THURSDAY, JULY 19, 1917.

ACROMEGALY AND THE EXTINCTION OF SPECIES.

Théorie de la Contre-évolution, ou Dégénérescence par l'Hérédité pathologique. Par le Dr. René Larger. Pp. xiv+405. (Paris: Félix Alcan, 1917.) Price 7 francs.

IN 1885, when Dr. Pierre Marie, who has just succeeded the late Prof. Déjerine in the chair of clinical neurology in the University of Paris, was the youthful director of the laboratory attached to La Salpêtrière, he was impressed by the similarity of the condition and symptoms presented by two women who had entered the great nerve hospital as patients. In both women a disastrous change had been wrought in their physical appearance and well-being; in the course of a year or two their faces had become big and ugly, so that even their relatives and friends failed to recognise them; their hands and feet grew in size and changed in shape, although the normal period for growth was long past. Dr. Marie perceived that the morbid state presented by these two women was identical, and that it was a diseased condition which, up to that time, had passed unrecognised. He published an account of his two patients,[1] giving the name "acromegaly" to the condition, because of the enlargement of the extreme parts of the body—the hands, feet, and face.

The original description was no sooner published than cases began to be reported by clinicians from every part of the world. Hundreds of cases are now on record. Very soon it was recognised that nearly all giants, besides suffering from a generalised overgrowth, were also the subjects of this peculiar, or acromegalic, kind of growth. As a result of thirty-two years of observation and experiment it may be regarded as now certain that gigantism, acromegaly, and a number of other conditions are directly related to a disordered state of the pituitary gland—an organ so minute that it forms only $\frac{1}{150000}$ part of an adult human body.

In his theory of "contre-évolution" Dr. René Larger has developed the idea that gigantism and acromegaly may attack not an individual here and there as amongst mankind, but may break out in a whole species or genus, so that all the individuals become affected, at first with a moderate degree of acromegaly, but finally with an unrestrained pitch of gigantism, in which condition the whole race or family finally perishes. He is of opinion that his theory explains many facts which now seem obscure to those who are studying living and extinct forms of animal life. He selects his examples from the great dinosaurians, the living and extinct great birds, and whales, elephants, and anthropoids, as mammalian representatives.

Although we are willing to admit that Dr. Larger is the first to apply in a systematic manner certain medical concepts to problems concerning the evolution and extinction of animal forms, and that he has rendered a service to biologists in doing so, we do not think that either his confrères in France or his colleagues abroad will agree that he has done justice to the present state of our knowledge regarding the growth of the human body. Dr. Larger regards the enlarged or disordered state of the pituitary gland, which is invariably found in the subjects of gigantism and of acromegaly, as merely one of many manifestations of the disease, whereas the prevailing and best-founded opinion is that a direct and causal connection exists between the disorder of the pituitary gland and the disturbance of growth. The pituitary is, however, only one element in a series of growth-controlling glands. In the mechanism of growth and of adaptation of the body to its surroundings the genital glands, the adrenal gland, the thyroid, the pancreatic, and the pituitary glands, and many minor bodies, take a part; between them they determine the shape given to the body, and the form given apparently depends on the dominance of one or more of the members of this growth-controlling endocrine mechanism.

When in his Croonian lectures of 1905 Prof. Starling gave the name of "hormones" to the "chemical messengers" sent out by one organ of the body to control the action or growth of any other organ or part of the body, he and Prof. Bayliss had a very clear appreciation of the important part hormones were to play in all biological investigation and speculation. They realised that they were dealing with the most primitive mechanism for co-ordinating the functions and systems of a composite animal body—one which must have ante-dated the appearance of a nerve-system, and could serve to link the tissues of the body to the germ plasm of the unborn seed. We cannot say that zoologists have shown any undue haste in applying and testing the theory of hormones.

In 1908 Mr. J. T. Cunningham (Proc. Zool. Soc., p. 434) applied the theory of hormones to explain inheritance; in his presidential address to the Section of Zoology of the British Association at Sheffield in 1910 Prof. C. C. Bourne clearly recognised the *rôle* of hormones in the evolution of new forms; in recent writings by Prof. A. Dendy and by Prof. E. W. MacBride it can be seen that they, too, have grasped the importance of hormones to zoologists. It is this wider concept of hormones that we should prefer to see applied to the problems which Dr. Larger has dealt with in his theory of "contre-évolution," but, even if we cannot get the whole loaf, we must be thankful to him for a piece of real bread.

A. KEITH.

[1] *Revue de Médecine* (1886), vol. vi., p. 297.

ELECTROTECHNICAL BOOKS.

(1) *The Range of Electric Searchlight Projectors.* By Jean Rey. Translated by J. H. Johnson. Pp. xiv+152. (London: Constable and Co., Ltd., 1917.) Price 12s. 6d. net.

(2) *The Calculation and Measurement of Inductance and Capacity.* By W. H. Nottage. Pp. 137. (London: The Wireless Press, Ltd.) Price 2s. 6d.

(3) *Electric and Magnetic Measurements.* By

Charles Marquis Smith. Pp. xii+373. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1917.) Price 10*s.* 6*d.* net.

(4) *A Laboratory Course of Practical Electricity for Vocational Schools and Shop Classes.* By M. J. Archbold. Pp. ix+211+exp. 98. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1916.) Price 5*s.* net.

(5) *Electrical Measurements and Testing: Direct- and Alternating-Current.* By Chester L. Dawes. Unpaged. (New York: John Wiley and Sons, Inc.) Price 3*s.* net.

(6) *Electrical Laboratory Course for Junior Students.* By Prof. Magnus Maclean. Pp. 120. (London: Blackie and Son, Ltd., 1916.) Price 2*s.* net.

(1) SINCE the outbreak of the war there has been an urgent demand by our air, naval, and military forces for information relating to the range of searchlight projectors. We therefore welcome this translation of M. Jean Rey's work. It is an open secret that during the course of the war very great improvements have been made in the manufacture of the carbons for projector lamps, and that they give a flux of light for a given power consumption from three to five times as great as that obtained from the old carbons.

The first electric searchlight was made by Louis Sautter in 1867. In the early lamps the carbons were arranged so that their axes were inclined at an angle. The efficiency was high, but the regulation of the carbons was a difficult and delicate operation. They are now always arranged with the carbons horizontal. In the first chapter the author gives an account of the experiments he carried out in the laboratory of the Sautter-Harlé works in 1902. He proved that for small arcs taking from 10 to 50 amperes the efficiency—that is, the ratio of the luminous flux to the electric power—increases with the current, but above 50 amperes the efficiency diminishes as the current increases. For instance, with a current of 250 amperes the efficiency is 13 per cent. less than with a current of 50 amperes. He also proved experimentally that the diameter of the crater was proportional to the square root of the product of the diameter of the positive carbon and the current. In chap. ii. formulæ are given for the illumination obtained with a specified reflector. From these it appears that, neglecting absorption, the illumination at a given distance is proportional to the square of the focal length of the reflector, and is inversely proportional to the square of the diameter of the crater. The efficiency of electric searchlights is next considered, the losses due to the front glass, the shadow losses due to the lamp, and the losses due to the flashing shutters being taken into account.

Blondel's law for the range of a searchlight is fully explained, and values are given for the coefficient of atmospheric transparency. When the humidity of the air is great the coefficient is perceptibly reduced, and when the air contains particles of dust the coefficient is very appreciably diminished. In the last chapter the difficult problem of the influence of visual acuity on the range is discussed, and references are given to Blondel's work.

Numerous interesting phenomena are mentioned. For example, when convoys, pioneers making trenches, aviators, etc., are caught by the beam of a searchlight at a great distance they generally imagine that they must be visible to the enemy and so take cover. It is pointed out that in many cases the enemy would be quite unable to see them. The work will prove of great value to engineer officers. We have noticed one or two misprints in some of the mathematical equations, but the corrections are obvious.

(2) A knowledge of easy methods of measuring and of rapid methods of calculating with high accuracy the inductance of currents and the capacity of conductors is of great value in radiotelegraphy. On these subjects, therefore, a great deal of experimental ingenuity and mathematical labour have recently been expended. Mr. Nottage begins by giving formulæ for inductance and capacity, and he illustrates their use by numerous numerical examples. He then describes experimental methods of measuring these quantities, and finally gives brief descriptions of the appliances now used in making these measurements. Extensive use has been made of papers which have recently been read to the London Physical Society and to the Institution of Electrical Engineers.

As the author is writing for the benefit of physicists and engineers, the mathematical proofs of the formulæ, which are as a rule long and tedious, have been omitted. The publication of a formula without proof, however, has its drawbacks. The user of a formula obtained in this way is at the mercy of misprints. As the limitations of the formulæ also are not given in all cases, he may easily fall into error. In chap. ii., formula (11), p. 41, we notice that in the formula for the joint capacity of two spheres ·3863 has been printed instead of 1·3863. The limitations of the formula for the inductance of a rectangle are not stated. Rayleigh's formula for the inductance of a concentric main, which is perhaps the most important of them all, has been left out altogether.

On p. 47 a formula (18) is given for the average potential of a single straight wire. We are quite unable to make sense of the formula. It is stated to be only approximate, but then the "accurate expression" (19) is also given; and finally, we are told that for all practical purposes the difference between the two formulæ is negligible. Doubtless also to the same degree of accuracy the approximate formula for the capacity of a wire deduced from that of a prolate spheroid by making the equatorial axis very long will agree with either. Unfortunately, the exact solution is not known. We therefore have to pass over the next fourteen pages, as we cannot understand them. Heaviside has shown how to calculate the capacity and inductance of horizontal antennæ

("Electrical Papers," vol. i., p. 42 and p. 101, or Russell, "Alternating Currents," vol. i., p. 199).

The collection of methods of measuring inductance and capacity given in chaps. iii. and iv. will be found useful. The discussion in chap. vi. of Duddell, Campbell, and Drysdale vibration galvanometers is good so far as it goes, but the reader would be grateful for more information. The author seems to have written the book rather hurriedly. The wireless electrician and the physicist, however, will find it useful.

(3) Prof. Smith's book consists partly of lectures and partly of laboratory exercises on electric and magnetic measurements. The arrangement of the subject is good, and the lengthy definitions and explanations of units will be helpful to students. The definitions of self and mutual inductance are very properly given in terms of the linkages of flux and current, but the author has not made it quite clear what a linkage is. In order to explain what is meant by a linkage, it is necessary to show how the linkages of the magnetic flux inside the wire itself with fractional parts of the current can be calculated. As an elementary knowledge of the calculus is presupposed, this can easily be done.

The definitions of electrostatic capacity are not quite happy. No clear distinction is made between the capacity of a conductor and the capacity between two conductors. For example, the author says that a condenser is "a device by means of which the capacity of an isolated conductor can be very greatly increased" by the presence near it of another charged conductor. Unless, however, the conductors have equal and opposite charges, the equations given later do not apply. The book is clearly printed and the methods are up to date.

(4) These leaflets form a laboratory course for boys and apprentices in vocational schools and shop classes. Gaps are left in the printing of the leaflet where the boy has to write down what he has observed, and spaces are provided for a sketch of the apparatus used and for a graph of his results. Rough sketches are given in the appendix of the apparatus used, and these will be a great help to beginners. Numerous easy examples are given. The leaflets are excellently adapted for the class of student for whom they have been written. The Brown and Sharp Wire Table and the "circular mil" are much in evidence. The "circular mil" is a quaint unit, being the area of a circle 1 mil (0·001 of an inch) in diameter. We hope that it will soon become obsolete.

(5) Mr. Chester Dawes is instructor in electrical engineering at Harvard University. This "loose-leaf" laboratory manual is intended to be used in conjunction with Timbie's "Electrical Measurements" and Karapetoff's "Elementary Electrical Testing." The leaflets are thoroughly practical, and the arrangement of the experiments is excellent. After doing, for instance, the experiment on "conduit-wiring," the student would have acquired excellent ideas about the best methods of installing electric-light wires in conduits. He would also know how to make joints in cables and how to test their insulation resistance. Given an elaborate electrical laboratory, this manual is admirably adapted to train students to become really useful electricians in the minimum possible time. Some of the questions asked on the leaflets will give them plenty of food for thought.

(6) This book gives a well-arranged series of experiments suitable for a junior course in an electrical engineering laboratory. They are all thoroughly utilitarian and will be a great help to the student when he goes to an electrical works or a power station. Prof. Maclean asks the student to obtain the "efficiency" of an arc lamp in watts per mean hemispherical candle-power. He very properly puts the word "efficiency" between quotation marks. The efficiency is really the mean hemispherical candle-power per watt, and it is high time that this definition were adopted by engineers. We are doubtful whether the use of Rousseau's diagram to measure the mean hemispherical candle-power of arc lamps is justified, considering how uncertain some of the measurements are owing to the continual fluctuation in the intensity and the colour of the light. One of the simpler methods of approximating to the mean hemispherical candle-power would be more suitable.

A. RUSSELL.

OUR BOOKSHELF.

Lessons in Pharmaceutical Latin and Prescription Writing and Interpretation. By Hugh C. Muldoon. Pp. vii+173. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1916.) Price 6s. net.

FOR the past quarter of a century the Latin used by medical practitioners in writing their prescriptions has become more and more simple, and the use of the vernacular has correspondingly increased. Nevertheless, so many prescriptions are still written in that language that the pharmacist must be sufficiently well acquainted with it to interpret them correctly. The author assumes no knowledge of Latin on the part of the student and endeavours to teach him what is essential in the limited time at his disposal. To accomplish this, much of the conjugation of the verbs and of the declension of the nouns, and so on, has been omitted, and the student's attention concentrated on those parts which are of constant recurrence.

The work is divided into twenty-five chapters. From the commencement the exercises are based on such words and expressions as occur in prescriptions, passing from the simplest to the more complex. While it is not, and does not profess to be, a complete Latin grammar of pharmacy, it certainly embodies a rational method of teaching a student the Latin essential to his calling without burdening his memory with a host of conjugations and tenses with which he will never meet. The necessary rules are clearly and concisely stated. Though written for American students, it can equally well be used by British, and undoubtedly deserves to meet with success.

British Insects and How to Know Them. By Harold Bastin. Pp. ix+129. (London: Methuen and Co., Ltd., 1917.) Price 1s. 6d. net.

THE inquiry often made by beginners for a small book giving trustworthy, if elementary, information about the common insects of our countryside may be safely answered by a recommendation of this handy little volume. After a short introductory chapter on the general characters of the Insecta and some of the varieties in life-history to be observed among them, the author takes a survey of the orders in ascending series, describing the leading structural features, the transformations, and the habits of the principal families as illustrated by their commoner and more conspicuous genera and species. The book contains a relatively large amount of information on systematic entomology, but Mr. Bastin has so much of interest to tell about the mode of life of many of the creatures which he mentions that the effect is far from that of the dry, catalogue-like summary which might easily have been the result of an attempt to survey the whole class of insects in little more than a hundred pages. The book is illustrated with twelve photographic plates, on each of which five or six figures are printed with admirable definition and softness. The frenulum and retinaculum of a hawk-moth's wings on plate ix. may be mentioned as treated with special success.

G. H. C.

Fresh-water Wonders and How to Identify Them. By J. H. Crabtree. Pp. 64. (London: C. H. Kelly.) Price 1s. 3d. net.

THE author of this little volume is an enthusiast on pond-life, and he seeks to introduce others to what has been to himself a world of wonder and beauty. He deals with diatoms, desmids, confervæ, Volvox, water-weeds of many kinds, amœbæ, infusorians, Hydra, rotifers, Bryozoa, Annelids and some other worms, bivalves, water-snails, water-fleas, crayfish, insect-larvæ, and amphibians. There are thirty photographic illustrations, many of which will be useful to beginners in identification.

It is a simple, unambitious book, but the author's standard of accuracy should have been higher. The amœba does not "flit about"; the young "volvoces" do not occupy "the parent cell"; the bell-animalcule does not feed on smaller "hydrozoa"; nematodes are not Annelids, nor "segmented like the river-worm"; a Cercaria is neither an Annelid nor a Planarian, as is alleged; the fresh-water mussel does not feed ravenously on water-spiders; the antennæ of Daphnia are not fringed with cilia, nor are the swimmerets of the crayfish. Whatever one may say at the fish-monger's, it seems a pity in a book to call the crayfish a fish, especially after calling it a crustacean. And why should one compare a tadpole with a "fish without wings"? We are amazed at the easy-going way in which the author has tolerated numerous inaccuracies. It is not the way of science.

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.]*

Radiation-Pressure, Astrophysical Retardation, and Relativity.

THE conclusion was reached by the late Prof. Poynting (Phil. Trans., 1903) that the radiation from a material body in space gives rise to a small retarding force, which acts cumulatively as a brake on its movement through the æther; and the consequence was deduced, the significance of which has not yet been exhausted, that the sun's radiation, acting in concert with its gravitation, operates to keep the solar system swept clear of fine cosmical dust. The system may travel through nebulous clouds, but no such clouds can permanently belong to it.

A view seems to be prevalent that this conclusion contradicts electromagnetic theory, because for an isolated radiator like a star this force of retardation is specified as proportional to its velocity through the æther, and this is said to violate the principle of relativity (see, for example, the *Observatory*, July, 1917, p. 275, on "Radiation-Pressure and the Solar Rotation"). The evolution of mathematical theories is now carrying the modes of formulation of that principle far away from the simple considerations on which it originally reposed; but it can fairly be said that none of the original enunciations seek to apply the principle that all motions are relative to systems that are not self-contained. If a body is losing its energy by radiation, it must surely stand in relation to the bodies or to the medium to which it transfers that energy, even though it be a star remote from all other bodies. Any kind of relativity that supersedes this consideration would seem to stand in self-contradiction.

As a matter of fact, however, Prof. Poynting's principle has nothing to do with the refined second-order negative results which were the source of the very interesting modern development regarding relativity. His effect is proportional to the first power of the velocity of the system; it is thus a direct consequence of the original Maxwellian theory, now universally accepted; to traverse it would appear to knock over the whole fabric of modern mathematical physics. How to reconcile it with special views on relativity is another matter.

The argument on this point may be found set forth in Proc. International Mathematical Congress, Cambridge, 1912 (vol. i., p. 213, "On the Dynamics of Radiation"), or in the forthcoming collected edition of Prof. Poynting's papers. It appears from it that the effect of the solar radiation incident on a particle of dust, in orbital motion round the sun, is simply to reduce the factor of its gravitation, while the effect of its own radiation again of the radiant energy which has been absorbed by it from the sun is to retard in a frictional manner its motion through the æther. There can be no question in general of this retardation being exactly annulled or compensated by diminution of the inertia of the particle due to loss of its energy; in the present case the particle, in fact, absorbs just as much energy as it radiates. The principle and its cosmical results seem to stand firm on established laws, and *a priori* views as to relativity must adapt themselves to it. Any attempt in that direction will have to take account of the inertia of free travelling radiation.

JOSEPH LARMOR.

Cambridge, July 14.

Oceanic Tidal Friction.

IN equation (26) of a paper in the current number of the Proceedings of the Royal Society (93 A, pp. 348–59) Mr. R. O. Street has given an expression for the rate of dissipation of energy in the oceanic tides which is probably the best yet obtained; it is proportional to the square root of the viscosity and to the square of the surface velocity. In view, however, of the uncertainty of many of the data involved, which he carefully states, some further discussion of the subsequent numerical application seems desirable. At the end of the paper it is shown that a periodic surface velocity with a maximum of 2 ft. per second all over the ocean, with a viscosity of $1{\cdot}4\times10^{-5}$ ft.^{2}/sec., would account for a retardation of the earth's rotation of amount 4′ of arc per century per century. Now it is easy to find from equations (11) on p. 303 of Lamb's "Hydrodynamics" that the surface velocity in mid-ocean for a tide of height 2 ft. is only of order 0·04 ft. per second; on the other hand, the effective viscosity is very much increased on account of turbulence. The available data on this question are scanty, but the writer has shown elsewhere (*Monthly Notices of R.A.S.*, vol. lxxvi., 1916, p. 512) that the effective viscosity in the ocean is probably of order 4 cm.^{2}/sec. = $4{\cdot}4\times10^{-2}$ ft.^{2}/sec. Thus Street's retardation must be multiplied by $(0{\cdot}02)^2(300)^{\frac{1}{2}}$, giving 0·02′ per century per century, which is inappreciable. No great part of the observed lunar acceleration can therefore be attributed to tidal friction in mid-ocean. The dissipation in shallow regions near the coast may be greater, as the velocity is greater there, but in view of the limited area concerned the total is unlikely to be important. As the retardation of the earth's rotation that is required to account for the lunar acceleration is about 10′·4 per century per century (*ibid.*, vol. lxxvii.; 1917, p. 453), Street's result on the whole confirms those of the earlier investigators, who regarded oceanic tidal friction as very small in amount, and were disposed to refer all the dissipation, if any, to the bodily tides.

HAROLD JEFFREYS.

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Gravitation and Thermodynamics.

ATTENTION has been given in NATURE to various deductions from the results of Dr. P. E. Shaw's experiments on "The Newtonian Constant of Gravitation as affected by Temperature" (Phil. Trans., A, 544, 1916). So far as the present writer is aware, attention has not been directed to the suggestive remarks of the late Prof. G. F. Fitzgerald, to be found in his Helmholtz memorial lecture (Transactions Chemical Society, 1896, pp. 889–95). In the course of his reference to Helmholtz's contribution to the theory of vortex motion, Fitzgerald remarks:—"It is difficult to weigh hot bodies accurately, and, in consequence, there does not seem to be any conclusive proof that the weight of a body does not change with its temperature. If it does not do so by a measurable amount, the simple vortex ring theory of matter can hardly be true."

J. S. G. THOMAS.

709 Old Kent Road, S.E.15, July 4.

The First New Moon in the Year 1 B.C.

IN making some computations last March about the occurrence of new moon, an error of statement was discovered in the ninth edition of the "Encyclopædia Britannica" under "Calendar," vol. iv., p. 594, and repeated in the eleventh edition, vol. iv., p. 993; it is also given in Barlow and Bryan's "Mathematical Astronomy," p. 215. The erroneous statement is that new moon occurred on January 1 in 1 B.C. New moon in January, 1 B.C., occurred on January 25, 12h. 26m. Jerusalem Mean Civil Time.

Dominion Observatory, Ottawa. OTTO KLOTZ.

PHOTOGRAPHS OF AURORA.

ATTEMPTS to measure the height of aurora were made prior to the end of the eighteenth century, and have been repeated at intervals since that date. The most direct method is obviously to determine the parallax as given by synchronous observations at two stations a sufficient distance apart. In the case of the earlier attempts to apply this method, it was only by the merest accident that observations would have been taken simultaneously, and even in that event it was improbable that the same point would have been selected for observation. Thus it was impossible to feel any great confidence in the older results, though, as a matter of fact, some of them were probably not far wrong. After the invention of the telephone, it became possible for two observers a sufficient distance apart to make simultaneous observations with theodolites, but some uncertainty necessarily prevailed as to the identity of the points selected for observation. Observations made in this way at Godthaab, in Greenland, with a 5·8-kilometre base, discussed by Prof. Paulsen thirty years ago, gave for the lower edge of aurora heights varying from 0·6 to 67·8 km., the average being only some 20 km. At Godthaab, however, the parallax was too small to measure in some 20 per cent. of the cases.

Towards the end of last century several people succeeded occasionally in attempts to photograph aurora, and in 1909 Prof. Carl Störmer, of Christiania, devised a satisfactorily successful method of securing photographs with only a few seconds' exposure, and in 1910 he and his assistants secured a good many pairs of photographs from two stations 5 km. apart, near Bossekop, in the north of Norway.

In 1913 Prof. Störmer took a much larger number of photographs, employing a longer base, observations being made at Bossekop and Store Korsnes, 27½ km. apart. His photographs include known stars as well as the aurora. An auxiliary photograph of the face of a watch gives the exact time, and thus the position of the star. A series of corresponding points can usually be recognised in the two photographs, and the geographical position as well as the height of the aurora—whether an arc, a band, a curtain, or a ray—can be calculated. The accompanying figures are reproductions of two pairs of photographs obtained by Prof. Störmer and his assistant in 1913.

Prof. Störmer has recently discussed in *Terrestrial Magnetism* a number of the measurements made on the photographs which he took in 1913. The majority of his calculated heights refer to the lower edge of the aurora, partly, no doubt, because it is usually the best defined, and partly because it possesses especial interest in connection with the theory which he supports, viz. that aurora arises from electrical corpuscles discharged from the sun. On this theory, the lower the visible limit of aurora, the more penetrating the discharge. Out of about 2500 height measurements, based on the photographs taken in 1913, only twenty-one gave an altitude under 90 km., and only sixteen an altitude above 220 km., the highest being 323 km. Nearly 70 per cent. of the heights ranged between 96 and 120 km. Prof. Störmer claims that, as regards frequency of occurrence, the results show two distinct maxima, one between 101 and 103 km., the other between 105 and 108 km.

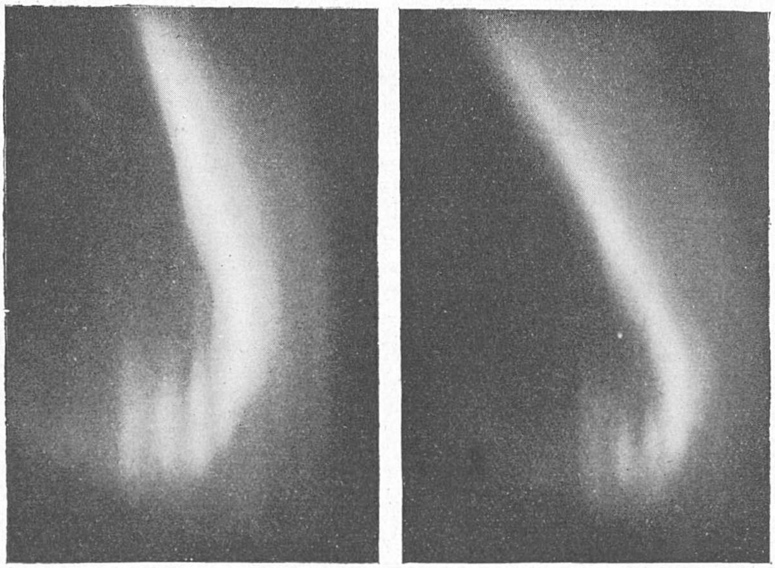


FIG. 1.—Aurora borealis, photographed simultaneously from Bossekop (right) and Store Korsnes (left) on March 11, 1913, 11h. 36m. G.M.T. Altitude of the lowest parts 93–99 km. The star is Deneb.

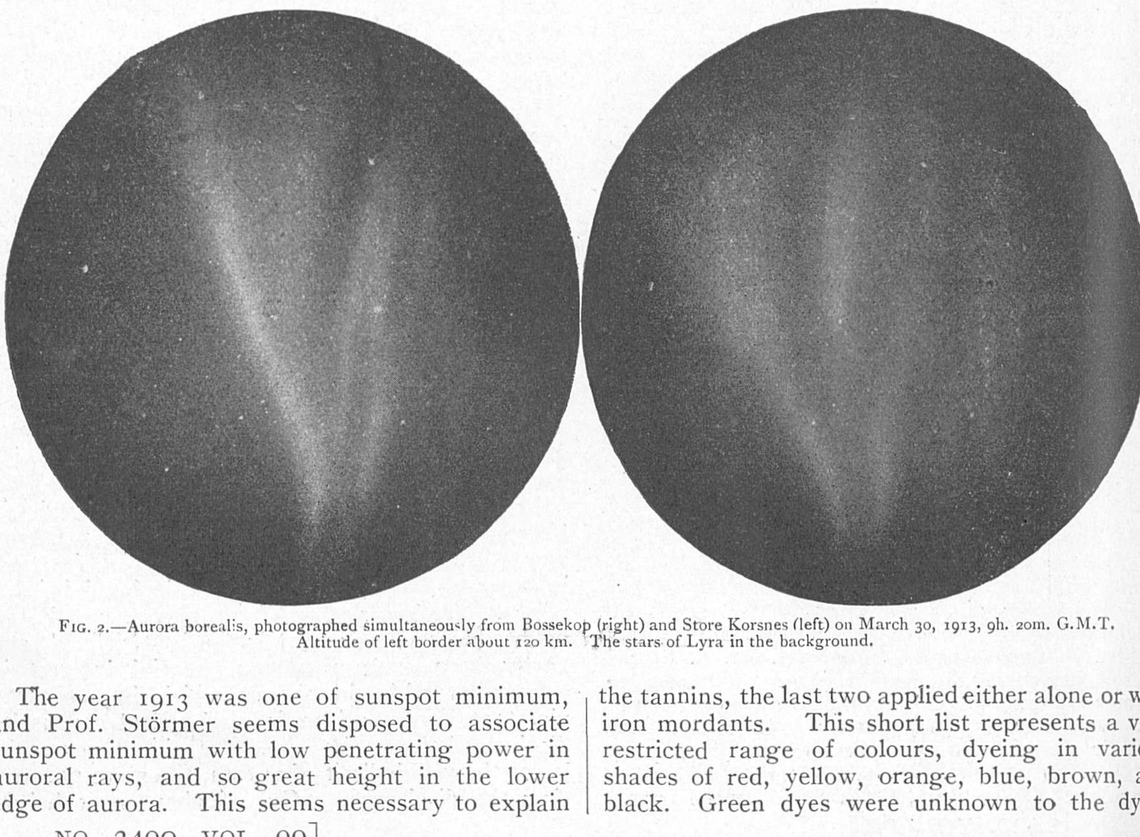


FIG. 2.—Aurora borealis, photographed simultaneously from Bossekop (right) and Store Korsnes (left) on March 30, 1913, 9h. 20m. G.M.T. Altitude of left border about 120 km. The stars of Lyra in the background.

The year 1913 was one of sunspot minimum, and Prof. Störmer seems disposed to associate sunspot minimum with low penetrating power in auroral rays, and so great height in the lower edge of aurora. This seems necessary to explain the fact that in 1910 he observed heights under 50 km. on several occasions. Moreover, unless this proves to be the case, or auroras attain much lower levels in Greenland than in Norway, we must suppose Prof. Paulsen's estimates to have been seriously at fault. The frequent association of aurora with magnetic disturbance gives an additional interest to Prof. Störmer's work. It is of obvious importance to have exact information as to the changes in progress in aurora during the large movements frequently shown on magnetograms during magnetic storms.

C. CHREE.

THE DYE PROBLEM AMONG THE ENTENTE POWERS.

THE synthetic dye problem as it presents itself to the French chemist was admirably stated by Prof. Auger in an address delivered on February 11 to the Société des Amis de l'Université de Paris. For more than forty centuries the art of the dyer was restricted by the narrow choice of available colouring matters. The ancients were acquainted with only ten dyeing principles, namely, Tyrian purple, madder, archil, weld, Persian berries, anatto, woad, indigo, catechu, and the tannins, the last two applied either alone or with iron mordants. This short list represents a very restricted range of colours, dyeing in various shades of red, yellow, orange, blue, brown, and black. Green dyes were unknown to the dyers of antiquity, who were forced to utilise mixtures of blue and yellow. The choice of medieval dyers was even narrower, for Tyrian purple became obsolete with the lapse of time, owing to the cost of production. But with the great geographical discoveries of the sixteenth century four new natural colouring matters were added to the list, namely, cochineal, logwood, quercitron, and fustic, and the use of indigo, which had fallen into abeyance, was revived.

The birth and development of modern chemistry added in the period 1790 to 1853 six more dyes and pigments: picric acid, chrome yellow, chrome green, Prussian blue, artificial ultramarine, and murexide. The period of intensive colour production began with Perkin's synthesis of mauve, since when many thousand dyes have been produced, of which about 3000 have at one time or another been utilised by dyers. The capture of this industry by German industrialists placed at the disposal of their military chiefs a new form of offensive, namely, war with poisons. The asphyxiating gases, chlorine and phosgene, and the lachrymatory liquid, benzyl bromide, were prepared in large quantities for the colour industry, and were ready to hand for a more nefarious use.

The tragic story of the red trousers adopted for the French Army constitutes one of the world-war's most cruel ironies. This colour was originally selected in order to encourage the cultivation of French madder, which colour principle was, however, entirely superseded by artificial alizarin in 1876. Nevertheless, the French War Office disbursed annually vast sums in the purchase of the latter dye from the Badische Anilin- & Soda-Fabrik, an astute German firm, which very obligingly established a special shade of alizarin red to suit the requirements of their French clients. With the outbreak of war the lives of thousands of France's incomparable soldiery were sacrificed to demonstrate that this excellent red, worn to support a dead industry, was an admirable target for the enemy.

This sombre episode is typical of the methods of peaceful penetration by means of which German industrialists endeavoured, only too successfully, for forty years before the war to acquire that chemical predominance which was to pave the way for military victory over their short-sighted rivals. The secret of this German success was to concentrate on essentials. Germany was alone at first in recognising what should be the correct relationship between theory and application, and between science and industry. Its Government assigned no limits to the endowment of universities and to the enrolment and encouragement of professors. The latter gained glory and profit from any of their discoveries receiving technical applications. German manufacturers prided themselves on possessing research laboratories rivalling, and often excelling, those of the universities. Sure of ultimate success, they no longer imposed on their research chemists the crippling task of obtaining immediately profitable results. Conscious that the field of inquiry is illimitable, they did not demand of their pioneers and prospectors payable discoveries to order. As the result of this far-sighted policy, carried into practice by patient and systematically co-ordinated workers, German industrialists ultimately were enabled to make discoveries which rendered them masters not only of the colour industry, but also of all other industries depending on chemical synthesis, such as the manufacture of pharmaceutical and photographic products and the production of artificial perfumes. In this way the large German firms acquired a systematically recorded mass of detailed practical experience which is far more valuable to them than their financial resources. It is true that the principles underlying the production of dyes and other fine chemicals may be gleaned from a perusal of patent specifications and other scientific publications; yet these disclosures are more apparent than real, for it is certain that very few, if any, of these processes, if carried out as described, could meet the competition which existed before the war. Large staffs of experienced technical chemists are required to put these syntheses into effective operation.

In the meantime, non-German chemical manufacturers and chemical users had fallen to a position of subordinance. The part played by the former was the collection of German intermediate products and the conversion of these substances into dyes, a comparatively simple and inexpert task compared with the highly skilled processes by which these intermediates were manufactured. The German manufacturers were very liberal towards their subordinates, and even encouraged the development of foreign factories of this type, realising that in these dependent enterprises they had very useful allies, which, by obscuring the ultimate origin of the dyes and other chemical products, neutralised national prejudice and flattered local patriotism by a spurious show of manufacturing activity.

One of these subservient French factories was at the outbreak of war devoted to the production of synthetic indigo from intermediates sent from Germany. This factory has since been requisitioned by the French Government, and with the aid of a committee formed to deal with chemical and pharmaceutical products is now organised to manufacture synthetic indigo for the new military uniforms.

It is satisfactory to note that a similar success has attended British efforts to cope with this important colour. The Rhenish firm of Meister, Lucius, & Brüning had installed at Ellesmere Port a factory in which only the last stage of their indigo synthesis was practised, in order that the firm might comply with the requirements of the English Patent Laws. Last year this factory was acquired by the Manchester firm of Messrs. Levinstein, Ltd., which at present is carrying out the indigo synthesis in all its stages on a larger scale than was the case when the works were still in German hands.

The steps taken in France to cope with the dye famine and other problems of chemical synthesis arising from the war are singularly comparable with those made in England. In both countries the Government has intervened to form State-aided companies, and British Dyes, Ltd., has its French analogue in the "Société Nationale des Matières Colorantes et Produits Chimiques." Meanwhile, private enterprise has played a very important part. The last surviving independent French dye factory at Saint-Denis has greatly increased its capital and organised its resources in order to deal intensively with dye production as soon as the claims of the explosives departments have abated. In Lancashire, Messrs. Levinstein, who have achieved noteworthy success as dye-makers, now form the nucleus of a group of co-ordinated firms working amicably in the production of dyes and other synthetic products. These firms, which include the Ellesmere Port indigo factory and Messrs. Claus, of Clayton, near Manchester, have working arrangements with other industrial undertakings not only in Great Britain, but also so far afield as Italy and America. This combination of the Lancashire colour firms and their associates is at present a most hopeful sign of renaissance for the chemical industries of the Entente Powers. G. T. MORGAN.

FRANCE AND NATIONAL SCIENTIFIC RESEARCH APPLIED TO INDUSTRY.

THE French Société d'Encouragement pour l'Industrie Nationale, always to the fore in matters of vital moment to industry, has recently been dealing with the question of scientific investigation as applied to manufacture. The "Economic Arts" Sub-Committee in particular is greatly interested in the co-ordination and co-operation of the various research and test laboratories in the country with the view of bringing science and industry into more direct contact after the war. In No. 1 (1917) of the society's Bulletin General Sebert has an article on the various establishments of the kind. Many of the Government departments in France have their own special laboratories, *e.g.* the various research laboratories of the French War Office and the Munitions Inventions Committee. A number of the scientific societies also have their own establishments, *e.g.* that founded by the Society of Electrical Engineers in 1886. Many tests are made there for different Government departments, and a number of important researches in electricity have been undertaken. Then there is the laboratory created by the French Photographic Society, which has done good work for the photographic profession and trade, and, more recently, for the kinematograph trade. By a decree passed in 1900 it was decided to widen the scope of the mechanical laboratory founded in 1854 by General Morin, the result being the foundation of the Laboratoire d'essais at the Conservatoire national des arts et métiers. To this institution many technical societies have made grants. It is divided into five sections, viz. physics, metals, materials of construction, mechanics, and chemistry. Here certain primary and secondary standards are kept. This laboratory has done good work in the carrying out of routine testing of all kinds, but its operations are evidently circumscribed through lack of funds. The laboratory had to close at the beginning of the war, though it has since been reopened at the instance of the Munitions Inventions Committee for the carrying out of experiments relating to war problems.

Useful as such establishments are, however, there is a strongly felt desire to establish in France a National Laboratory on the scale of our own National Physical Laboratory, the Bureau of Standards (U.S.A.), and the Reichsanstalt at Charlottenburg.

M. Armand Gautier, of the Institute, recently expressed at the Academy of Sciences his personal ideas regarding the creation of a central laboratory of the kind, and an epitome of his contribution is printed in the Bulletin of the Société d'Encouragement already referred to. He suggests the formation of a council consisting of manufacturers of the first rank, scholars who are specialists in particular branches of science, and a small number of Ministers of State or members of the National Council. This council would draw up a list of the questions to be dealt with and appoint the most eminent men to carry out the investigations. The council would also approach the manufacturers, etc., who would be most likely to benefit from the researches, and the latter would do the rest by the provision of annual grants for the execution of the work. The State would have no responsibility, direction, or supervisory powers, but would provide the funds necessary for the establishment and equipment of the institution. Each manufacturer would undertake to assist according to the extent of his business, but the share of each would be fixed as low as possible. M. Gautier thinks that there would be no difficulty in inducing manufacturers to lend their support, as it is they who would most directly profit from the results of the researches. E. S. HODGSON.

NOTES.

A CORRESPONDENT in Petrograd gives us a rather gloomy account of the difficulties of carrying on scientific work or publications under the present conditions in Russia. He says:—"It is, in fact, now almost impossible to print here scientific works having small circulations, as the prices demanded by the compositors, printers, papermakers, and other workers connected with the production of books are 200–300 per cent. higher than they were in February, immediately before the Revolution. The results are beginning to be felt already—factories are being closed and the number of unemployed getting larger every day. Scientific work and teaching are at present almost impossible, as many of the institutes and universities are 'requisitioned' by irresponsible revolutionary organisations and troops; thus the Polytechnic Institute has been occupied since March 5 by about 2500 soldiers, and as the sanitary arrangements were never intended for such a number of people, having no ideas of sanitation, living and sleeping in the lecture- and drawing-halls, the shameful state of the institute may be imagined. All efforts to eject these unwelcome guests and those of other organisations have proved abortive, as the 'Provisional Government' has no power to do it. Almost all courses of lectures are thus interrupted, and it is possible to conduct only some laboratory exercises and examinations. The students themselves take a large part in the different revolutionary organisations, and also make demands to have the direction and control of all the affairs of universities and institutes. The future of our seats of learning seems precarious indeed, as there are no visible signs of order succeeding the general anarchy, which, as of course you know from the daily papers, reigns everywhere supreme."

IT was suggested in NATURE of May 24 (p. 250) that the atmospheric conditions in this season of the year would probably favour observations on the transmission to this country of the sound of firing from the Western front. This anticipation has been realised, for on several occasions during the past six weeks the reports of continuous distant firing have been noticed in the London district. Dr. H. S. Allen, who previously recorded hearing the sounds from Chessington, informs us that sounds of bombardment were noticed by several observers at New Malden on June 3, 4, and 5. More recently he has heard the characteristic sounds on several occasions from Graffham Common, in West Sussex. The common lies between Petworth and Midhurst, on the north side of the South Downs. The reports are usually most distinct in the evening, and were heard very clearly on the still evenings of June 21 and 22. The German bombardment on the Nieuport front on July 10 accounts for the specially distinct reports heard from 5 p.m. on that date. The *Evening Standard* of July 11 states that between Horsham and West Grinstead the terrific gunfire in Flanders was heard more distinctly on the previous day than at any time during the war. The reports can be recognised readily by the frequency of their occurrence, the usual interval between successive reports being only a few seconds, and by the peculiar character of the concussion, which may be said to be felt rather than heard. According to a correspondent of the *Manchester Guardian* (July 12), persons on the higher ground to the north of London heard "the strange, heavy sound, that was like the muffled slamming of colossal doors." Further evidence with regard to the sound of the Messines mines is given in the first German account of the battle (quoted in the *Times* for July 14). The most marked feature of the explosion, according to an observer one kilometre from the northernmost mine, was the movement of the ground. The blow was accompanied "by a terrible crash, not so very loud, but so powerful and of such a kind as has never been heard after the explosion of the heaviest enemy shell or mine torpedo."

OWING to conditions resulting from the existing war, the International Exchange Service of the Smithsonian Institution, of Washington, is temporarily discontinued to almost all the countries of Europe and to India.

AT a meeting of the council of the Ray Society held on July 12, Dr. B. Daydon Jackson, vice-president, in the chair, the resignation as treasurer of Dr. DuCane Godman on account of ill-health was announced. The thanks of the council for his services during the past fourteen years were accorded to him, and Dr. S. F. Harmer was elected treasurer in his place.

DR. J. SCOTT KELTIE has retired from the editorship of the *Geographical Journal*, a position which he retained jointly with Mr. A. R. Hinks since his retirement from the secretaryship of the Royal Geographical Society two years ago. The *Journal* was founded in its present shape in 1893, a year after Dr. Keltie became assistant secretary and editor. On his retirement, after thirty-two years in the service of the society, Dr. Keltie has been elected a member of the council and awarded the society's Victoria medal for geographical research.

THE death is announced, at the age of seventy-eight, of Dr. J. M. Crafts. A graduate of the Lawrence Scientific School at Harvard, he studied chemistry afterwards at Freiberg, Heidelberg, and Paris. For many years he occupied a chair of chemistry in Cornell University, and from 1898 to 1900 he was president of the Massachusetts Institute of Technology. Since the latter date he had been engaged in chemical research in Boston. In 1885 Dr. Crafts was awarded the Jecker prize by the Paris Academy of Sciences, and was made a chevalier of the Legion of Honour. He had published researches upon organic silicium compounds, arsenic, ethers, studies in thermometry, catalytic reactions in concentrated solutions, etc.

PROF. E. G. HILL, principal of Muir College, University of Allahabad, died on June 28 at Naini Tal, India, at the age of forty-five. He was the son of the Rev. George Hill, D.D., of Nottingham, and was educated at Leeds, and later at Magdalen College, Oxford, whence he entered in 1895 the Indian Educational Service as professor of chemistry at Muir College. Shortly afterwards he became a fellow of Allahabad University, and the dean of the science faculty, and in 1913 was appointed principal of his college. He contributed a number of original papers on a variety of chemical subjects to the Transactions of the Chemical Society between the years 1903 and 1907. Among these may be mentioned:—Analysis of reh (natural alkaline salts); hydrolysis of ammonia salts by water; the coloured constituents of *Butea frondosa;* and a new colouring matter from *Nyclanthes arbor tristis*. He also acted as meteorologist to the United Provinces Government.

ORNITHOLOGISTS will learn with a mixture of regret and pride of the death of Mr. Eric B. Dunlop, who was killed in action on May 19. Born and bred in the Lake District—he was the eldest son of Mr. A. B. Dunlop, J.P., of Windermere—his innate love of birds found an exceptionally fine field for development, and he made the most of his opportunities, especially in regard to disappearing species, like the common buzzard, peregrine falcon, and raven. On the outbreak of war he was engaged upon a study of the nesting habits of birds in northern Manitoba, and coupled these investigations with a no less careful study of the fur-bearing mammals of Canada in regard to their seasonal changes and variation. In 1915 he decided to suspend his work and take his place in the fighting line, and accordingly enlisted in the 78th Canadian Grenadiers. But on his arrival in England he transferred to the Border Regiment, and was in France barely a month before he fell. We who are left have lost a comrade whom we could ill spare.

IT will be remembered that in NATURE for January 25 of this year Prof. Eugenio Rignano had a letter on a suggested "quadruple scientific Entente." The French original of this letter also appeared in the *Revue générale des Sciences* for January 30, and has given rise to a good deal of discussion. In the *Revue* for June 15 Prof. E. Gley fully agrees with Prof. Rignano about the malady of the German hegemony of scientific literature, but advances some criticisms on the proposed means of dealing with this evil. Prof. Gley's examples are naturally taken from the literature of that branch of science—physiology—with which he is most familiar; and he points out that the general tendency of nations is to make the publication of scientific work more and more national. The attempt, chiefly apparent, it seems—at least so far as physiology is concerned—in Germany, to publish the work of scientific men of other nations in their own languages is, according to him, a danger of monopoly hidden under the cloak of apparent internationalisation. Further, we must allow for a sextuple Entente, to include the United States and Japan; and it seems that this would increase the difficulty of making the projected journals suffice for their task. Ententist organisation is certainly desirable, especially for year-books of analysis of published work, but Prof. Gley brings forward certain difficulties in the matter, which are, however, it would seem, not insurmountable. An Ententist organisation of detailed "handbooks" of science, something like the best German books, seems to Prof. Gley much more possible. A second part of the article is devoted to the development of laboratories in Germany, which has played a great part in Germany's scientific hegemony, and to the lessons that France might learn in this respect. In the *Revue* for April 15 M. Ch. Marie suggested the path to be followed in the organisation of scientific records and other publications by the countries of the Entente.

THE *Archives of Radiology and Electrotherapy* for June (vol. xxii., No. 1) contains an article by Mr. H. C. Gage on simplified X-ray methods. The necessity in the present war of coping swiftly with a maximum of cases at a minimum of expense has led to the evolution of new ideas and the modification of old methods. The localisation of foreign bodies and the radiography of the limbs for fractures are dealt with at length. Attention is directed to the use of rapid bromide paper, with which it is possible to make good radiographs if an intensification screen be employed for the deeper parts. By its use economy is effected and weight for transport reduced.

THE *Indian Journal of Medical Research* for April (vol. iv., No. 4) contains a number of valuable papers dealing with a variety of subjects—bacteriological studies of cholera-like microbes, vitality of the tubercle bacillus outside the body, *rôle* of the blood in ovulation in mosquitoes, a substitute for "nutrose" (pea-nut flour, ninety-four parts; casein, five parts; sodium carbonate, one part), etc. Lieut. Mackenzie Wallis, R.A.M.C., describes a new test for chlorine in drinking water. This consists of an acid solution of benzidine or tolidine, which yield a yellow colour with so little as 0·005 part of chlorine per million of water, and do not react with chlorides. The same author has also investigated the ability of chloramine-T to sterilise water for drinking purposes. One drop of a saturated aqueous solution of chloramine-T (about a 15 per cent. solution) will sterilise two litres of water, containing an excess of organic matter, in thirty minutes. Water so treated has no unpleasant taste or smell, as is the case when bleaching powder and other hypochlorites are used.

MR. J. ARTHUR HUTTON gives an account of the investigations (which he has now carried on for many years) into the life-history of the salmon in the *Salmon and Trout Magazine* for April. The method of "scale-reading" is that mainly employed, and the results apply particularly to the River Wye, but there is also a general discussion of the Billingsgate Market statistics, and a strongly urged plea for the general improvement of the system of collecting salmon statistics throughout the United Kingdom.

THE Madras Fisheries Bulletin, No. 11, consists of a description of the edible molluscs found on the shores of the Presidency. Mr. Jas. Hornell, the writer, gives good accounts of the occurrence and natural history of each of the principal species, and adds a figure for each of the more important animals. Except in the case of the poorer classes of coast dwellers, shell-fish are either despised or neglected as articles of food in India—that is, in comparison with the littoral fishing industries of Britain, France, and Japan, for instance. But it also appears to be the case that the larger and more valuable edible molluscs of other parts of the world are either very small or absent on Indian shores, and the suggestion is made that the indigenous supplies should be supplemented by the introduction and cultivation of more valuable species. The report is written from this point of view.

A BRIEF but felicitous series of notes on the breeding habits of the merlin appears in *British Birds* for July by Mr. E. R. Paton. These cover the whole period, from the first appearance of the merlin on an Ayrshire moor to the disappearance of the young, three in number. The male seems to have taken no part in incubation until near the time of hatching. Both parents took part in feeding the young, but while the female kept to the moor, the male hunted largely for food in a neighbouring wood. Though the nest was in the middle of a grouse-drive, yet no young game-bird was ever killed by either of the parent birds. Incubation lasted thirty days, and did not commence until the full clutch of three eggs was laid. The young were apparently able to fly by the end of July—that is to say, when about one month old.

MR. W. H. T. TAMS, in the July issue of the *Entomologists' Magazine,* directs attention to the fact that while the noctuid moth, *Euplexia lucipara,* taken in the British Isles differs but little, in external appearance, from specimens taken in Canada, yet in the structure of the genitalia of the males the differences are of a very striking character. Being now on active service with the Canadian Army Corps, Mr. Tams remarks that he is, for the present, quite unable to carry his investigations further into this subject, and hence appeals to entomologists who may have opportunities for work of this description to make a careful study of specimens of this species drawn from widely different areas of its range, which is considerable, since it is found all over Europe and Asia, as well as in North America. Such an inquiry, he contends, would afford valuable data as to the relation between these structural differences in the genitalia and the geographical distribution of the individuals.

To the *American Naturalist* for April (vol. li., No. 604) Dr. P. Hadley contributes a valuable paper on the flagellate genus Trichomonas, usually a harmless parasite in the intestine of various animal hosts. Dr. Hadley states that these organisms multiply exceedingly in the intestines of diarrhœic turkeys, penetrate the epithelium, and, invading the tissues of the host, become intracellular parasites living in the manner of sporozoa and playing a pathogenic *rôle* associated with the disease known as "blackhead." The author does not state definitely if he considers that the protozoal parasites hitherto recognised as the cause of "blackhead," and regarded as *Eimeria avium,* are in reality stages in the life-history of Trichomonas. The questions raised are of much interest, and call for further elucidation.

THAT legislation enacted to secure the extermination of "vermin" in response to popular clamour is ever dangerous we have always held. Australia is now learning this to her sorrow. For thirty years compulsory poisoning laws have been in force, and the *Scientific Australian* for March, which has just reached us, now complains that, as a result of these laws, the carrion hawks, crows, and native carnivora have been well-nigh wiped out. As a consequence, decaying bodies are left to be demolished by blow-flies, which have now increased to such an appalling extent as to threaten the sheep on the runs with destruction, the animals becoming "fly-blown" and infested with the larvæ of this troublesome and dangerous insect. Similarly, the *Victorian Naturalist* for April relates that, for the last month or two, wheat buyers have been at their wits' end to protect the immense wheat stacks at country stations, especially in the Wimmera district, from mice, which have increased to an incredible extent. Most of the stacks have now been enclosed by sheets of galvanised iron, openings in which are left to correspond with kerosene tins, sunk in the ground, and partly filled with water. It is no uncommon occurrence to capture 10,000 mice in this way in a single night. At Minyip, recently, the catch for two nights weighed rather more than a ton. Australia would do well to follow the lead of Canada and the United States and appoint a Bureau of Economic Ornithology, which might also be charged with the task of inquiry into the status and usefulness, or otherwise, of such of the native carnivora as have escaped the unfortunate and ill-considered legislation which has brought about such disastrous results.

OF the many varieties of rice grown in India, some of the most interesting are the deep-water paddies grown in Orissa. Unlike other paddies, these deep-water forms, of which eight are known to be cultivated, can endure complete submergence for seven to ten days without sustaining any material damage. As the water rises the plants keep growing, maintaining their heads above water, and plants 10–15 ft. long have been measured, yielding at the same time a bumper harvest. The value of these paddies is that land which would otherwise be unutilised, since at crop seasons it is always under water, is found to be admirably suited to them, and a good return has been realised, owing to the introduction of these deep-water forms, from land which formerly was valueless. The account of the deep-water paddy of Orissa is given in the Journal of the Department of Agriculture, Bihar and Orissa, vol iv., p. 66, by Mr. E. L. Rout, Inspector of Agriculture, Cuttack.

THE *Times Trade Supplement* for July contains some interesting statistics as to the production of potash salts and products in the United States in 1916. The total production represented 8830 tons of potash, of which 5750 tons were obtained from mineral sources and 3080 tons from organic sources. Of the former, 3850 tons were obtained from natural salts or brines, and 1900 tons from alunite and silicate rocks, including recoveries from furnace-flue dusts. Of the potash from organic sources 1110 tons were obtained from kelp, 220 tons from pearl ash, and 1750 tons from miscellaneous industrial wastes. Canadian felspar, which has long been imported for use in pottery manufacture, is now imported by American manufacturers of fertilisers for use as potash manure. Portland cement works in Ontario are also producing potash as a by-product from the felspar used in making the cement. It is claimed that more than 80 per cent. of the potash of the felspar is recovered, and at a cost less than the freight charges paid on imported German potash before the war.

Two articles on the Near East in the July number of the *Geographical Journal* (vol. l., No. 1) are of special interest at the present time. The first, by Dr. E. W. G. Masterman, is on Palestine. Dr. Masterman, who knows Palestine well, and is secretary of the Palestine Exploration Fund, has no exaggerated views on the value of the country as a field for colonisation, and believes that the first needs of Palestine must be afforestation, irrigation, and the restoration of the terraces on the mountain-sides. Side by side with these efforts, he insists on an organised attack on the causes of the prevalent diseases—malaria, ophthalmia, dysentery, tuberculosis, and others. So far as present conditions go there is little room for increased population, and Dr. Masterman foresees no immediate opening for settlers on an extended scale after the war. The second paper is a long one, by Mr. H. C. Woods, on the Bagdad Railway and its tributaries. This paper deals also with the other railway lines and projects in Asia Minor, and with those in Syria so far as they act as feeders to the Bagdad line.

IN the Proceedings of the Cotteswold Naturalists' Field Club for 1916, p. 129, Mr. C. T. Gardiner gives a detailed study of the Silurian inlier on the east of the South Welsh coalfield between Usk and Pontypool. Dr. F. R. Cowper Reed describes and figures some new species from the area. The Wenlock Shales, it is urged, have a greater extension than appears on the Geological Survey map, while the Ludlow area is correspondingly reduced. A newly discovered outlier of Old Red Sandstone is indicated.

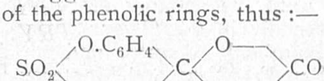
THE seventeenth report of the committee of the British Association on Photographs of Geological Interest appeared in 1910, and is now supplemented by the eighteenth report (1916), drawn up under the care of Prof. W. W. Watts and Prof. S. H. Reynolds. A large part of the interval has been unsuited for photographic work, especially along our coast-line, but valuable additions have been made from special localities, such as the series by Prof. Reynolds from the Carboniferous section in Burrington Combe, Somerset, following on his great Avon gorge series, and Mr. Godfrey Bingley's extensive studies of the Magnesian Limestone of Sunderland. Geologists desiring prints or lantern-slides from the negatives named in the lists now published are asked to communicate with the individual photographers, whose names and addresses are conveniently given.

THE study of earthquakes in California is in the hands of the Weather Bureau in that State, assisted by observers at twelve first-class stations and by 314 "climatological observers." The results for the year 1916 are contained in an interesting paper by Mr. A. H. Palmer, contributed to the Seismological Society of America (Bulletin, vol. vii., 1917, pp. 1–17). The total number of earthquakes recorded during the year is sixty-six, which exceeds the number felt throughout the rest of the United States. None of them attained a destructive intensity, and two-thirds were so slight that they were felt at one station only. They occurred more frequently near the coast than in the interior, the region of greatest frequency being that about Monterey Bay. At San Francisco there was only one very slight shock. A peculiar feature of these earthquakes is the comparative absence of the earthquake-sound, which is mentioned in only one-fifth of the records. The earthquakes are attributed generally to movements along the well-known faults which traverse the State in a south-easterly direction, but the evidence is too scanty to enable the author to assign an earthquake to any particular fault. The State of California is one of the most interesting seismic regions, and it is to be hoped that the Weather Bureau will not remain content until the network of stations is greatly expanded, especially in the Owens Valley, the Imperial Valley, Humboldt County, and in the districts surrounding San Francisco and Monterey Bay.

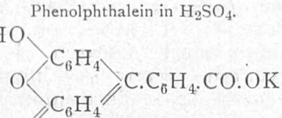
Science for June 1 contains an interesting address by Prof. G. A. Miller on the function of mathematics in scientific research. It is rather discursive, but contains many striking epigrams; for instance, "I would be inclined to say that *modesty* is the attitude of mind which has contributed most powerfully to mathematical progress"; "Unless we become like children in faith and fancy, we should not expect to add much that is fundamentally new to the kingdom of mathematics"; "Science is not primarily a grazing country; large tracts are suitable for agriculture and mining," and so on. One very remarkable discovery is referred to, namely, that the Maya people of Central America had a positional system of notation with various *different* signs for zero. While recognising the value of scientific organisation and the promotion of research, Prof. Miller gives the timely warning that "the greatest danger of research to-day is that its popularity tends to research hypocrisy." We may perhaps add to this that a good training in mathematics is one of the best preventives of hypocrisy and intellectual dishonesty of every kind. Finally, we may note that, in the speaker's opinion, mathematics is so far abreast of the time as to be ready to discuss the problems arising from our new views about the constitution of the physical world. This is good hearing, because Prof. Miller knows as well as any man alive the difference between analysis which deals with continuous variables and that which is concerned with discrete sets of elements.

A LECTURE on "Chemistry in Industry" was delivered at the Royal College of Science for Ireland, Dublin, on Tuesday, July 10, by Prof. Gilbert T. Morgan, who is now conducting a summer course in "Wool Dyes and Dyeing" under the auspices of the Department of Agriculture and Technical Instruction for Ireland. The relation between chemistry and the food-producing industries shows how essential it is to follow up every clue discovered in the laboratory in the hope that ultimately the discovery may prove to be of practical value. Chemistry is also intimately concerned in the production of cement, glass, and ceramic ware. Its services in the production of munitions of war are even more obvious. A remarkable characteristic of chemical industries is the tendency for the enterprises to become merged together, so that the waste products of one section become the raw material of another manufacture. It is only by encouraging this association of related industries that chemical manufacture can be conducted efficiently. Manufacturers of high explosives utilise their plant in the production of fine chemicals. Dye-producers drift into the manufacture of synthetic drugs and photographic chemicals.

DR. JAMES MOIR, in a paper read before the Royal Society of South Africa on "Colour and Chemical Constitution," describes the colour changes produced by substitution in some fifty derivatives of phenolphthalein and fluorescein. The most striking novelty in the paper is the discovery that when these substances are dissolved in concentrated sulphuric acid they give a coloration which is five times as intense as in alkali, and is produced by a band of lower wavelength, the frequency being half as fast again in sulphuric acid after allowing for a constant load due to combination of sulphuric acid with the oxygen of the dye. As, however, fluorescein in alkali and phenolphthalein in sulphuric acid give identical absorption bands, it is suggested that there is in each case a linking up of the phenolic rings, thus :—



Phenolphthalein in H_2SO_4.



Fluorescein in potash.

THE Journal of the Society of Engineers for May contains an account, by Lord Headley, of the goods clearing house system and machinery. It is now some eight or nine years since Mr. Gattie and Mr. Seamen introduced to public notice the extremely ingenious system of electro-magnetic machinery for dealing with heavy goods, and practical demonstrations have been given with full-sized machinery at the works of the New Transport Co., at Battersea. It is estimated that 97 per cent. of the life of railway wagons is spent standing still in sidings or shunting yards, and that 0.5 per cent. only is spent in running loaded. It is claimed that the goods clearing system would enable 80 per cent. of these wagons to be dispensed with. Official estimates of the surplus profits of the proposed London goods clearing house on its first year of working give a profit of 9,295,948*l.* on a capital outlay of 14,000,000*l.* It would appear that there are serious abuses due to railway mismanagement, and it is claimed that the new system would abate or do away with these. In brief, the system proposed is to collect all goods by motor lorries and to deliver them at one building instead of at many scattered stations. On arrival, the body of the lorry containing the goods is hoisted off by electric cranes, another body is dropped into place, and the lorry sets off immediately on another journey. The goods are sorted inside the house, according to their destination, by means of machinery, consisting of endless chains of trucks electrically controlled in such a way that goods may be picked up or deposited in any portion of the house. The control is effected from a central switch-board, and when the proper key is depressed the goods on the truck controlled are moved along and transferred to other trucks leading to other bays on the same floor, or up escalators to other floors. The goods are carried on trays, and the trucks are fitted with roller magnets which automatically transfer the trays at the proper instant. There is little doubt that such a system would go far to relieve the congestion in many London streets, and would dispense with a large amount—if not all—of the shunting operations at railway goods stations.

IT is announced that the "Dictionary of National Biography" has been presented to the University of Oxford by the family of the late Mr. George M. Smith, and will in future be published by the Oxford University Press.

OUR ASTRONOMICAL COLUMN.

THE RELATIVITY THEORY AND THE MOTION OF MERCURY'S PERIHELION.—The circumstance that especially attracted the attention of mathematicians to Einstein's new theory of relativity was the fact that it accounted for the whole excess of motion ($43''$ per century) of the perihelion of Mercury over that indicated by planetary theory. Dr. L. Silberstein, in a paper entitled "The Motion of the Perihelion of Mercury deduced from the Classical Theory of Relativity" (*Monthly Notices*, R.A.S., April, 1917), points out that it is not necessary for a relativity theory to explain the whole excess of Mercury's perihelion; part of it can reasonably be ascribed to the stratum of matter composing the zodiacal light. He himself prefers the older, simpler relativity theory, which he asserts to be unobjectionable in its foundations, and to accord well with observation in the field of physics. He notes that it would not indicate the bending of a ray of light in a gravitational field, as Einstein's does. It is hoped that this critical experiment may be made at the total solar eclipse of May, 1919.

In the classical relativity theory, as in Newtonian mechanics, the rate of increase of momentum mv is equal to the force N. But the inertia coefficient m is not a constant, but a function of velocity, "precisely as the familiar transversal mass of an electron."

He proceeds to investigate a formula that will account for the whole of Mercury's excess. Putting β=velocity of planet/velocity of light, and $\gamma=(1-\beta^2)^{-\frac{1}{2}}$, *i.e.* $1+\frac{1}{2}\beta^2$, then if M_0, m_0 be rest-masses of sun and planet, $m=m_0\gamma$. Assuming for the law of force $M_0 m_0 \gamma^{n-1}/r^2$, or its equivalent, $M_0 m \gamma^{n-2}/r^2$, where n is an arbitrary constant, he shows that the value 6 for n gives the centennial excess 43″ for Mercury and 8·6″ for Venus. "Why n is just 6 I do not know. But as little do we know why the exponent of r is -2."

ANOMALOUS DISPERSION.—By the use of the electric furnace Dr. A. S. King has found it possible to investigate the anomalous dispersion of the more refractory elements, under conditions which can be kept well controlled (*Astrophysical Journal*, vol. xlv., p. 254). The amount of anomalous dispersion shown by a line is proportional to its intensity in absorption, provided the vapour absorbing the line in question has the requisite non-uniform distribution equivalent to a prism. Lines which show a strong anomalous dispersion at a low temperature frequently show refraction in the opposite direction when the temperature is raised, thus indicating that the vapour prism absorbing such lines has been inverted. When two elements with different melting points are mixed, the direct and inverted effects may occur simultaneously, and a similar result has been found in the case of a single element for lines which require different temperatures for their production. Thus the blue line of calcium, λ 4227, may show the inverted effect, while at the same time the H and K lines show anomalous dispersion of the regular type. Each element thus has the capacity to give its own anomalous dispersion independently of other vapours which may be present, and a similar relation holds for particles of the same element emitting lines of different character. No evidence was found for mutual repulsion of close lines, one of which is in a condition to show large anomalous dispersion, and it would appear that the theoretical effect is too small to be detected by laboratory methods now available.

THE VARIABLE STAR *u* HERCULIS.—The conclusion that *u* Herculis is a variable of the β Lyræ type has been verified by W. Dziewulski, from observations made with a 4-in. comet-seeker at the Cracow Observatory (*Astronomische Nachrichten*, No. 4887). The observations indicate no correction to Hertzsprung's period of 2·051027 days. At principal and secondary minima the magnitudes are 5·51 and 5·17 respectively, while at the two maxima the magnitude is 5·01. The light-curve is slightly unsymmetrical.

THE FUTURE OF THE DISABLED.

THE problem of the disabled sailor and soldier is one of great magnitude. Fortunately, it is only a small minority of the sick and wounded that is doomed to total disablement and to become the helpless subjects of their neighbours' loving care for the rest of their lives. For the majority hope and anticipation remain in varying degree—hope of restoration, more or less complete, of the maimed body, and anticipation of a life of some amount of independence and usefulness in the future. The latter is to be sought in a course of adequate treatment and training which is now receiving careful attention.

The disabled are frequently under the mistaken apprehension that if they again become industrially efficient the pensions awarded to them as disabled men will be taken away or diminished. This idea is quite devoid of foundation; the pension, once awarded, can never be withdrawn or reduced.

Those who wish to help the disabled man can often best aid him by enabling him to obtain a clear idea of the various openings that lie before him. The organisation now in being for training the disabled man, for opening to him a satisfactory place in life, and incidentally for carrying his cure a stage further, is not yet complete, but for some time past it has been far more effective than is commonly known, and it is steadily growing.

In a new periodical entitled *Recalled to Life*,[1] the first number of which was issued in June, the problem of the disabled is, and will be, considered in all its aspects.

Among the contents there is a memorandum prepared by Sir Alfred Keogh, Director-General, Army Medical Service, on the treatment of the disabled. Col. Sir Robert Jones discusses orthopædic surgery in its relation to war. With regard to treatment, it is important to note that when surgery, massage, exercises, electrical treatment, and other curative measures have carried the cure so far as it will go, manual training will frequently carry it a stage further, and when the patient finds that he is really capable of doing some useful and remunerative work he acquires a new zest for life.

The after-care of the blind is provided for at St. Dunstan's under the guidance of Sir Arthur Pearson. In the education of the blind two cardinal factors have to be appreciated. First of all, those who have lost their sight must be *taught* to be blind, and, having realised their state, they must be re-educated and trained. The principal occupations and industries taught at St. Dunstan's are the reading of Braille, typewriting, cobbling, mat-making, basket-making, and joinery. The men acquire these industries in a quarter the time that is generally supposed to be necessary to teach a blinded man a trade. The explanation of this speedy training is to be sought, first, in the employment of blind teachers, and, secondly, in the adoption of short working hours (9.30 to 12 and 2.30 to 4.30). The whole outlook of a man becomes different when he finds himself in the hands of a teacher who labours under the same disability as himself. Working under the handicap of blindness imposes a mental strain very much greater than might be imagined, and the shortness of the working day, paradoxical as at first it may seem, is one of the principal reasons for the remarkable speed with which handicrafts are acquired at St. Dunstan's. The subject of pensions is dealt with very fully in another article by Capt. Basil Williams, and other important papers and reports appear in this journal, which is illustrated by many plates showing disabled men practising the handicrafts they have learnt. Finally, a tabulated list is given of training classes for the disabled.

We commend *Recalled to Life* to the serious attention of all those who are aiding in the great work of succouring the disabled and of helping them to become again useful members of the State.

REFRACTORIES USED IN THE IRON AND STEEL INDUSTRY.

ALTHOUGH the Faraday Society held a general discussion on refractories so recently as November last, prominence was given to this matter in so far as it affects the requirements of the iron and steel industry at the May meeting of the Iron and Steel Institute. The subject was very ably introduced by Mr. Cosmo

[1] Editor: Lord Charnwood. Assistant Editor: Everard Cotes. (London John Bale, Sons, and Danielsson, Ltd.) Price 2*s*. net.

Johns, the furnace manager of Vickers, Ltd., and took the form of a compact statement of the properties of the refractories in general use and the urgent need for systematic research work along certain lines.

In any given metallurgical process the ideal refractory must be infusible and non-volatile; its volume must not vary during the temperature fluctuations that occur; it must be chemically inert; it must have sufficient structural strength and be a non-conductor of heat. No such substance is known. Whether any such material can be prepared only the future will show. Up to the present the refractories actually used are simply the best approximations to the above ideal, which have been reached almost entirely by experience gained by empirical trials spread over a century or more. As Mr. Johns observes:—"The methods employed to-day represent the survival of the fittest by the searching test of commercial success, but it by no means follows that they represent the best obtainable"; and, further:—"The art has been so long in front of the science of the refractory industry that the most urgent need at the present is for an expression in terms of scientific precision of the most successful practice in manufacturing the refractory product and of the physico-chemical changes which take place when they are used."

As regards the materials available, leaving aside carbon and its compounds with silicon, which have only a limited application, they are chiefly the oxides, silica, alumina, lime, magnesia, and chromium oxide, or compounds of these with oxides of iron, sodium and potassium, and traces of other substances, regarded as impurities, some of which may act as catalysts. The raw materials for coke-oven bricks, blast-furnace bricks, and casting ladle nozzles are the fireclays, most of which were obtained from home sources before the war. Again, quartzite, the raw material of silica bricks, used in acid open-hearth furnace construction, is entirely derived from home supplies. On the other hand, magnesite, the raw material of basic refractories used in basic open-hearth and electric furnace construction, is nearly all imported, either in the raw or calcined state. Chromite, the raw material of bricks used where a neutral refractory is required, which will not have a reducing action such as the carbon refractories exert, has also to be obtained from abroad. The materials available are therefore strictly limited, and they never occur in a state of purity in Nature. Their manufacture into finished refractories involves a succession of processes which vary according to the purpose for which they are intended, and the final product is always a mineral aggregate, often of great complexity. In consequence of this the refractory does not possess a melting point, but rather a softening range spread over a considerable temperature interval, which results finally in the material failing to perform its functions. It is essential that any refractory should be "burnt" at a temperature somewhat higher than it will be called upon to endure in practice; otherwise serious difficulties arising from volume changes, especially shrinkages, will be encountered.

Texture and porosity determine very largely the suitability or otherwise of refractories for particular purposes. The relative size of the grains, and the extent of the surface exposed by the more resistant constituents to the others used as a bond or matrix, are most important factors in contributing to the ability of the material to perform useful service. Another point of importance is the influence of mass in promoting or retarding inversions. Some inversions occur almost instantaneously once the critical temperature has been reached, but with others marked hysteresis occurs. Porosity must always occur when the refractory is composed of more than one constituent, and where their chief volume changes are dissimilar, or occur at different temperatures. Little is known of the effect of porosity on properties, but it is obvious that it permits the deposition of extraneous material in the interior of the bricks and renders them permeable to gases.

Both tenacity and compressive strength are important properties of refractories at high temperatures. Abrasion is caused by the movement of solid substances while in contact with their heated surfaces; erosion is due to the passage of dust-laden gases at high velocities. Almost nothing is known as to the conditions which may be expected to retard abrasion and erosion, and in what way they are related to the mechanical properties of the materials. There is accordingly urgent need for the accurate determination of tenacity and compressive strength, over wide ranges of temperature, of the chief refractories under both oxidising and reducing conditions. Not less important is the property of resistance to corrosion caused either by slags or gases. The effects of acid slags on basic refractories, and of basic slags on acid refractories, are well known. Less familiar, except to experts, are the instances of gas corrosion of the silica bricks in the gas ports and uptakes of open-hearth furnaces due to the alternating passage of oxidising and reducing gases with the resulting formation of fusible silicates.

It is satisfactory to be able to record that the Geological Survey is preparing a memoir of the mineral resources of this country, and is dealing specially with refractories. Mr. Johns points out that the concentration and purification of these, their proximate and ultimate analysis, their mineralogical description, and their thermal analysis are all matters requiring scientific investigation. Pioneer work has already been carried out under Dr. Mellor at the Pottery Laboratory, Stoke-on-Trent. Researches are also in contemplation, or have been initiated, at various universities and technical institutions in the country.

H. C. H. C.

THE COMPLEXITY OF THE CHEMICAL ELEMENTS.[1]

THE elements of the chemist are now known to be complex in three different senses. In the first sense the complexity is one that concerns the general nature of matter, and therefore of all the elements in common to a greater or less degree. It follows from the relations between matter and electricity which have developed gradually during the past century as the result of experiments made and theories born within the four walls of this institution. Associated initially with the names of Davy and Faraday, they have only in these days come to full fruition as the result of the very brilliant elucidation of the real nature of electricity by your distinguished professor of physics, Sir Joseph Thomson. Such an advance, developing slowly and fitfully with long intervals of apparent stagnation, needs to be reviewed from generation to generation, disentangled from the undergrowth that obscures it, and its clear conclusions driven home. This complexity of the chemical elements is a consequence of the condition that neither free electricity nor free matter can be studied alone, except in very special phenomena. Our experimental knowledge of matter in quantity is necessarily confined to the complex of matter and electricity, which constitutes the material world. This applies even to the "free" elements of the chemist, which in reality are no more free then than they are in their compounds. The difference is

[1] Discourse delivered at the Royal Institution on Friday, May 18, by Prof. Frederick Soddy, F.R.S.

merely that whereas in the latter the elements are combined with other elements, in the so-called free state they are combined with electricity. I shall touch but briefly on this first aspect, as in principle it is now fairly well understood. But its consistent and detailed application to the study of chemical character is still lacking.

The second sense in which the elements, or some of them at least, are known now to be complex has, in sharp contrast to the first, developed suddenly and startlingly from the recognition in radio-active changes of different radio-elements, non-separable by chemical means, now called isotopes. The natural corollary of this is that the chemical element represents rather a type of element, the members of the type being only chemically alike. Alike they are in most of those properties which were studied prior to the last decade of last century, and probably due, as we now think, to the outer shells of the atom—so alike that all the criteria hitherto relied upon by the chemist as being the most infallible and searching would declare them to be identical. The apparent identity goes even deeper into the region reached by X-ray spectrum analysis, which fails to distinguish between them. The difference is found only in that innermost region of all, the nucleus of the atom, of which radio-active phenomena first made us aware.

But, though these phenomena pointed the way, and easily showed to be different what the chemist and spectroscopist would have decided to be identical, they did more. They showed that although the finer and newer criteria relied upon by the chemist in his analysis of matter must of necessity fail in these cases, being ultimately electrical in character, yet the difference should be obvious in that most studied and distinctive characteristic of all—the criterion by which Dalton first distinguished the different kinds of atoms—the atomic weight. Those who have devoted themselves to the exact determination of these weights have now confirmed the difference in two separate cases, which, in the absence of what perhaps they might regard as "preconceived notions," they were unable to discover for themselves. This is the experimental development to which I wish more especially to direct your attention It indicates that the chemical analysis of matter is, even within its own province, superficial rather than ultimate, and that there are indefinitely more distinct elements than the ninety-two possible types of element accommodated by the present periodic system.

The third sense in which the elements are known to be complex is that which, in the form of philosophical speculations, has come down to us from the ancients, which inspired the labours of the alchemists of the Middle Ages, and, in the form of Prout's hypothesis, has reappeared in scientific chemistry. It is the sense that denies to Nature the right to be complex, and from the earliest times, faith outstripping knowledge, has underlain the belief that all the elements must be built up of the same primordial stuff. The facts of radio-active phenomena have shown that all the radio-elements are indeed made up out of lead and helium, and this has definitely removed the question from the region of pure speculation. We know that helium is certainly a material constituent of the elements in the Proutian sense, and it would be harmless, if probably fruitless, to anticipate the day of fuller knowledge by atom building and unbuilding on paper. Apart altogether from this, however, the existence of isotopes, the generalisation concerning the periodic law that has arisen from the study of radio-active change on one hand and the spectra of X-rays on the other, and experiments on the scattering of α particles by matter do give us for the first time a definite conception as to what constitutes the difference between one element and another. We can say how gold would result from lead or mercury, even though the control of the processes necessary to effect the change still eludes us. The nuclear atom proposed by Sir Ernest Rutherford, even though, admittedly, it is only a general and incomplete beginning to a complete theory of atomic structure, enormously simplifies the correlation of a large number of diverse facts. This and what survives of the old electronic theory of matter, in so far as it attempted to explain the periodic law, will therefore be briefly referred to in conclusion.

The Free Element a Compound of Matter and Electricity.

Although Davy and Faraday were the contemporaries of Dalton, it must be remembered that it took chemists fifty years to put the atomic theory on a definite and unassailable basis, so that neither of these investigators had the benefit of the very clear view we hold to-day. Davy was the originator of the first electrochemical theory of chemical combination, and Faraday's dictum, "The forces of chemical affinity and electricity are one and the same," it is safe to say, inspires all the modern attempts to reduce chemical character to a science in the sense of something that can be measured quantitatively, as well as expressed qualitatively. Faraday's work on the laws of electrolysis and the discovery that followed from it when the atomic theory came to be fully developed, that all monovalent atoms or radicles carry the same charge, that divalent atoms carry twice this charge, and so on, can be regarded to-day as a simple extension of the law of multiple proportions from compounds between matter and matter to compounds between matter and electricity. Long before the electric charge had been isolated, or the properties of electricity divorced from matter discovered, the same law of multiple proportions which led, without any possibility of escape, to an atomic theory of matter led, as Helmholtz pointed out in his well-known Faraday lecture to the Chemical Society in this theatre in 1881, to an atomic theory of electricity.

The work of Hittorf on the migration of ions, the bold and upsetting conclusion of Arrhenius that in solution many of the compounds hitherto regarded as most stable exist dissociated into ions, the realisation that most of the reactions that take place instantaneously and are utilised for the identification of elements in chemical analysis are reactions of ions rather than of the element in question, made very familiar to chemists the enormous difference between the properties of the elements in the charged and in the electrically neutral state.

More slowly appreciated and not yet perhaps sufficiently emphasised was the unparalleled intensity of these charges in comparison with anything that electrical science can show, which can be expressed tritely by the statement that the charge on a milligram of hydrogen ions would raise the potential of the world to 100,000 volts. Or, if we consider another aspect, and calculate how many free hydrogen ions you could force into a bottle without bursting it, provided, of course, that you could do so without discharging the ions, you would find that were the bottle of the strongest steel—the breech of a gun, for example—it would burst, by reason of the mutual repulsion of the charges, before as much was put in as would, in the form of hydrogen gas, show the spectrum of the element in a vacuum tube.

Then came the fundamental advances in our knowledge of the nature of electricity, its isolation as the electron, or atom of negative electricity, the great extension of the conception of ions to explain the conduction of electricity through gases, the theoretical reasoning, due in part to Heaviside, that the electron must possess inertia inversely proportional to the diameter of the sphere on which it is concentrated by reason of the electromagnetic principles discovered by Faraday, leading to the all-embracing monism that all mass may be of electromagnetic origin.

This put the coping-stone to the conclusion that the elements as we apprehend them in ordinary matter are always compounds. In the "free" state they are compounds of the element in multiple atomic proportions with the electron. The ions, which are the real chemically uncombined atoms of matter, can no more exist free in quantity than can the electrons.

The compound may be individual as between the atom and the electron, or it may be statistical, affecting the total number merely of the opposite charges, and the element presumably will be an insulator or conductor of electricity accordingly. Analogously, with compounds, the former condition applies to unionised compounds, such as are met with in the domain of organic chemistry, or ionised, as in the important classes of inorganic compounds, the acids, bases, and salts. Just as the chemist has long regarded the union of hydrogen and chlorine as preceded by the decomposition of the hydrogen and chlorine molecule, so he should now further regard the union itself as a decomposition of the hydrogen atom into the positive ion and the negative electron and a combination of the latter with the chlorine atom.

One of the barriers to the proper understanding and quantitative development of chemical character from this basis is perhaps the conventional idea derived from electrostatics that opposite electric charges neutralise one another. In atomic electricity or chemistry, though the equality of the opposite charges is a necessary condition of existence, there is no such thing as neutralisation or the electrically neutral state. Every atom being the seat of distinct opposite charges, intensely localised, the state of electric neutrality can apply only to a remote point outside it, remote in comparison with its own diameter. We are getting back to the conception of Berzelius with some possibility of understanding it, that the atom of hydrogen, for example, may be strongly electro-positive and that of chlorine strongly electro-negative, with regard to one another, and yet each may be electrically neutral in the molar sense. Some day it may be possible to map the electric field surrounding each of the ninety-two possible types of atom over distances comparable with the atomic diameter. Then the study of chemical character would become a science in Kelvin's sense, of something that could be reduced to a number. But the mathematical conceptions and methods of attack used in electrostatics for macroscopic distances are ill-suited for the purposes of chemistry, which will have to develop methods of its own.

We have to face an apparent paradox that the greater the affinity that binds together the material and electrical constituents of the atom, the less is its combining power in the chemical sense. In other words, the chemical affinity is in inverse ratio to the affinity of matter for electrons. The helium atom offers a very simple and instructive case. Helium is non-valent and in the zero family, possessing absolutely no power of chemical combination that can be detected. Yet we know the atom possesses two electrons, for in radioactive change it is expelled without them as the α-particle. The discharge of electricity through it and positive-ray analysis show that the electrons, or certainly one of them, are detachable by electric agencies, although not by chemical agencies. One would expect helium to act as a diad, forming helides analogous to oxides.

Prof. Armstrong for long advocated the view that these inert gases really are endowed with such strong chemical affinities that they are compounds that have never been decomposed. They certainly have such strong affinities for electrons that the atom, the complex of the + ion and electrons, cannot be decomposed chemically. Yet in this case, where the affinity of the matter for the electron is at a maximum, the chemical combining power is absent.

These gases seem to furnish the nearest standard we have to electric neutrality in the atomic sense. The negative charge of the electrons exactly satisfies the positive charge of the matter, and the atomic complex is chemically, because electrically, neutral. In the case of the electro-positive elements, hydrogen and the alkali metals, one electron more than satisfies the positive charge on the ion, and so long as the equality of opposite charges is not altered the electron tries to get away. In the case of the electro-negative elements, such as the halogens, the negative charge, though equal presumably to the positive, is not sufficient to neutralise the atom. Hence these groups show strong mutual affinity, one having more and the other less negative electricity than would make the system atomically neutral like helium. The electron explains well the merely numerical aspect of valency. But chemical combining power itself seems to require the idea that equal and opposite charges in the atomic sense are only exactly equivalent in the case of the inert gases. None of these ideas are now new, but their consistent application to the study of chemical compounds seems curiously to hang fire, as though something were still lacking.

It is so difficult for the chemist consistently to realise that chemical affinity is due to a dissociating as well as to a combining tendency, and is a differential effect. There is only one affinity, probably, and it is the same as that between oppositely charged spheres. But, atomic charges being enormous, and the distances over which they operate in chemical phenomena being minute, this affinity is colossal, even in comparison with chemical standards. What the chemist recognises as affinity is due to relatively slight differences between the magnitude of the universal tendency of the electron to combine with matter in the case of the different atoms. Over all is the necessary condition that the opposite charges should be equivalent, but this being satisfied, the individual atoms display the tendencies inherent in their structure, some to lose, others to gain electrons, in order, as we believe from Sir Joseph Thomson's teaching, to accommodate the number of electrons in the outermost ring to some definite number. Chemical affinity needs that some shall lose as well as others gain. Chemical union is always preceded by a dissociation. The tendency to combine, only, is specific to any particular atom, but the energy and driving power of combination are due to the universal attraction of the + for the − charge, of matter for the electron.

The Electrical Theory of Matter.

Another barrier that undoubtedly exists to the better appreciation of the modern point of view, even among those most willing to learn, is the confusion that exists between the earlier and the present attempt to explain the relation between matter and electricity. We know negative electricity apart from matter as the electron. We know positive electricity apart from the electron, the hydrogen ion, and the radiant helium atom, or α-particle of radio-active change, for example, and it *is* matter in the free, or electrically uncombined, condition. Indeed, if you want to find matter free and uncombined, the simple elementary particle of matter in the sense of complexity being discussed, you will go, paradoxically, to what the chemist terms a compound rather than to that which he terms the free element. If this compound is ionised completely it constitutes the nearest approach to matter in the free state. Thus all acids owe their common acidic quality to really free hydrogen, the hydrogen ion, a particle more different from the hydrogen atom than the atom is from the hydrogen molecule. Positive electricity is thus emphatically not the mere absence of electricity, and any electrical theory of matter purporting to explain matter in terms of electricity does so by the palpable sophistry of calling two fundamentally different things by the same name. The dualism remains, whether you speak of matter and electricity, or of positive and negative electricity, and the chemist would do well to stick to his conception of matter until the physicist has got a new name for positive electricity which will not confuse it with the only kind of electricity that can exist apart from matter.

On the other hand, the theory of the electromagnetic origin of mass or inertia is a true monism. It tries to explain consistently two things—the inertia of the electron and the inertia of matter—by the same cause. The inertia of the former being accounted for by the well-known electromagnetic principles of Faraday, by the assumption that the charge on the electron is concentrated into a sphere of appropriate radius, the two thousand-fold greater inertia of the hydrogen ion, for example, can be accounted for by shrinking the sphere to one two-thousandth of the electronic radius.

But the electrical dualism remains completely unexplained. Call the electron E and the hydrogen ion H. The facts are that two E's repel one another with the same force and according to the same law as two H's repel each other, or as an H attracts an E. These very remarkable properties of H and E are not explained by the explanation of the inertia. Are E and H made up of the same stuff or of two different stuffs? We do not know, and certainly have no good reason to assume that matter *minus* its electrons is made of the same thing as the electron. We have still to reckon with two different things.

The Chemical Elements not necessarily Homogeneous.

I pass now to the second and most novel sense in which the elements, or some of them at least, are complex. In their discovery of new radio-active elements M. and Mme. Curie used radio-activity as a method of chemical analysis precisely as Bunsen and Kirchhoff, and later Sir William Crookes, used spectrum analysis to discover cæsium and rubidium, and thallium. The new method yielded at once, from uranium minerals, three new radio-elements—radium, polonium, and actinium. According to the theory of Sir Ernest Rutherford and myself, these elements are intermediate members in a long sequence of changes of the parent element uranium. In a mineral the various members of the series must co-exist in equilibrium, provided none succeed in escaping from the mineral, in quantities inversely proportional to their respective rates of change, or directly proportional to their periods of average life. Radium changes sufficiently slowly to accumulate in small but ponderable quantity in a uranium mineral, and so it was shown to be a new member of the alkaline-earth family of elements, with atomic weight 226·0, occupying a vacant place in the periodic table. Polonium changes 4500 times more rapidly, and can only exist to the extent of a few hundredths of a milligram in a ton of uranium mineral. Actinium also, though its life period is still unknown, and very possibly is quite long, is scarce for another reason: that it is not in the main line of disintegration, but in a branch series which claims only a few per cent. of the uranium atoms disintegrating. In spite of this, polonium and actinium have just as much right to be considered new elements probably as radium has. Polonium has great resemblances in chemical character both to bismuth and tellurium, but was separated from the first by Mme. Curie, and from the second by Marckwald. In the position it occupies as the last member of the sulphur group, bismuth and tellurium are its neighbours in the periodic table. Actinium resembles the rare-earth elements, and most closely lanthanum, but an enrichment of the proportion of actinium from lanthanum has been effected by Giesel. The smallness of the quantities alone prevents their complete separation in the form of pure compounds, as was done for radium.

The three gaseous members, the emanations of radium, actinium, and thorium, were put in their proper place in the periodic table almost as soon as radium was, for, being chemically inert gases, their characterisation was simple. They are the last members of the argon family, and the fact that there are three of about the same atomic weight was probably the first indication, although not clearly appreciated, that more than one chemical element could occupy the same place in the periodic table.

The extension of the three disintegration series proceeded apace, new members were being continually added, but no other new radio-element—new, that is, in possessing a new chemical character—was discovered. The four longest lived to be added, radio-lead, or radium-D, as it is now more precisely termed, and ionium in the uranium series, and mesothorium-I and radiothorium in the thorium series, could not be separated from other constituents always present in the minerals—radium-D from lead, ionium and radiothorium from thorium, and mesothorium-I from radium. An appreciable proportion of the radioactivity of a uranium mineral is due to radium-D and its products, and its separation would have been a valuable technical achievement, but though many attempts have been made, this has never been accomplished, and, we know now, probably never will be.

Seven years ago it was the general opinion in the then comparatively undeveloped knowledge of the chemistry of the radio-elements that there was nothing especially remarkable in this. The chemist is familiar with many pairs or groups of elements the separation of which is laborious and difficult, and the radiochemist had not then fully appreciated the power of radio-active analysis in detecting a very slight change in the proportions of two elements, one or both of which were radio-active. The case is not at all like that of the rare-earth group of elements, for example, in which the equivalent or atomic weight is used as a guide to the progress of the separation. Here, the total difference in the equivalent of the completely separated elements is only a very small percentage of the equivalent, and the separation must already have proceeded a long way before it can be ascertained.

Human nature plays its part in scientific advances, and the chemist is human like the rest. My own views on the matter developed with some speed, when, in 1910, I came across a new case of this phenomenon. Trying to find out the chemical character of mesothorium-I, which had been kept secret for technical reasons, I found it to have precisely the same chemical character as radium, a discovery which was made in the same year by Marckwald, and actually first published by him. I delayed my publication some months to complete a very careful fractional crystallisation of the barium-radium-mesothorium-I chloride separated from thorianite. Although a great number of fractionations were performed, and the radium was enriched, with regard to the barium, several hundred times, the ratio between the radium and mesothorium-I was, within the very small margin of error possible in careful radio-active measurements, not affected by the process. I felt justified in concluding from this case, and its analogy with several other similar cases then known, that radium and mesothorium-I were non-separable by chemical processes, and had a chemical character not merely like, but identical. It followed that some of the common elements might similarly be mixtures of chemically identical elements. In the cases cited the non-separable pairs differ in atomic weight from two to four units. Hence the lack of any regular numerical relationships between the atomic weights would, on this view, follow naturally (Trans. Chem. Soc., 1911, vol. xcix., p. 72). This idea was elaborated in the Chemical Society's Annual Report on Radio-activity for 1910, in the concluding section summing up the position at that time. This was, I think, the beginning of the conception of different elements, identical chemically, which later came to be termed "isotopes," though it is sometimes attributed to K. Fajans, whose valuable contributions to radio-activity had not at that date commenced, and whose first contribution to this subject did not appear until 1913.

In the six or seven years that have elapsed the view has received complete vindication. Really three distinct lines of advance converged to a common conclusion, and, so far as is possible, these may be disentangled. First there has been the exact chemical characterisation from the new point of view of every one of the members of the three disintegration series with lives over one minute. Secondly came the sweeping generalisations in the interpretation of the periodic law. Lastly there has been the first beginnings of our experimental knowledge of atomic structure, which got beyond the electronic constituents and at the material atom itself.

In pursuance of the first, Alexander Fleck, at my request, commenced a careful systematic study of the chemical character of all the radio-elements known, of which our knowledge was lacking or imperfect, to see which were, and which were not, separable from known chemical elements. Seldom can the results of so much long and laborious chemical work be expressed in so few words. Every one that it was possible to examine was found to be chemically identical either with some common element or with another of the new radio-elements. Of the more important characterisations, mesothorium-II was found to be non-separable from actinium, radium-A from polonium, the three B-members and radium-D from lead, the three C-members and radium-E from bismuth, actinium-D and thorium-D from thallium. These results naturally took some time to complete, and became known fairly widely to others working in the subject before they were published, through A. S. Russell, an old student, who was then carrying on his investigations in radio-activity in Manchester. Their interpretation constitutes the second line of advance.

Before that is considered, it may first be said that every case of chemical non-separability put forward has stood the test of time, and all the many skilled workers who have pitted their chemical skill against Nature in this quest have merely confirmed it. The evidence at the present day is too numerous and detailed to recount. It comes from sources, such as in the technical extraction of mesothorium from monazite, where one process is repeated a nearly endless number of times; from trials of a very great variety of methods, as, for example, in the investigations on radium-D and lead by Paneth and von Hevesy; it is drawn from totally new methods, as in the beautiful proof by the same authors of the electrochemical identity of these two isotopes; it is at the basis of the use of radio-active elements as indicators for studying the properties of a common element isotopic with them, at concentrations too feeble to be otherwise dealt with; and from large numbers of isolated observations, as well as prolonged systematic researches. One of the finest examples of the latter kind of work, the Austrian researches on ionium, will be dealt with later. The most recent, which appeared last April, is by T. W. Richards and N. F. Hall, who subjected lead from Australian carnotite, containing therefore radium-D, to more than a thousand fractional crystallisations in the form of chloride without appreciably altering the atomic weight or the β activity. So that it may be safely stated that no one who has ever really tested this conclusion now doubts it, and, after all, they alone have a right to an opinion.

This statement of the non-separability by chemical methods of pairs or groups of elements suffers perhaps from being in a negative form. It looks too much like a mere negative result, a failure, but in reality it is one of the most sweeping positive generalisations that could be made. Ionium, we say, is non-separable from thorium, but every chemist knows thorium is readily separated from every other known element. Hence one now knows every detail of the chemistry of the vast majority of these new radio-elements by proxy, even when their life is to be measured in minutes or seconds, as completely as if they were obtainable, like thorium is, by the ton. The difference it makes can only be appreciated by those who have lived through earlier days, when, in some cases, dealing with the separation of radio-constituents from complex minerals, after every chemical separation one took the separated parts to the electroscope to find out where the desired constituent was.

As the evidence accumulated that we had to deal here with something new and fundamental, the question naturally arose whether the spectrum of isotopes would be the same. The spectrum is known, like the chemical character, to be an electronic rather than mass phenomenon, and it was to be expected that the identity should extend to the spectrum. The question has been tested very thoroughly, by A. S. Russell and R. Rossi in this country, and by the Austrian workers at the Radium Institut of Vienna, for ionium and thorium, and by numerous workers for the different isotopes of lead. No certain difference has been found, and it may be concluded that the spectra of isotopes are identical. This identity probably extends to the X-ray spectra, Rutherford and Andrade having shown that the spectrum of the γ-rays of radium-B is identical with the X-ray spectrum of its isotope lead.

(To be continued.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Merthyr Education Committee has accepted with thanks an offer from Mr. H. Seymour Berry to equip a technical mining and engineering institute at a cost of 10,000*l.*, in commemoration of the part his late father, ex-Alderman J. M. Berry, had taken in the public life of the town.

THE trustees of the Beit Fellowships for Scientific Research, which were founded and endowed four years ago by Mr. Otto Beit in order to promote the advancement of science by means of research, have recently elected Mr. Leslie Hartshorn to a fellowship. Mr. Hartshorn will carry out his research in the Imperial College at South Kensington.

A CONFERENCE on new ideals in education is to be held at Bedford College, Regent's Park, London, on August 14-21. The inaugural address will be delivered by the President of the Board of Education, Mr. H. A. L. Fisher, on August 15 at 10 a.m. Among the subjects and speakers we notice the following: On August 15, Mr Frank Roscoe, on the mind of youth; on August 16, Prof. Bompas Smith, on problems of the urban continuation school; on

August 17, Mr. R. G. Hatton, on the problem of the rural continuation school; and on August 18, Mr. W. G. W. Mitchell, on some new ideals in geometry teaching, and Miss Dewdney, on self-instruction in elementary arithmetic. The committee invites teachers conducting experiments in education to communicate with the secretary, 24 Royal Avenue, Chelsea, S.W.3.

AT the meeting of the London County Council Education Committee on July 11 the applications of the governing bodies of the London polytechnics for grants from the Council were considered. The committee decided to recommend that grants for the year 1917-18 only be made, as it was felt that in the circumstances of the present times it is impossible to forecast the position three years ahead. Eventually the following block grants for 1917–18 were decided upon: Battersea Polytechnic, 11,133*l.*; Birkbeck College, 7100*l.*; Borough Polytechnic, 9100*l.*; City of London College, 4040*l.*; Northampton Polytechnic, 4400*l.*; Northern Polytechnic, 9650*l.*; Regent Street Polytechnic, 14,300*l.*; Sir John Cass Technical Institute, 4000*l.*; South-Western Polytechnic, 7300*l.*; Woolwich Polytechnic, 9700*l.* A special grant of 1567*l.* was made to the governing body of Battersea Polytechnic for the establishment of a superannuation fund for the teachers in the secondary school.

WE have recently noticed with satisfaction the signs of an improved temper on the part of professed "humanists" with respect to the position to be accorded to natural and experimental science as an element in general education. The attention of our readers has been directed within the last few months to articles by writers so important as Mr. A. C. Benson and Lord Bryce. Now we have another even more sympathetic utterance from the Master of Balliol College, Oxford, who contributes to the *English Review* an expression of his views on "Natural Science in Education," beginning with the following words: "If there is one lesson more than another which the war is going to teach us, it will be the lesson as to the future place of natural science in our education." This is fairly obvious, and from one point of view almost a commonplace, for the majority of the public look to science merely for the sake of its practical application. It is not so much the invention of new flying machines or the discovery of new explosives that the world requires, but more exact knowledge in every direction. Science purifies common observation and teaches the nature and use of evidence. By science we learn something of the rules of the universe, and their control of the conditions under which human life exists. These rules cannot be ignored, and, as the writer remarks, "how powerless against them is even the best Parliamentary debating." Then there is the further and deeper influence which can only be justly expressed by the term "spiritual"—that effect of mingled awe and exultation which is produced when science opens out some profound vista of the universe. All the methods to be used in education require good teachers, and therein lies one of the difficulties of the time immediately ahead of us. The author touches on many of the questions concerning which debate is still going on, such as, for example, the already generally overloaded curriculum. While it is comforting to reflect that the best classical teachers admit that there has been a great deal of wasted drill in grammar and composition, it is the ignorance and apathy of the public which are to blame in having so long accepted without stronger remonstrance the purely bookish character of the system under which our boys and girls have been brought up.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 28.—Sir J. J. Thomson, president, in the chair.—Sir Robert **Hadfield**, Ch. **Chéneveau**, and Ch. **Géneau**: A contribution to the study of the magnetic properties of manganese and of some special manganese steels. (1) The research has had for its object the investigation of the mass-susceptibility of manganese metal, and of certain of its alloys with iron and other metals. The work was carried out on a Curie-Chéneveau magnetic balance. (2) Manganese itself, when free from occluded gases, is para-magnetic, its value of χ being $+11{\cdot}0\times10^{-6}\pm2$ per cent. This corresponds on Weiss's theory to a number of magnetons equal to 6. The removal of occluded gases is essential, as the ferro-magnetic properties of certain specimens of manganese are shown to be due to the presence of hydrogen. (3) The manganese alloys investigated, with one exception, are all para-magnetic, χ varying from $17{\cdot}0\times10^{-6}$ to $259{\cdot}0\times10^{-6}$. The exception mentioned is a silico-manganese steel containing 6 per cent. of silicon, which is distinctly ferro-magnetic. (4) An endeavour is also made to correlate the values of the mass-susceptibility with the composition of the alloys. In this connection it has been shown that the quantity of manganese within the limits investigated has very little influence upon the susceptibility, whilst increase of carbon tends to decrease it. In general it is concluded that in these special steels the susceptibility decreases as the carbon-manganese ratio increases. (5) The carbon-manganese ratio being constant, addition of chromium, nickel, or tungsten raises the susceptibility. (6) The addition of copper to a manganese-nickel steel also raises the susceptibility—this notwithstanding the diamagnetism of copper.—W. R. **Bousfield**: Note on the specific heat of water. Replying to criticisms by Callendar (Bakerian Lecture, Phil. Trans., A, 212, p. 1, 1912) on the methods for investigating the specific heat of water described in a former paper (W. R. Bousfield and W. Eric Bousfield, Phil. Trans., A, 211, p. 199, 1911), it is pointed out that the observations of Callendar do not substantially affect the question as to which figures are more correct in the lower range of temperature from 0° to 40° or 50° C. Callendar and Barnes differ from other observers in placing the minimum value for the specific heat of water in the neighbourhood of 40° C., whilst other observers put it at about 25° C.—W. R. **Bousfield** and C. Elspeth **Bousfield**: The specific heat of aqueous solutions with special reference to sodium and potassium chlorides. The specific heats of solutions of NaCl and KCl ranging from saturated solutions to quarter-normal solutions at mean temperatures of 7°, 20°, and 33° C. have been determined by the method and apparatus used for the determination of the specific heat of water and described in a former paper (Phil. Trans., A, 211, p. 199, 1911). The corresponding densities have also been determined. The relation of the specific heat of the solution to the specific contraction of the water is studied, and it is shown that the specific heat of a series of solutions of different concentrations may be reckoned on the hypothesis that the specific heat of the solute is constant, whilst the mean specific heat lowering of the water is proportional to the specific contraction of the water. The temperature variations of the specific heats of the solutions are also compared with the temperature variations of the specific heat of water. The minimum value on the temperature-specific heat curve, which occurs at about 25° C. in the case of water, disappears altogether in solutions of half-normal to normal strength. This curve for the most concentrated solutions becomes a straight line.—

Sir George **Greenhill**: The Rankine trochoidal wave. The Rankine trochoidal wave (Phil. Trans., 1863), either as rollers or as a starting wave, can be divided up by vertical planes perpendicular to the wave crest into compartments, and the compartments sheared along each other. The investigation is made of the extra field of force in addition to gravity when the shear is made continuous and the planes removed in order that the continuity of pressure should be preserved in the interior of the water, and for the new wave motion to persist. Also when the planes stand over to the vertical and the circular orbits in the roller are in parallel planes. A geometrical investigation is added of the molecular rotation in the interior of the Rankine wave.—Dr. P. E. **Shaw**: The tribo-electric series. (1) The tribo-electric series, in which solid materials are arranged in order according to the charge they acquire when rubbed together, is trustworthy with due precautions. (2) Most solids are found to alter their place in the series if heated above a certain temperature which is specific for each material. This temperature is called the critical temperature. The surface in its new condition is termed abnormal. (3) The series may be divided into an upper Group A and a lower Group B. It is found that these groups have tendencies contrary to one another as the surfaces of the materials are rendered (*a*) matte, or (*b*) abnormal, or (*c*) pressed, or (*d*) flexed. If under any of these agencies Group A becomes more + forming, Group B becomes more − forming, and *vice versa*. (4) Anomalous effects are observed when liquid mercury is used as one of the materials, its behaviour being quite unlike that of solid surfaces. (5) As to theory, it is suggested that the prevalent idea that the electric double-layer existing at the surface of solids has the − layer outermost in all cases is incorrect. Normally the materials in Group A would have − outermost, those in Group B having + outermost. Orientation of surface atoms would give rise to changes in the disposition of the two electric layers and so account for observed effects. (6) Tribo-electricity undoubtedly affords a means, of extraordinary delicacy, of discriminating between materials apparently alike. Two instances are seen in the group of furs and the group of woods.—J. J. **Nolan**: The nature of the ions produced by the spraying of water. Part i. gives an account of the determination of the mobilities of the very mobile ions produced by the spraying of water. Groups of ions are found, positive and negative, some of very high mobility. In part ii. the less mobile ions described in a previous paper are discussed. Treating the ions as minute spheres of water, it is shown that their sizes as deduced from an empirical modification of Stokes's law would agree with the sizes calculated from the ordinary theoretical mobility formulæ. Certain evidence, however, tends to show that the larger of these ions are not simple spheres of water, but that they consist of loose groupings of various numbers of some smaller water-globules. In part iii. it is shown that the very mobile ions can be accounted for by supposing that they consist of aggregates of various numbers of water-molecules, the numbers of molecules in the various ions being related to one another in a regular way. Some of these ions have the same mobility as ions produced in air by X-rays, etc. It is suggested that the ordinary gaseous ion consists of a group of water-molecules, the size of the group depending on the degree of moisture of the gas.—Prof. J. C. **McLennan**: The absorption spectra and the ionisation potentials of calcium, strontium, and barium.—J. **Small**: Geotropism and the Weber-Fechner law.—Prof. W. B. **Bottomley**: The isolation from peat of certain nucleic acid derivatives.

BOOKS RECEIVED.

Spiritualism and Sir Oliver Lodge. By Dr. C. A. Mercier. Pp. xi+132. (London: Mental Culture Enterprise.) 4*s.* 6*d.* net.

A Manual of Field Astronomy. By A. H. Holt. Pp. x+128. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 6*s.* net.

Laboratory Manual of Bituminous Materials for the Use of Students in Highway Engineering. By Prévost Hubbard. Pp. xi+153. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 6*s.* net.

The Fundus Oculi of Birds, especially as Viewed by the Ophthalmoscope. By Casey Albert Wood. Pp. 180+plates lxi. (Chicago: The Lakeside Press.)

Fifty-fifth Annual Report of the Secretary of the State Board of Agriculture of the State of Michigan and Twenty-ninth Annual Report of the Experiment Station from June 1, 1915–June 30, 1916. Pp. 896. (Lansing, Mich.: Wynkoop Hallenbeck Crawford Co.)

Critique des Propulseurs. Par Paul Popovatz. Pp. 131. (Paris: Gauthier-Villars et Cie.)

Science and Industry. The Place of Cambridge in any Scheme for their Combination. The Rede Lecture, 1917. By Sir R. T. Glazebrook. Pp. 51. (Cambridge: At the University Press.) 1*s.* 6*d.* net.

The National University of Ireland. Calendar for the Year 1917. Pp. viii+579. (Dublin: A. Thom and Co., Ltd.)

The Biology of Waterworks. By R. Kirkpatrick. (Economic Series, No. 7.) Pp. vi+58. (London: British Museum, Natural History.)

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