rise. In Group II. there is a sharp rise to maximum, followed by a long period of decline. As a rule it is possible to determine the group to which a star belongs by mere inspection of the light-curve, but harmonic analysis is necessary to fix its place in the group. The stars of Group I. are brighter than those of Group II., and it is possible that they may be found to include "giants" and "dwarfs" respectively. The inequalities in the intervals between successive maxima, and in the brightness at different epochs, call for much further investigation.

INTERNATIONAL ELECTRIC AND MAGNETIC UNITS.

THE U.S. Bureau of Standards has issued a useful and interesting critical *résumé*[1] of the principles underlying the establishment of the present international system of practical electric and magnetic units, together with a survey of the various attempts that have been made to "rationalise" them so as to make the factor 4π one of less prominence in the equations most used in practice.

The international system of C.G.S. units is not strictly a C.G.S. system, for it is actually defined in terms of two arbitrary units, the international ohm and the international ampere, together with length and time. Nevertheless each unit in the system is the representative for practical purposes of the corresponding unit in the C.G.S. electromagnetic system, and differs from it only slightly. The small differences are determined by absolute measurements made from time to time. One of the advantages of the international system is that it does not give undue prominence to magnetic pole strength; as Mr. Dellinger puts it: "The complexity of the dimensional expressions of the electromagnetic system and its poor correspondence to the conditions of practice are in part due to its being based upon an unimportant phenomenon." He points out that a free magnetic pole does not exist in Nature, magnetic pole strength does not appear in engineering formulæ, and it is consequently a satisfaction to find that it can be dispensed with in theory also.

Magnetic units, however, are not entirely free from confusion, notwithstanding the casting into oblivion of the once useful but now unnecessary conception of the free magnetic pole. Gauss was a great man with an ugly name. Physicists and "practicians" alike have always been partial to employing the names of great men for electrical and magnetic units (even if the great man in question had not been more particularly identified with the quantity to be christened than with others of the same category), and ugly names for units have had a strange fascination for them. So "gauss" has been seized upon both for the unit of induction and for the unit of magnetising force. This double usage is recognised by the American Society for Testing Materials, and, provisionally, by the American Institute of Electrical Engineers, but Mr. Dellinger clearly voices the disapproval of the Bureau of Standards. It is true that the numerical equality of B and H in non-magnetic media, and their appearance as terms in the equation $B=H+4\pi J$, both tend to encourage the idea that they are of the same physical nature, but "the argument that dimensional identity indicates physical identity is refuted by the example of energy and torque. Who would measure torque in joules or calories?" B, in fact, characterises the magnetised state of the medium, and H is the agency tending to produce that state, just as the deflection of a spring is physically different from the mechanical force producing it. There is no authority for considering μ to be a purely numerical ratio. μ is one of the two quantities (μ and K) which are effective in the propagation of electromagnetic waves, and must therefore be an actual physical property unless K involves both the physical properties which are dynamically necessary in a medium for the propagation of waves. The possibility of comparison is rendered worse by the fact that the name "gauss" was tentatively adopted in 1895 by the B.A. Committee on Electrical Standards as the C.G.S. unit of magnetomotive force. Mr. Dellinger suggests that the "gauss" be retained as the unit for B only, or that it be avoided altogether. The "gilbert" has been adopted as the C.G.S. unit of magnetomotive force, and the gilbert per cm. is already widely used as the C.G.S. unit of H. The C.G.S. unit of magnetic flux is the "maxwell," and B can always be called the maxwell per sq. cm.

The attempts to "rationalise" the units to make 4π less conspicuous date back to Oliver Heaviside's publications in 1882.[2] His proposals involved, however, an entirely new set of practical units. Perry, Fessenden, Fleming, and Giorgi followed with other proposals between 1889 and 1901, and the matter was revived again by Ascoli last year,[3] and, finally, by Prof. V. Karapetoff. Prof. Karapetoff uses the international ohm and ampere as fundamental units, the ampere-turn as the unit of magnetomotive force, and the C.G.S. units for magnetic flux and induction. The system of "ampere-turn" units is treated at some length in Mr. Dellinger's paper, and the equations required to make the ampere-turn fit in with the units of other magnetic quantities are given; but he concludes by expressing the opinion that none of the proposed changes in some, or all, of the existing systems of international electric and magnetic units offer advantages sufficient to justify the confusion and inconvenience that would be involved.

[1] Scientific Papers of the Bureau of Standards. No. 292, "International System of Electric and Magnetic Units." By J. H. Dellinger, Assistant Physicist, Bureau of Standards. (Washington: Government Printing Office, 1916.) Price 10 cents.

[2] The *Electrician*, vol. x., p. 6 (1882); "Electrical Papers," vol. i., pp. 199, 262, 432; vol. ii., pp. 543, 575 (1892).

[3] *L'Elettrotecnica*, vol. ii., p. 731 (1915); *Electrical World*, vol. lxvii., p. 876 (1916).

ARGENTINE METEOROLOGY.[4]

EVIDENCE of the activity and progress of the work carried on under the direction of Mr. W. G. Davis in the years preceding his retirement in March, 1915, after thirty-five years' service in the Meteorological Department of the Argentine Republic, is contained in the undernoted memoirs.

In the work dealing with the "History and Organisation" of the Oficina Meteorológica, Mr. Davis gives a succinct account of the initiation and development of the service founded in 1872 by Dr. A. B. Gould, first director of the Cordoba Astronomical Observatory. In 1884, when Dr. Gould retired, there were fewer than twenty meteorological stations in operation. In 1901 the number had increased sixfold, with, in addition, 240 rainfall stations, while in 1914 there were no fewer than 212 stations, of which forty-two were of the first class, *i.e.* provided with automatic instruments. The rainfall was then being recorded at no fewer than 1930 points. The great strides made in the meteorological representation of the country during the period covered by the directorship of Mr. Davis is well shown on maps indicating the position of the various classes of stations in 1884, 1901, and 1914. A Daily Weather Map was started in 1902, and is now based on reports from more than 200 ordinary stations and 1350 rainfall stations, including observations from the neighbouring Republics.

An excellent series of maps is given showing seasonal and annual values of all the elements of climate except cloud amount and humidity. A selection of the data on which these are based is given on pp. 154 to 181.

[4] (1) "Servicio meteorológico Argentino: Historia y organización, con un resumen de los resultados." (In Spanish and English.) Pp. 181+maps and charts. (Buenos Aires, 1914.) (2) Anales, tomo xv., "Clima de Buenos Aires," 2 parts. Pp. 1221. (Buenos Aires, 1912.) (3) Anales, tomo xvii., parte 1, "Observaciones de las Islas Orcadas en los años 1905 á 1910." (In Spanish and English.) Pp. 720. (Buenos Aires, 1912.) (4) Anales, tomo xvii., parte 2, "Clima de las Islas Orcadas del Sud. Discusión de las observaciones meteorológicas y magnéticas en la Isla Laurie." (In Spanish and English.) Pp. vi+314+22 plates. (Buenos Aires, 1913.) (5) Boletin No. 4, "La termodinámica de la atmósfera terrestre, desde la superficie hasta el plano de desvanecimiento." Por F. H. Bigelow. (In Spanish and English.) Pp. 142. (Buenos Aires, 1914.) (6) Boletin No. 5, "Resultado de las observaciones del magnetismo terrestre." Por Luis G. Schultz. (In Spanish and English.) Pp. 12+4 plates. (Buenos Aires, 1914.)

Unfortunately, no heights are given, and there are many errors in the geographical co-ordinates of the stations, some of considerable magnitude. The remainder of the meteorological section of the volume is devoted to an important paper by H. Helm Clayton on "Atmospheric Circulation and the Weather in Argentina."

The hydrometric section was founded in July, 1902, and there are now 109 gauges at work on the principal rivers and lakes, daily forecasts being made of the probable height at important points. The elevation of the underground water is also gauged at twenty-two stations. The magnetic branch of the service was established in 1904, with a central station at Pilar, near Cordoba, in charge of Mr. L. G. Schultz, who, with assistants, prosecuted field-work at regular intervals, notably in 1908 and during 1912–13. This work is "sufficient to give a very fair knowledge of the values of the magnetic elements in all parts of the country, as well as their respective secular variations." Lines of equal declination, inclination, horizontal intensity, and vertical intensity for the epoch January, 1914, are given in graphic form, while mean hourly values of the principal magnetic elements registered at Pilar from 1905 to 1914 are shown for the months, seasons, and the year (pp. 56–145). Bulletin No. 5 contains a condensed summary of the magnetic results with special reference to the field-work accomplished. Vol. xv. of the Anales contains the hourly and other meteorological observations made in Buenos Aires from 1877 to 1910, in continuation of the series published in vol. i. of the Anales. The printing of the discussion, which is ready, has been meanwhile postponed owing to the reduction of appropriations.

The hourly meteorological and magnetic observations made at Laurie Island, South Orkneys (lat. 61° S.), from 1905 to 1910, with a discussion of all the available material since 1903, appears in vol. xvii. of the Anales. This station was taken over in February, 1904, from the Scottish National Antarctic Expedition, and is now completing its thirteenth year under Argentine auspices. The maintenance of this observatory involves the dispatch every summer of a relief expedition from Buenos Aires. The climate of the South Orkneys is in general insular from October to March, and continental during the rest of the year, when the surrounding seas are frozen. At all seasons the island is enveloped in a current of Antarctic origin, so that the mean temperature of the warmest month (February) does not exceed 0·6° C. The coldest month is July, with a mean of −11·9° C., and the mean annual temperature is −4·4° C. The extremes noted have been 8·8° and −40°. Föhn is not uncommon, and during its occurrence the temperature, even in midwinter, rises considerably. The mean annual pressure is 744 mm., with extreme readings of 774·7 and 709·1 mm. Pressure is low from January to May, and again in November, and relatively high from June to October, and also in December there is much cloud and the air is very humid. Storms are comparatively rare, and are most common at the equinoxes, and least frequent at the solstices. The station lies in the west-wind system, and winds from the east are seldom observed. The upper currents are also from the west, and the cloud drift becomes more and more towards the east as the height increases. The lower clouds are at a greater height in summer than in winter. The precipitation, mostly in the form of snow, and difficult to measure owing to drift, amounts to 447 mm. (17·60 in.) annually. The snow is deepest a month before the winter solstice, and in some summers does not disappear at sea-level. The diurnal range of all the elements, although distinct, is very small. An interesting chapter on the frequency and distribution of the ice in the seas surrounding the South Orkneys, showing the very variable conditions experienced from year to year, concludes the meteorological summary of the results. The rest of the volume is taken up with a discussion of the magnetic data to 1912. The analysis of the whole material is very complete, and there are twenty-two plates, some of which possess new features.

Bulletin No. 4, by Prof. Bigelow, as the title suggests, is highly mathematical, and does not lend itself to condensation.

R. C. M.

A PLAGUE OF VOLES IN ITALY, AND ITS CONTROL.

DURING the past summer the province of Foggia in Apulia has suffered great depredations by field-voles (*Pytymys savii*), the grain crop having been almost entirely destroyed. Prof. Splendore has given an account (in two papers in *Rendiconti R. Accad. Lincei, Classe fis. mat. nat.*, vol. xxv., July and August, 1916) of his investigations, carried out in Prof. Grassi's laboratory in Rome, with the view of finding some method of destroying the voles. Of about forty voles sent to him from Cerignola (province Foggia), some died *en route*, and had been partially eaten by the survivors; the others died a few days after arrival in Rome. In all these a coccobacillus was present in the blood, in the internal organs, and in the lymphatic glands. Around Cerignola there was a remarkably high mortality among the voles, attributed by Prof. Splendore to the coccobacillus which was found in all the voles examined. This spontaneous epizootic, which spread extensively, presents the features of a septicæmia, the internal organs being congested, especially the spleen and liver, which are always enlarged. Prof. Splendore has compared the coccobacillus with *Bacillus typhi murium* and the *typhi-coli* group, and considers that it presents such clear differences as to justify him in placing it, provisionally at least, in a new species—*Bacterium pytymysi.*

Healthy, well-nourished voles from a locality where the epizootic was not known to occur died in less than twenty-four hours after subcutaneous inoculation with an emulsion of the spleen or liver of an infected vole; others fed with infected material died in three or four days. When dead or infected voles were placed among healthy ones, the latter developed the disease in a few days. The organism was found to be pathogenic also to mice, rats, and rabbits.

Prof. Splendore isolated the organism from the intestine of fleas found on an infected vole. The intestinal contents of three similar fleas were inoculated subcutaneously into a healthy vole, which died in less than twenty-four hours. Another healthy vole, placed in a vessel with three vole-fleas, died three days later. Both voles were found to exhibit the usual congestion of the internal organs and to contain the coccobacillus. Prof. Splendore considered that these experiments confirmed his previous suspicion that the natural method of propagation of the infection is by means of fleas. He recommended that voles infected by inoculation should be distributed in the areas invaded by voles, where the epizootic has not yet appeared, so that the disease would be propagated by fleas and would continually extend until the areas were freed from the rodents. It will be interesting to see how far this method has been successful in ridding the country of a destructive pest. Possibly the new organism may be found useful in attacking other species of destructive rodents, *e.g.* rats, but investigations will no doubt first be made as to its pathogenic relations to domestic animals and man.

SCIENCE AND INDUSTRY, WITH SPECIAL REFERENCE TO THE WORK OF THE NATIONAL PHYSICAL LABORATORY.[1]

AFTER a reference to the work of the Privy Council Committee, the speaker pointed out that, in the words of their first report, "the object of the scheme is to bring scientific knowledge to bear practically upon our everyday industrial and commercial life." He continued:—In this process, as we shall see, and as has been well pointed out by various recent writers—see Dr. Rosenhain's paper before the West of Scotland Iron and Steel Institute, "The National Physical Laboratory: its Work and Aims," and Dr. Mees's pamphlet on "Science and Industry," issued by the Advisory Committee of the Privy Council—three distinct stages may be observed. We need:—

(1) The work of the man of science in his research laboratory.

(2) Investigations which go on in an industrial research laboratory, developing new processes or introducing new products.

(3) The works laboratory proper, controlling the quality of raw materials, finished products, and processes.

Let us note then, in the first place, we must have scientific knowledge. That point I need not labour, but note also that to be successful that knowledge must be pursued for its own sake. Each of the modern practical applications of science had its foundations in purely scientific work, and, to quote Prof. Gregory, in his recent book, "Discovery; or, The Spirit and Service of Science," "was not the result of deliberate intention to make something of service to humanity." It is scarcely necessary to illustrate this; let me, however, give one classical example. The discovery of the laws of electromagnetic induction is due to Faraday, and is described in his first three series of "Experimental Researches," published in 1831–33. Oersted, Ampère, and Arago had investigated some of the phenomena connected with the magnetic force produced by an electric current, and to Faraday it appeared clear that, conversely, it should be possible to produce electricity from magnetism, as he put it. It is difficult to picture the world to-day without electric power, and yet the whole development of electrical machinery, as we know it, rests on the laws described in these brief scientific papers. Each advance of knowledge brings its benefits to mankind, and in a general way Faraday may have hoped to be a benefactor to his race by widening the sphere of knowledge, but it was the desire to know the truth which led him on and to which we owe such tremendous consequences.

We must have the student of pure research, the genius who goes on his way discovering new truths, irrespective of consequences, laying bare more and more of Nature's secrets and unravelling her mysteries.

In England we have never lacked such men; our roll of great discoverers has been a glorious one. Too frequently their lives have been hard and difficult, prophets without honour they have lived; to-night it is not my task to speak of them beyond urging the importance of giving every encouragement to such men by supporting, in the most generous spirit, any among you here in your University or elsewhere who are advancing the bounds of knowledge, searching for truth in some of its difficult byways. The endowment of pure science is essential; without it the attempt to apply science to industry fails.

This, however, is not my subject to-night; let us turn for a short time to the third need among those enumerated above—the works laboratory proper. My audience will appreciate perhaps more fully than I can the need for this.

It is necessary, if for no other reason, to maintain the standard of the output, to secure that the proper grade of material is supplied to the works, to check the instruments in use, and to test the product in its various stages of manufacture. The days are gone when successful manufacture could be carried on entirely by rule of thumb, trusting to the skill of some trained workman for the success of each delicate operation, when the hereditary instinct, passed down from father to son, was sufficient to produce each year practically the same results. New processes come, which appear likely to improve production or to reduce its cost; the works laboratory serves to test these. New products are suggested, which may or may not have the advantages claimed for them; this can be investigated in the works laboratory, and all these investigations and tests must go on in the works themselves under the eyes of men familiar with the process of manufacture in its every stage. The works laboratory must extend, and others are more competent than I to outline the direction of extension and to guide its growth.

Now between these two—the man of science researching in his university or college, and the works chemist toiling in his shop—there is a gap. Some means are needed to make the discoveries of science available to the manufacturer, to secure to him the advantages which come from the growth of knowledge to keep him in the forefront of his trade. This, if I grasp the problem aright, is the function of a laboratory of industrial research, and among such laboratories the National Physical Laboratory should hold a prominent place. The National Physical Laboratory has another function to fulfil—it is a great standardising and testing institution. I will recur again to that aspect of its work; for the present let us consider what is required in a laboratory for industrial research and see how far these requisites are supplied at Teddington. Quoting again from Dr. Mees's paper, already referred to, "This kind of research work," he says, "involves a laboratory very different from the usual works laboratory, and also investigations of a different type from those employed in a purely industrial laboratory. It means a large, elaborately equipped and heavily staffed laboratory engaged largely on work which for many years will be unremunerative, and which for a considerable time after its foundation will obtain no results which can be applied by the manufacturer."

This work clearly needs a special home; it cannot be done in the laboratory of a technical institute. The main work in a laboratory such as that of a technical institute must be educational. The object of the professor is to educate his pupils so that each may apply his knowledge to his lifework in the future. For this he will teach them to research. They will help him in his own investigations, and these may well have a bearing on the industry of the district. They may commence to solve for themselves simple problems akin to those they will meet with in their future work, but their power and opportunity to apply the new discoveries of science to the manifold problems of industry must be limited. For such work training is required, and full and elaborate equipment; the plant of a technical school laboratory must be designed to serve many purposes, all aimed at educating the pupils to apply science, and at teaching them the methods to follow. It is not their work, while still at college, to solve the conundrums of the manufacturer. The research laboratory is necessary if progress is to be made. Abbe realised somewhere about 1876 that British optical in-

[1] Abridged from an address delivered to the Birmingham and Midland Institute, on December 4, by Dr. R. T. Glazebrook, C.B., F.R.S.

struments had reached the highest possible development unless a radical change could be produced in the optical properties of glass, and the researches of Schott and himself, aided by subsidies from the Bavarian Government, lasted a number of years before the first catalogue of Jena glass was produced. Synthetic indigo was discovered by von Baeyer about the year 1880; it was not until some twenty years later that it was put commercially on the market, and in that time it is reported that no less than 1,000,000*l.* was spent by the Badische Anilin- & Soda-Fabrik before this desired end was reached.

Standardisation in all its branches is an important function of such a laboratory, and this involves research. The methods of measurement, the materials in which the standards can best be expressed, the accuracy of reproduction, and the conditions of use, all need investigation.

One other aspect of the matter remains to be considered, though very briefly. If we are to have a National Industrial Research Laboratory, who is to pay for it, who is to support it? The obvious answer is, the nation, but this in some quarters at once raises a difficulty. It is claimed that the results of any successful research bring profits, in the first instance, to some particular class, and that class ought to pay. For example, the discovery of some new and valuable alloy would profit, in the first instance, the manufacturer of the alloy and the persons employing it in their special trade. Before, therefore, you undertake an investigation you must secure, so it is said, the co-operation and financial support of a limited class who will presumably benefit by the success of the investigation. And no doubt, as a general rule, in cases in which it can be applied, this principle is a sound one, but such cases are limited. If a manufacturer comes with a conundrum, which he desires to have answered for his own private benefit, he must pay; but if a competent committee controlling an industrial research laboratory concludes that a research is of importance and likely to lead to knowledge of benefit to the whole industry with which it is concerned, I would plead that the cost of such a research should be met out of national funds. It is very difficult to say what individual will profit most in the end. An improvement in an industrial process leading to more employment and to a cheaper method of manufacture benefits a wide circle beyond the man who introduces the process. Germany—not merely Messrs. Schott and Zeiss—has profited by the labours of Abbe and his co-workers at Jena, labours rendered possible in the first instance by State help. No doubt there are cases where the co-operation of an industry can, and should, be secured; sometimes, too, it will be in the public interest to protect a discovery by a patent, if only to prevent action by a private firm restricting the free use of the discovery, but, in my opinion, it is not well to hamper those who control the laboratory by conditions aimed at securing support from industry before any special research is commenced.

The needs of the nation at the present time are too serious, the danger of delay too pressing, and the State may well devote large sums to industrial research without minute inquiry as to whether the research is going to benefit Messrs. A. B. specially, and what share, therefore, of the expense Messrs. A. B. must be asked to guarantee. In America the Bureau of Standards, in Germany the Reichsanstalt and the Material-Prüfungs-Amt, work thus for the national good, and this should be the task of our English industrial research laboratory.

And here let us note the importance of keeping the test work a live thing by the aid of research. Instruments are tested to see, among other objects, if they come up to standard, but the standard of to-day is too low some years hence; the tests must be so regulated as to tend to a gradual improvement in the product, and this can be done only by accompanying the tests with continuous research—research into methods of construction, into the materials most suitable for use, into the scheme of tests most helpful towards forming a correct opinion of the value of the instrument. Research must go hand in hand with testing. Without such close co-operation routine tests grow obsolete and cease to be of value; worked thus they prove an important aid to the manufacturer and a most desirable check on his production.

I trust I have convinced you—probably you did not need convincing—that laboratories of industrial research are necessary.

There must be more than one; in many cases an industry can be best served by a laboratory near its principal centre. Large firms, again, may each prefer to have their own; trade secrets and trade jealousies may interfere with full co-operation—this must be so to some extent—but a private laboratory on a really sufficient scale is expensive; too often it becomes little more than what I have called a works laboratory for testing the products of the factory, and for the smaller firms, at least, the only way to secure the full advantage of scientific advance is by co-operation—co-operation in the laboratory, co-operation, with specialisation in production, in the works themselves.

There is much for us all to do, and I ask your active support to make the National Physical Laboratory more efficient, more worthy of its name.

Increased funds must be provided, and it is only through the aid of the manufacturers, and of those who from experience have profited by the work of the laboratory, that the authorities can be induced to do all that is needed to establish the laboratory in a secure position.

On Friday, December 1, in the hall of the Institution of Civil Engineers, some of us listened to an address by Lord Crewe, President of the Privy Council Committee, on the subject of industrial research. It was in reply to a deputation from the Joint Board of Scientific Societies. Sir J. J. Thomson, president of the Royal Society, had spoken eloquently on the claims of pure science, Sir Maurice Fitzmaurice dealt with engineering, and Prof. Baker with industrial chemistry.

Lord Crewe announced that a large sum—the exact figure was not mentioned—is to be at the disposal of the committee during the next five years, and outlined the scheme for its expenditure. Associations are to be formed representing various trades or industries; the representatives of these will discuss with members of the Advisory Committee and other experts questions needing scientific investigation, and when these are determined the grant, supplemented in most cases by funds raised privately or contributed by the industry, is to be used to carry them out. Such work needs laboratories, and it is here, it seems to me, that the future of the National Physical Laboratory lies. Lord Crewe spoke in generous terms of the work of the laboratory in the past; its many friends who heard him were grateful for his cordial recognition of our labours, and he indicated a sphere of wider usefulness under less difficult conditions in the future. Let me picture to you what I trust that sphere may be.

In many cases, no doubt, the researches contemplated must go on in special laboratories arranged and equipped for the purpose—laboratories closely connected with the industry it is desired to help, situated at the great manufacturing centres; but there are many other researches of wide interest and great importance for which a central laboratory is the proper home, a laboratory fitted and equipped in an ample manner, with a trained and competent staff animated, like those, my colleagues, who have built up the National Physical Laboratory, with a love for science, and yet withal with a keen appreciation of the practical side of the question discussed and a real desire to help our country by the application of science to industry.

The body controlling industrial science research must have access to a laboratory in which may be studied the many problems which do not require for their elucidation appliances of the more specialised "works" character, or opportunities only to be found in particular localities; where a staff is available, able and experienced, ready to attack under the advice of men skilled in industry the technical difficulties met in applying new discoveries on a manufacturing scale or to develop ideas which promise future success.

Such a *rôle* the National Physical Laboratory should be prepared to play; such is the future which I trust may be in store for it.

COAL AND FUEL ECONOMY.

IT may be hoped that nowadays no one needs to be reminded about the importance of the economical use of coal. We require all, and more than all, of the power and by-products which can be obtained from it, and are beginning to realise the value of the thousands of tons poured annually into our atmosphere with none but deleterious effects.

A committee of no fewer than forty-six members appointed by the British Association at the 1915 meeting, and containing representatives qualified to speak on the various aspects of the problem, presented its first report at the Newcastle meeting last September, when it was the subject of a joint discussion between the Chemical and the Engineering Sections.

At the same meeting there was also a discussion by the geologists and the chemists on the chemical and microscopical characters of different varieties of coal with a view to their more effective utilisation as fuel and to the extraction of by-products. The two discussions, though at the meeting quite distinct, may well be considered together, since they deal with different aspects of the same question. It is not proposed here to deal with the many papers seriatim, but rather to review the general lines of the discussion.

When chemists, geologists, and engineers meet to consider the coal question, three different views are ever present. The chemist regards coal as *the* valuable source of raw material for the manufacture of synthetic drugs, dyes, and certain high explosives and ammonium sulphate, and would have us carbonise all our coal in by-product recovery plants so as to waste none of these precious substances. Though these substances represent only a small percentage by weight of the coal, their value to chemical industry is such that he cannot sit idly by and see them burnt away, particularly as the consumption of the resulting coke would help to diminish the smoke nuisance. The geologist looks upon coal as a rock of varying physical properties and chemical composition, and, feeling that his duty is to find coal by mapping outcrops or stratigraphical evidence, regrets, in his endeavours to extend our coalfields, that the chemist does not come to his assistance in assigning a particular value to the coal in each seam. The chemist investigates a sample of coal for some specific purpose, benzol or ammonia content, for example, but the geologist would like him to come forward with a definite classification, saying which coals were best for steam or domestic purposes, etc. He feels that both ultimate and ordinary commercial analyses should be carried out, and that the chemist should know the nature of the roof and floor of the seam from which his sample was taken. The palæobotanist might be of great value in association with chemistry, for, as it is known that coal consists of an assemblage of the remains of very many kinds of plants, if it could be shown that particular by-products resulted from particular plants or parts thereof, palæobotanical investigation would show the commercial value of coal from any one seam.

There are, however, certain difficulties. Though much has been discovered by the action of solvents, chlorine, etc., on coal as regards the cellulose and resinic constituents, so many secondary changes may have taken place in the history of a seam that to associate them with individual plants or parts of plants may not be justified, for the decomposition of the original vegetable constituents might prove to be more important than the constituents themselves.

The engineer would have us turn our coal into cheap power, preferably electrical, on account of the ease of distribution. Just as there are trunk lines of railway, so there should be trunk lines of electric power generated from the largest and most economical machines in stations situated in the best localities for the needs of any district where land is cheap and coal and water plentiful. But just as the branches from a trunk railway enable the towns at their termini to develop in a way impossible without the trunk line, so trunk power mains would enable collieries to use their friable coal unfit for transport by turning it into electrical energy, at the same time extracting the by-products, for they would have a means for distributing their power which at present they do not possess.

It would really seem that for industrial purposes this is the line for advance, having in view economy, and the North-East Coast power system may be taken as an example in this country of the theory put into successful practice. It goes a long way to satisfy the chemist in his reasonable desire for by-products, and the efficiency of the conversion of coal into electricity is great if properly developed.

Economy in the domestic consumption of coal is more difficult. Gas is acceptable for cooking purposes, but the Englishman has a strong preference for warming himself by the direct radiation from a fire instead of the far more economical stoves so common in other countries. People must be educated in this matter, and no doubt the Domestic Fuel Sub-Committee of the General Committee mentioned at the commencement of these remarks will see to it that this is attempted. Manufacturers realise that smoke pouring from their chimneys implies bad stoking, and this means waste, and is consequently avoided so far as possible, but smoke from a domestic chimney conjures up visions of the crackling fire and genial warmth within the house.

The two discussions at Newcastle, if not producing any very new points, helped greatly in showing how we stand in relation to this most important question, and it is to be hoped that the committee will be in a position to present much valuable information in their next report. A *rapprochement* between chemists and engineers seems to be coming about, but the chemist and the geologist look as though they would continue grubbing for some time yet in a coal-seam on individual purposes intent. The satisfactory solution of the problem will require all three to work hand in hand, and now is the time, when co-operation is on everyone's lips, to achieve this happy result in the interest of the nation.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

IN reply to an inquiry, official confirmation has reached us of the announcement made by the registrar at the meeting of the council of the University College of Wales, Aberystwyth, on December 15, to the effect that friends of the college had expressed their intention of contributing the sum of 100,000*l.* to the funds of the college, subject to a reservation of their right to make such proposals as they may deem expedient to the council, either as to the capital or as to the income therefrom. The sum of 20,000*l.* will be set aside annually by the donors for this purpose for the next five years.

THE annual meetings of the Geographical Association will be held on Friday and Saturday, January 5–6, at the London Day Training College, Southampton Row, W.C. After the presidential address a discussion on the value of modelling in the early teaching of geography will be opened by Miss N. Catty, and a lecture on regions in human geography, with special reference to Europe, will be given by Prof. H. J. Fleure. There will also be a discussion on the resolutions drawn up by the Five Associations (now the Council for Humanistic Studies), to be opened by Mr. H. J. Mackinder. On January 6 a joint meeting of the Geographical and Mathematical Associations will be held to discuss "The Teaching of Map Projections." This discussion will be opened by Prof. T. P. Nunn.

THE Journal of the British Science Guild for November contains several reports and memoranda on the organisation of science and the improvement of facilities for education. In the "Memorandum on the Encouragement of Teaching and Research in Science in British Universities" attention is directed to the great variations in the salaries of professors in the faculty of science at different institutions. Liverpool and Manchester head the list with average salaries of 853*l.* and 888*l.* respectively, Southampton and Aberystwyth coming last with 325*l.* and 320*l.* Reference is particularly made to the inadequate arrangements as regards salaries and facilities for scientific education in the University and colleges of Wales, and it is suggested that such institutions should receive additional State support. Other suggestions include the elimination of temporary and associate professorships at State-aided universities, and the substitution of "Regius Professorships," appointment and dismissal resting with the Crown or with a body appointed by the Crown. Another important matter is the provision of an adequate scale of pensions. The "Report on Reforms necessary in National Education" covers wide ground, a series of concrete recommendations being made. Various steps are suggested to eliminate the gaps between elementary schools, secondary and technical schools, and the universities. It should be incumbent on employers to provide facilities for persons between the ages of fourteen and seventeen to attend continuation schools for six hours per week within the hours of employment, "leaving certificates" should be established at elementary and secondary schools, and scientific method and training should be more generally encouraged. Teachers at training colleges should be given a larger measure of freedom and responsibility. Here again salaries, superannuation schemes, and conditions of tenure require to be placed on a more satisfactory footing. In elementary schools the physical development of the children and the encouragement of manual and other work developing initiative should be given especial attention.

THE Proceedings of the Institute of Chemistry, part iv. (November, 1916), contains the proposed new regulations for the admission of fellows and associates, originally promulgated in the 1914–15 report, as amended in the light of conditions resulting from the war. For admission to the associateship a candidate may proceed under either Regulations A or B. The former comprise (1) an approved preliminary examination of matriculation standard; (2) (*a*) four years' day training at a recognised university or college, or (*b*) three years' such training and two years under a fellow of the institute, or (*c*) a degree in chemistry and physics taken at a recognised university, with, in the case of pass graduates, a subsequent year's training in chemistry at a recognised university or college, or two years' experience under a fellow; and (3) an examination in general, theoretical, and practical chemistry conducted by the institute, the candidate having in every case produced satisfactory evidence of training in physics and mathematics. Under Regulations B a candidate is to be admitted if he has a degree with first- or second-class honours in chemistry, or a degree or diploma recognised by the council as equivalent, obtained after a three years' day course, with three years' subsequent experience of a standard and character approved by the council, or such degree or diploma obtained after a four years' day course, with two years' subsequent experience. The regulation as to training in physics and mathematics is again applicable. The qualifications for the fellowship are to consist of three years' continuous occupation in the study and practical work of applied chemistry since admission as associate, and either the production of records of original research, or the devising of processes or inventions of sufficient merit in the opinion of the council, or the production of evidence of knowledge and ability equivalent to such conditions, or the passing of an examination in a special branch of chemistry.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Anthropological Institute, November 28.—Prof. A. Keith, president, in the chair.—Prof. G. Elliot **Smith**: The common objections to the reality of the migrations of early culture. After citing a series of instances which proved the reality of the cultural migrations, and exposing the lack of cogency in the arguments commonly brought forward in opposition to the admission of the only possible explanation of the facts, the fashionable speculation of the present generation of ethnologists was then examined, that, "in order to meet similar needs" and "in similar circumstances," two peoples "in a similar stage of culture" may independently develop essentially identical customs, arts, and beliefs. Attention was directed to the fact that such cultural identities frequently occur among peoples whose "needs," "circumstances," and "states of culture" are as dissimilar as it was possible for them to be. Moreover, of kindred peoples—even members of the same race—living side by side for many centuries, in similar circumstances and with identical needs, one of them may possess the whole of the complex outfit of the megalithic culture, whereas the other may be totally free from any trace of it. As W. J. Perry has shown, the coincidence of the presence of ancient mines or pearl-beds reveals the fact that the stone-using culture-complex was introduced by immigrants who came to exploit these sources of wealth.

Linnean Society, December 14.—Sir David Prain, president, in the chair.—Miss I. **McClatchie**: Observations on the root-system of *Impatiens Roylei,* Walp. The primary root-system of *Impatiens Roylei* consists of a somewhat short tap-root, a whorl of four robust lateral roots, and a number of accessory laterals. These soon become obsolete and are replaced by a large superficial root-system of adventitious origin derived from the lower half of the hypocotyl. In plants in which the first and subsequent nodes trail along the ground, additional roots are produced from these. Abortive roots commonly arise at the bases of lateral branches, and further development can be induced also in these by suitable manipulation. Various other factors, such as wounding, increasing the height of the soil, etc., also induce accessory root-formation. —Miss A. J. **Davey** and Miss M. **Gibson**: The distribution of monœcious plants, and the occurrence of hermaphrodite flowers in *Myrica Gale,* with observations on variations of sex. *M. Gale,* the common bog myrtle, is described as being typically diœcious, but mention has been made by several authors of the occasional occurrence of the monœcious condition. Observations during several successive years on a large area of Myrica in the peat moors of Somerset show that there is always a small proportion of monœcious plants, which present all gradations between the normal pistillate and staminate types. Further, it has been found that the sex of a plant may vary from year to year.

Optical Society, December 14.—Mr. F. J. Cheshire, president, in the chair.—L. C. **Martin**: The refractometry and identification of glass specimens, especially lenses. The determination of the refractive index generally requires at least one plane-polished surface in the specimen, but the method described could be used for lenticular, irregular, or unpolished pieces of glass. By immersing the specimen in a liquid of equal refractive index the system became optically homogeneous for light of a particular wave-length. The liquid, which may be a mixture of carbon disulphide and alcohol or a solution of mercuric potassium iodide, is contained in a prism cell on the table of a spectrometer, and is kept mechanically stirred. Spectra from the usual sources are observed by refraction through the prism, of which the sides are plane parallel glass. The introduction of the specimen diffuses the light, but any particular spectrum line may be focussed by adjustment of the strength of the liquid. The refractive index of the liquid and specimen is then found in the usual manner.—Dr. R. S. **Clay**: A workshop method of determining the refractive index of a block of glass of which only one face is polished. The method was shown to be based, as are the Abbe and Pulfrich refractometers, upon the determination of the critical angle when light passes from the medium of which the refractive index is to be found into one of which the index is known. The hemispherical ball of Abbe or the cube of the Pulfrich refractometer is replaced by an isosceles right-angle prism. This must, of course, have a higher refractive index than that of the substance it is required to measure. A simple telescope, composed of two spectacle lenses with a cross-wire at their common focal plane, is used to take the readings. A drop of liquid of high refractive index (*e.g.* quinoline or oil of cassia) is placed on the hypotenuse face of the prism, and this is placed upon the polished face of the glass of which the refractive index is required. Sodium light is caused to fall on one side of the block of glass, and the light emerging from one face of the prism is received by the telescope. The latter is turned until the critical angle is obtained, shown by one-half of the field of the telescope becoming black, and the dividing line of the field being on the cross-wire of the telescope. The observation is repeated for light falling on the opposite side of the glass block, and emerging from the other face of the prism. The angular distance between the two positions of the telescope determines the refractive index of the glass by a simple calculation, or the scale can be divided to give the refractive index directly.

Royal Meteorological Society, December 20.—Major H. G. Lyons, president, in the chair.—C. **Salter**: The measurement of rainfall duration. Save for an article by Mr. Baldwin Latham in 1880, practically no attention appeared to have been paid to this subject until 1903, when Dr. H. R. Mill commenced collecting records for the British Isles, the number of which has grown until, in "British Rainfall, 1915," as many as forty-eight records were published. An examination of these records revealed certain inconsistencies which were probably due to personal and instrumental causes. The differences appeared to be due principally to the varying degrees of sensitiveness of the recording instruments to very light rain, and the suggestion had been made that if rain of very low intensity were omitted from the records a closer approximation to homogeneity would be attained.—Prof. H. H. **Turner**: Discontinuities in meteorological phenomena: third note. In two previous papers it has been suggested that meteorological history is divided into definite chapters of average length $6\frac{1}{3}$ years, the separating dates being assigned according to a regular law. Further, that if these chapters are numbered consecutively those with even numbers differ in certain essential respects from those with odd numbers. The present paper gives the systematic analysis of fifty-five years' monthly rainfalls at twenty-eight European stations. The division into alternating chapters is clearly brought out, and it is apparently possible to assign the separating dates from this material within a month. This precision is made possible by the existence of a five-monthly periodicity, for which some evidence was given in a former communication, but which is clearly established by the mass of evidence here submitted. The division into chapters has been connected in a former paper with the movements of the earth's axis. In the present paper some earthquake statistics are put forward which appear to be favourable to this view.

MANCHESTER.

Literary and Philosophical Society, November 28.—Mr. T. A. Coward, vice-president, in the chair.—H. **Bolton**: The Mark Stirrup collection of fossil insects from Commentry, Central France. This collection of insects is now in the Manchester Museum, and was obtained by the late Mr. Mark Stirrup from his friend, Charles Brongniart, author of the classical memoir, "Recherches pour servir à l'histoire des Insectes Fossiles des Temps Primaires." It consists of nine specimens, of which five are blattoids, one is a fragmentary wing of *Goldenbergia* (*Microdictya*) *hamyi,* two belong to new genera and species, and one is indeterminable. All the insect remains occur in a compact and thin flaggy mudstone. The blattoid wings belong to five species, of which two are referable to the genus Necymylacris, and three to the genus Phylloblatta. Four of the species are new; the fifth is an example of *Phylloblatta brongniarti* of Handlirsch. Of the two new genera, one is considered to have close relationships with the family Perlidæ, whilst the second is regarded as an archaic type of the family Panorpidæ.—J. W. **Jackson**: Faceted pebbles from Pendleton, Lancashire.—Dr. F. E. **Bradley**: Presence of arsenic in baking-powder.—W. H. **Todd**: Behaviour of a blackbird.

DUBLIN.

Royal Dublin Society, November 28.—Prof. G. H. Carpenter in the chair.—Prof. W. **Brown**: The fatigue of nickel and iron wires when subjected to the influence of transverse alternating magnetic fields. The fatigue under these conditions is less than that due to longitudinal alternating magnetic fields by 8·5 per cent. for nickel and 25 per cent. for iron, and in both cases the time taken to attain the maximum value of fatigue with the transverse field was about double that with the longitudinal field.—Prof. E. A. **Letts**: The chemistry of foul mud deposits. The sulphides and carbonates usually present in foul mud deposits are those of iron, calcium, and, more rarely, magnesium and sodium. It has been stated, but also denied, that the action of hydrogen sulphide on carbonates, and the opposite, namely, that of carbon dioxide on sulphides, is a reversible reaction, *e.g.*:

$$FeS+\overbrace{2CO_2}^{\text{Excess}}+2H_2O \rightleftharpoons Fe(HCO_3)_2+\underbrace{H_2S}_{\text{Excess}}.$$

In the first part of their paper the authors prove that the actions are reversible. The second part of the paper deals with actual analyses of foul mud deposits before and after keeping.—E. J. **Sheehy**: Abnormality in arterial arches in a rabbit. The right subclavian artery is absent. A blood-vessel which originates from the aorta behind the left subclavian runs dorsal to the œsophagus and trachea, and appears on the right side, where it serves as a subclavian, *i.e.* it branches into the right vertebral artery and blood-vessels to the arm. The recurrent laryngeal nerve associated with the abnormal blood-vessel is quite normal, even though the vessel which it usually embraces is absent. Persistence of an unusual portion of the embryological blood system, namely, the right descending aorta, explains this exceptional condition, and the normal position of the recurrent nerve suggests that the nervous system was well developed previous to the obliteration of the embryonic arches.

PARIS.

Academy of Sciences, December 4.—M. Camille Jordan in the chair.—W. **Kilian** and J. **Révil**: Discontinuities of sedimentation and the levels of the breccias in the French Alps.—W. **Sierpinski**: The *rôle* of Zermelo's axiom in modern analysis.—G. **Julia**: The forms of Dirichlet and the loxodromic substitutions of the Picard group.—M. **Brillouin**: Fundamental solution in a heavy liquid with free surface.—M. **Baticle**: The calculation of thick arches submitted to uniform pressure.—B. **Globa-Mikhailenko**: A new figure of equilibrium of a fluid mass in rotation.—L. **Roy**: The problem of the wall and its application to the discharge of a condenser on its own dielectric.—L. **Gentil**: The "Trouée de Taza," northern Morocco. The Miocene deposits found at Taza confirm the view put forward in earlier papers, that there was communication between the Mediterranean and the Atlantic during the Neogene epoch, the narrowest point being at the gap of Taza.—J. **Boussac**: The existence, between Modane and the Col de Chavière, of a *fenêtre* showing the Trias under the Permian.—P. de **Sousa**: The earthquakes of the eighteenth century in the neighbourhood of the oval Lusitania-Spain-Morocco depression.—F. **Baco**: Variations of a sexual hybrid of the vine by grafting on one of its parents.—C. **Sauvageau**: A Laminaria new for the French coast, *Laminaria Lejolisii*.—J. **Georgévitch**: The various forms of *Ceratomyxa Herouardi*.—A. **Lumière** and E. **Astier**: Tetanus and frost-bite. Evidence that precautions against tetanus should be taken in cases of lesions caused by frost-bite.—A. **Arnoux**: The mechanical protection and preservation of eggs. The newly laid egg is wrapped up in layers of a material impregnated with a solution of sodium silicate, and air-dried for twelve hours. The preservative properties of the alkaline silicate are well known. The above method of applying it gives mechanical strength; the treated eggs can be allowed to roll down a flight of stairs without breaking.

BOOKS RECEIVED.

Fertilizers. By the late Dr. E. B. Voorhees. Revised edition by J. H. Voorhees. Pp. xv+365. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 6*s*. 6*d*. net.

The Fauna of British India, including Ceylon and Burma. Coleoptera, Rhynchophora, Curculionidæ. By Dr. G. R. K. Marshall. Pp. xv+367. (London: Taylor and Francis.) 15*s*.

A Memoir on British Resources of Sands suitable for Glass-making. By Dr. P. G. H. Boswell, with Chemical Analyses by Dr. H. T. Harwood. (London: Longmans and Co.) 1*s*. 6*d*.

The Principles of Electric Wave Telegraphy and Telephony. By Prof. J. A. Fleming. Third edition. Pp. xvi+911. (London: Longmans and Co.) 30*s*. net.

The "Wellcome" Photographic Exposure Record and Diary, 1917. Northern Hemisphere and Tropical Edition. Pp. 256. (London: Burroughs, Wellcome and Co.) 1*s*.

DIARY OF SOCIETIES.

TUESDAY, JANUARY 2.

RÖNTGEN SOCIETY, at 8.15.—A Spectroscopic Investigation of Some Sources of Ultra-violet Radiation in Relation to Treatment by Ultra-violet Rays: C. A. Schunk.

SATURDAY, JANUARY 6.

GEOLOGISTS' ASSOCIATION, at 3.—The Age of the Chief Intrusions of the Lake District: J. F. N. Green.—The Ibex-zone at Charmouth: W. D. Lang.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.

Advertisements and business letters to be addressed to the Publishers.

Editorial Communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.