THURSDAY, FEBRUARY 18, 1904.

MORPHOLOGY OF THE FLOWERING PLANTS.

Morphology of Angiosperms. Part ii. Morphology of Spermatophytes. By J. M. Coulter and C. J. Chamberlain. Pp. x + 348; illustrated. (New York and London: Appleton and Co., 1903.)

DURING the last decade or so the aspects of vegetable morphology have undergone an astonishing change, one indeed almost approaching the nature of a revolution. Many of the controversies of twenty years ago have now ceased to excite interest, and those old standing problems on which attention will always be concentrated have come to be regarded from other standpoints, whilst hosts of new ones have hustled themselves to the front. Several causes have contributed to effect this change in the whole perspective of the science. The introduction of more precise methods of observation and experiment has resulted in the disintegration of more than one cherished superstition, but it has been at the same time fertile in good results by leading to a re-examination of the foundations of our morphological beliefs. Our horizon has been greatly extended by the remarkable advances made in palæontology and cytology, and we have been thus enabled to link together many facts and phenomena the connection of which had hitherto been unsuspected or at the best but guessed at.

Sooner or later the newer points of view come to be reflected in new types of text-books. The volume before us is one of these pioneer works. It makes no pretence of dealing with the whole range of so vast a subject as that of the morphology of angiosperms, but the authors have wisely selected, out of the mass of information at their disposal, such material as may illustrate the main thesis they had in view in writing the book. This thesis might perhaps be fitly described as the angiosperms from a phylogenetic standpoint. The whole treatment converges to this end, including also the somewhat curtailed account of angiospermic anatomy separately contributed by Prof. E. C. Jeffrey.

Naturally the different portions of the work are of unequal value; this is partly to be attributed, as in the case of the later geological evidence, to the comparative exiguity of trustworthy information, and in part also, perhaps, to considerations of space.

The general character of the treatise may be gathered from the headings of the earlier chapters. Thus we find the microsporangium, the megasporangium, the female gametophyte, fertilisation, the endosperm, all receiving a full treatment in separate chapters. Other important phases in the life-history of a typical angiosperm are similarly dealt with, and each phase is treated from a comparative standpoint.

One of the most interesting discussions, at least to an advanced student, is that on the phylogeny of the two main divisions of the angiosperms. The various probabilities are ably put forward and sifted, and after reviewing the whole, the authors are inclined to consider the dicotyledons as having sprung from a stock distinct from that which gave birth to the monocotyledons. They are inclined to regard the unquestioned similarity in the stages characteristic of the germination of the embryosac, in the two phyla respectively, as being attributable rather to convergence than to community of origin, much in the same way, perhaps, as we now recognise heterospory to have appeared independently in all the advanced groups of vascular cryptogams. But in this instance, as in others in which there is also room for great divergence of opinion, one cannot fail to be struck by the fairness with which they present the evidence, even when it militates against their own particular view.

The angiosperms as a whole are likewise considered to have originated independently of the gymnosperms, in spite of the apparent points of contact exhibited, *e.g.* by the Gnetaceæ in certain of their reproductive structures, with the higher group. The differences are held to be of such moment as to be irreconcilable with any close affinity, and the authors emphasise their position by proposing to retain the term spermaphyte as one of mere convenience, and not as in any way implying near relationship. Probably many will agree with this attitude of caution in the absence of more palæontological evidence than we at present possess, and it is at any rate clear that modern work has sufficed to accentuate the remoteness of the gymnosperms, not only from the dicotyledons with which they were formerly grouped, but from the whole angiospermic class.

It cannot, of course, be expected that all the theoretical interpretations and conclusions advocated by the authors will commend themselves with equal force to other botanists, and we find ourselves unable to follow them in all their proposed modifications of terms. Thus it does not appear to be a substantial gain to limit, even implicitly, the term *dioecious* to the gametophyte. The word is perfectly well understood in connection with the sporophyte, and if we accept (as it seems reasonable to do) their own conclusion that the spore-mother cell is the point at which the sporophyte generation terminates, the term may still serve according to the current use. For if the gametophyte is regarded as being inaugurated on the division of the spore-mother cell, the spores themselves, produced within the tissues of the sporophyte, form an early stage of the sexual generation. This view is based on the important nuclear changes associated with the formation of the spores, and it has already been adopted, at least in this country, as a cardinal point in the life-history of the higher plants. The objection raised against the terms gynæcium and andrœcium by reason of their conveying a significance as to sex is quite parallel to the one before mentioned; but no one would regard the term male or female, as applied to an animal, to be incorrectly used on the ground that the sexual elements are the real male and female cells. The matter is not affected by the fact that these tissues are often segregated from the soma at so early a period, and with such definiteness, that many zoologists have concluded that there is a fundamental distinction between soma and sexual tissues comparable with that which in plants finds its expression in alternation of generations.

On the other hand, the proposal to replace the expression "double fertilisation" by that of "triple fusion" strikes us as a good one. It is by no means certain that the process indicated is really of the nature of fertilisation at all, and until more evidence enables us to form a reasoned opinion as to the meaning of these remarkable phenomena that precede the formation of endosperm in a large number of cases, it is better to avoid taking up, even nominally, what may prove to be a totally untenable position. Indeed, we already know that endosperm may arise, in some instances, independently not only of the addition of the extra male nucleus but also even of the fusion of the two polar nuclei themselves.

It is not possible to discuss the many points raised in this interesting work in any detail. Every serious student of botany will certainly peruse it for himself and can form his own judgment on controversial matters. He will be aided in this by the copious references to literature which form not the least valuable feature of this fine book.

Here and there we note an occasional slip, *e.g.* the suggestion that the investigations which have led to a general disbelief in the occurrence of centrosomes in angiosperms originated in Germany. But as a general rule the statements are remarkably free from inaccuracy. It is not possible to conclude this notice without commenting on the excellent manner in which the book is got up. The text, and especially the illustrations, both in character and execution, are all that could be desired.

J. B. F.

APPLICATIONS OF PHYSICAL CHEMISTRY.

Physical Chemistry in the Service of the Sciences. By J. H. van 't Hoff. Edited by Prof. Alexander Smith. Pp. xviii+126. (The University of Chicago Press, 1903.) Price 1.50 dollars.

THIS handsome volume is based on a course of nine lectures delivered in 1902 at Chicago, where Prof. van 't Hoff was the guest of the university; it deals with the extension of Avogadro's law to solutions, and the thermodynamical principle of the conservation of energy; the thermochemical and electrical methods of determining what chemical changes are able to do work, and the theory of ionisation; the application of the phase-rule in relation to the extraction of pure salts from the Stassfurt deposits, and to the metallurgy of iron and steel; osmotic pressure in its physiological applications, and the catalytic action of enzymes; and the nature of the salts deposited by the evaporation of sea-water, and the reasons for their formation. The lecturer has thus, by carefully chosen examples, illustrated the bearing of modern physical chemistry on manufacture, on physiology, and on geology.

Prof. van 't Hoff tells a curious tale of the celebrated Kekulé, professor at Bonn, who thirty years ago took the pessimistic view that chemistry, as a science, had come to a stand, and that a Newton was necessary before further advance could be made. It was an unfortunate utterance, for no science has made greater strides within the last quarter of a century, and Prof. van 't Hoff has done much to contribute to its advance. The fortunate conjunction of three men, van 't Hoff with his magnificent powers of generalisation, Arrhenius with his keen insight, and Ostwald with his encyclopædic knowledge and rare gift of exposition, has largely aided the rapid progress of physical chemistry. But the first step was taken by van 't Hoff and Le Bel, in their simultaneously conceived theory of the representation of the molecule in three dimensional space.

In discussing the aid which physical chemistry has given to pure chemistry, the author states:—

"The most recent development of physical chemistry has been characterised rather by the establishment of comprehensive principles which fertilise the whole foundation of the science, and which promise to furnish nourishment for a large part of the chemistry of the future."

A short explanation of the nature and laws of osmotic pressure is then followed by a brief statement of the nature of a reversible cycle and its application to the case of carnallite. The "principle of maximum work" is next considered, and the fallacy contained in it, and the suggestion is thrown out that all thermochemical work should be repeated, "with the object of determining the ability of each reaction to do work." This suggestion is again illustrated by help of carnallite as an instance. At $-21°$, the temperature of equilibrium between carnallite and its components,

$$MgCl_2KCl.6H_2O + 6H_2O \rightleftharpoons MgCl_2.12H_2O + KCl,$$

the possibility of doing work is zero. But above this temperature, the reaction can overcome a resistance such as a pressure; hence $dE = -W dT/T$, and a cyclic change is possible. For finite values $E = -W\Delta t/T$; hence, while at the transition temperature where $\Delta t = 0$, $E = 0$, both above and below it the sign of E changes. Of course, at absolute zero, $E = W$, where $\Delta t = -T$, and the heat developed will be a measure of the capacity to do work, and the fact that Berthelot's principle of maximum work holds in many cases is merely due to the temperature of experiment being relatively low—only 273° above absolute zero. At 1000°, on the contrary, acetylene is formed with absorption of heat, and water decomposes in spite of the fact that its formation is accompanied by evolution of heat. This abridgment of van 't Hoff's argument will give an idea of the simple and clear method of statement. In a similar manner the connection of the capacity to do work with electromotive force is explained, and illustrated by the example of a thallium–thallium chloride–potassium thiocyanate cell. Arrhenius's conception of ions is thus introduced and shortly described.

In dealing with the connection between physical and industrial chemistry, van 't Hoff emphasises the circumstance that in Germany the most hearty co-operation exists between manufacture and science, alluding to the fact that it is not there expected that the physical chemists shall give "tips" to the industrial chemists, but that the education of the latter as physical chemists will open up new points of view, and gradually lessen the purely empirical methods by which the industrial chemist often tries to progress. The salt industry is next discussed; this is followed by an exposition of Cohen's experiments on allotropic tin, a short and masterly exposition of the metallurgy of iron, and the relations between α and β ferrite, pearlite, cementite, and carbon.

In considering the bearing of physical chemistry on physiology, the measurement of osmotic pressure by *tradiscantia discolor,* and by blood-corpuscles, and the curious experiments on the human eye by Dr. Massart are discussed, as well as Loeb's discovery of the *rôle* of osmotic pressure in fertilisation. The influence of enzymes as accelerators or retarders of chemical action, and their effect in promoting synthesis as well as decomposition are particularly alluded to.

The last chapters, dealing with geological phenomena, are suggestive; the type chosen is the very complicated relationships between the Stassfurt salts, in which no fewer than twenty-six components are present. A graphic representation of the conditions under which these salts are capable of existence is annexed.

Prof. van 't Hoff possesses in an almost unique degree the power of simple exposition and suggestiveness. On reading this book one is tempted to exclaim, "Why was all this not thought of ages ago?" But the fact is, all great discoveries can be simply stated, but it usually needs a great discoverer who can add to his discoveries simple methods of exposition. The magic consists in clearness of thought, and this is admirably illustrated in this interesting book.

W. R.

SCHOOL MATHEMATICS.

A School Geometry. Parts i.–v. By H. S. Hall, M.A., and F. H. Stevens, M.A. Pp. xii+340+ix. (London: Macmillan and Co., Ltd., 1903.) Price 4*s.* 6*d.*

Exercises in Theoretical and Practical Geometry. By R. B. Morgan. Pp. 96. (London: Blackie and Son, Ltd., 1903.) Price 1*s.*

Graphs: or the Graphical Representation of Algebraic Functions. By C. H. French, M.A., and G. Osborn, M.A. Pp. vii+64. (London: W. B. Clive.) Price 6*d.*

PART V. of the new geometry by Messrs. Hall and Stevens has been recently issued, and the whole work, so far as it is completed, is now conveniently published in one volume. The final part, dealing with solid geometry, is in preparation, and will be awaited with interest in many quarters.

The authors follow the reform movement cautiously, on strictly orthodox lines, and adhere closely to the recommendations of the Mathematical Association and to the new Cambridge syllabus. The advantages of the newer methods of teaching geometry are very manifest in this excellently written text-book. A great change has been effected in the country in a comparatively short time, but the subject is not yet sufficiently emancipated from the older influences. The field of elementary geometry is at present only partially covered. We are strongly of opinion that examiners, teachers and writers should take a more comprehensive view of the scope of the subject. The scheme still generally followed in schools deals only with the shapes and sizes of figures, and takes no account of their relative positions. That is, attention is confined to scalar properties, and a vital portion of this essentially vector subject is ignored. It seems to us that boys at school should receive some account of the geometry of space, that is, they should be introduced to the conception and domain of vectors. This domain is far reaching and of supreme importance, and in subsequent study is seldom fully comprehended because, in the supposed interests of logic, persons responsible for the teaching of geometry have neglected a part of their duties and have failed to treat the subject in a thorough manner. The foundation of a knowledge of vectors should be laid in the geometry and drawing classes, where it can be done appropriately and effectively, and able writers like the present authors could exert much influence for good by introducing the subject in their deservedly popular text-books.

Mr. R. B. Morgan's book consists of a collection of more than six hundred exercises in geometry, together with a few specimens of recent examination papers, the purpose of which seems to be to illustrate the course of geometry as outlined in the new Cambridge schedules. No answers are given to the examples, or hints for solution or explanations of any kind, and the book is only adapted for use in conjunction with an ordinary text-book. In the latter sufficient examples are usually provided, and generally of a superior merit to those under review, so that the sphere of usefulness of Mr. Morgan's book seems likely to be very restricted.

The text-book by Messrs. French and Osborn is one of the University Tutorial Series. It is a supplement to the "New Matriculation Algebra" of the series, and is intended primarily for students preparing for the London matriculation examination. The subject is introduced by some typical examples of statistical graphs, in which special attention is paid to the choice of scales and the kind of information to be obtained from graphs. The authors then at once proceed to the development of the properties of algebraical functions by means of graphs, the examples being confined mainly to equations of the first, second and third degrees. The problems dealt with relate to maxima and minima values, the solution of equations, limiting values and asymptotes, symmetrical properties, and the determination of algebraical curves to pass through two, three, or four points.

It will thus be seen that trigonometrical, exponential and logarithmic functions are outside the scope of the work, as are also considerations relating to slope, rate of increase, and the calculus. But the ground that is mapped out by the authors is well covered, and the book will be found very useful to the class of students for whom it is intended.

OUR BOOK SHELF.

Eton Nature Study and Observational Lessons. Part i. By M. D. Hill and W. M. Webb. Pp. x + 155. (London: Duckworth and Co., 1903.) Price 3*s.* 6*d.* net.

THERE is no doubt that nature-study ought to take an important place in education, but, if it is to be of use, it must be set about in the right way. If the boy is merely told certain wonderful facts, he swallows them as a whale swallows small fry, and waits open-mouthed for more. They are soon forgotten, he acquires no good mental habit, and the net result is very small.

The authors of this book have adopted a different plan. The boy has presented to him some natural object, such as a plum, a seed-pod, a sea-anemone, a crab, a sycamore leaf, mould, a mushroom, a blind-worm, a hedgehog, a bulb, a log of wood, a branch, a growing bud, a seedling, a leaf. On these he writes notes, which are partly answers to definite questions put to him and partly other observations which he makes unaided. He is being trained to observe for himself. The variety of subjects over which the book ranges is an excellent feature. Besides those already mentioned, there is the sun; by means of a simple piece of apparatus he sets about observing its apparent movements.

If the book ended with these observational lessons it would be very defective. A boy is by instinct a hunter. It is the hunting instinct that leads him to chase a butterfly, and he impales it lovingly on a pin and sets it and preserves it rather as a trophy than as a specimen from which something is to be learnt. The thing is to guide this hunting and collecting instinct. An attempt at this is made by means of the suggested outdoor studies which are interspersed among the observational lessons. For example, a little information is given about the dispersal of seeds by means of the plant's own catapults, or by the help of the wind or of animals. Fired by this knowledge the young naturalist (or rather boy that is to be converted into a naturalist) is to go out and collect illustrations of these various methods. He is also taught how to make a sundial, on the understanding that he is to set to work to make one for himself. He is encouraged to keep an aquarium (salt-water or fresh-water), to study clouds and spiders' webs, to collect and identify leaves in autumn, to make observations on fungi, British mammals, domestic mammals, to make a bird calendar, to inspect the bark of trees and the characters of timber. Rocks and fossils are not left out. Certainly it is his own fault if he becomes a narrow specialist before he is out of his teens.

The observational lessons will benefit all who are privileged to be taught in this way. The suggested studies will be helpful to those who have more than the average keenness. Summing up, we may describe it as a book that will teach the teacher how to set about his work, and that will thus be highly useful. The illustrations, with the exception of the one on p. 91, are good and really illustrative.

Camera-Kunst. Eine internationale Sammlung von Kunst-Photographien der Neuzeit. Unter Mitwirkung von Fritz Loescher. Herausgegeben von Ernst Juhl. Pp. viii + 107. (Berlin: Gustav Schmidt, 1903.) Price 4*s.* 6*d.* net.

IN these 107 pages the compilers have brought together a series of essays which gives the reader a good idea of the camera art as practised in various countries. The idea in this work has been to request some photographers, well known in their own countries, to contribute each a chapter dealing with the present state of photography in their respective countries from the point of view of art, and the result is an interesting set of opinions. Those who have written for this volume are Ernst Juhl, Hamburg; Edward J. Steichen, New York; Fritz Loescher, Berlin; Robert Domachy, Paris; Otto Scharf, Krefeld; Alfred Stieglitz, New York; Dr. Adolf Thiele, Kappel-Chemnitz; W. Bandelow, Krackow; and J. C. Warburg, London. With the increasing development of art-photography such a book as the one before us will undoubtedly be of interest to the widest circle of photographers whether amateur or professional. Not only are the opinions of each contributor given in words, but in every case a series of excellent illustrations is added showing the various styles and types of pictures of well-known photographers. Thus, to take the case only of those exhibiting the British types, we have examples of the work of Warburg, Horsley-Hinton, W. A. Stewart, Page Croft, Archibald Cochrane, Craig Annan and Alexander Keighley.

Enough perhaps has been said to acquaint the reader with the kind of book he has here to deal with. When it is mentioned that the get-up of the book is, on the whole, excellent, although attention may be drawn to some of the illustrations which are somewhat spoilt by the printing on the back, photographic readers will be sure to find it a valuable addition to their literature.

The Arcadian Calendar. By E. D. Cuming and J. A. Shepherd. Pp. xii + 215; illustrated. (London: G. Newnes, Ltd., 1903.) Price 6*s.* net.

FROM the humorous character of the illustrations it would be quite reasonable to suppose that in this entertaining little volume natural history subjects were discussed from the comic point of view; and, indeed, this was the opinion entertained by the present writer when these essays appeared in their original form as articles in the *Strand Magazine*. No greater mistake could be made; for, as a matter of fact, the observations on the habits and mode of life of the beasts, birds, fishes and invertebrates of the British islands recorded in its pages are remarkable for their accuracy as well as for their general interest. Mr. Cuming, the author of the letterpress, is, we believe, chiefly known to the public as a writer on sporting subjects; but he is evidently a keen and appreciative observer of animated nature, and he has our best congratulations on his appearance in a new *rôle*.

As its title implies, the work treats of the ways of animals at different seasons of the year; and in the section devoted to the winter months we find collected certain observations which, to ourselves, at any rate, are new. For instance, the fact that both birds and mammals may, in exceptional circumstances, become frozen to the ice on which they are resting is not mentioned in any natural history work with which we are acquainted; while the observations on the reason why many birds roost in company, if not novel, are at least interesting. Neither must we omit to refer to the author's explanation of the present relative scarcity of swallows and martins in this country; this scarcity being attributed partly to the numbers and aggressive habits of the British sparrow, and partly to the slaughter of swallows, as an article of food, by the inhabitants of southern Europe.

As to the illustrations, which are exceedingly clever and excellent of their kind, it is probable that they appeal more closely to the popular taste than they do to our own. Conjointly, the author and the artist have succeeded in producing a dainty and attractive volume, which ought to command a large sale as a gift-book.

R. L.

LETTERS TO THE EDITOR.

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

The Victoria Nyanza Jelly Fish.

IN a note occurring in your last issue (p. 348), mention is made of an interesting fact with which zoologists have for some time been familiar, namely, that the medusa characteristic of Lake Tanganyika exists at present in the Victoria Nyanza also. As it seems to be suggested that this discovery is in some way or another adverse to the theory of the origin of a portion of the fauna of Tanganyika for which I have been responsible, you will perhaps allow me space to point out that, so far from the fresh knowledge being in any way antagonistic to the view in question, the existence of the jelly fish in other lakes beside Tanganyika is exactly what one would, and did, anticipate, supposing the halolimnic theory to be correct.

The medusa in the Victoria Lake is identical with that in Tanganyika, and its presence in the former can be explained in two ways.

It may have, so to speak, existed there from all time, in which case the rest of the halolimnic fauna, or at least a part of it, should be found along with the jelly fish. In this case we should have a confirmation and extension of the view which I have already put forward, that the ancient sea from which the halolimnic "relic" sprang spread much further towards the east than was at first supposed.

It is, however, quite possible that the medusa has been recently transported to the Victoria from Tanganyika, owing to the opening up of the new trade routes, and the carriage of water in gourds and other vessels from one basin to the other.

This second view, to me, seems extremely likely, and it is certainly supported by the fact that the Victoria jelly fish is identical with that in Lake Tanganyika. Had it been long isolated in the former lake it would almost certainly now have presented specific differences, just as the fresh-water shells of the Victoria differ slightly from those of the neighbouring lake basins.

J. E. S. MOORE.

Royal College of Science, London.

The Blondlot *n*-Rays.

THERE can be no doubt that the results obtained by M. Blondlot and others at Nancy are most remarkable, even if they should prove to be, as Herr Lummer's communication to the Berlin Physical Society would lead us to suppose, purely subjective, or, as he prefers to put it, "objective phenomena in the retina."

I have endeavoured to repeat M. Blondlot's experiments, but quite without effect, using calcium sulphide screens of the dimensions he suggests, that is, about 16 mm. by 2 mm.

A thin layer of gum is spread over a sheet of cardboard and the powder sprinkled over the surface until as large an amount as possible adheres to the screen. No difference in the colour or intensity of the phosphorescent glow appears to take place when a lead screen or the hand is interposed between the phosphorescent screen and an Auer burner completely enclosed in a tin-iron box with an aluminium window, nor does the interposition of a quartz lens in various places have any effect.

A very much larger screen was exposed to the Auer burner, one half being screened with lead and the other with thin aluminium, so that only the latter half was exposed to the radiation of the *n*-rays. The luminosity of the screen was, however, quite uniform throughout, although a sharp line ought to have separated the two parts of the screen, as the intensity of the phosphorescence should have been different in the two sides.

I am at a loss to find any other explanation of M. Blondlot's results than that he has come across a radiation to which some men are blind and others not so.

Self-hypnotism due to fatigue of the optic nerve may account for results of one observer alone if he were to manipulate the lead screens and to make observations at the same time, but I think that M. Blondlot will have taken the precaution to get others to work the screens for him whilst he observed, and then compared results.

I may perhaps venture to note that a few years ago, in the course of some photometric work with fluorescent bodies, I was led to try whether one fluorescent body would increase or diminish the brightness of another (*Phil. Trans.*, vol. cxci. p. 92), but could not detect any such change within the errors of observation.

The fact that M. Blondlot has actually measured the wave-length of the *n*-rays leaves little doubt (in my mind) that what he has observed is, in the true sense, an objective and not a subjective effect, but at the same time the fact also that so many others who have tried in apparently the same way have failed, and failed deplorably, leaves still less doubt that the precise conditions upon which the effect depends yet remain to be discovered.

JOHN BUTLER BURKE.

Cavendish Laboratory, February 8.

Radiations producing Photographic Reversal.

IN a paper read before the Röntgen Society last December I pointed out that the β or γ rays from radium are capable of producing photographic reversal—a result more recently confirmed by Mr. Skinner, of the Cavendish Laboratory.

Since that particular property, shared by radiations generally, appeared likely to furnish a test of use in discriminating between rays of various kinds, I have examined also the reversing effect of polonium emanation upon photographic plates.

I find that these rays are capable of reversing pressure marks, but are unable to modify the action of X-rays or daylight upon the plate. Neither will they, even with prolonged exposure, show any tendency to reverse their own photographic effect, as happens in the case of light or rays from radium.

It is remarkable that, in their power of inducing photographic reversal, X-rays and the emanation from polonium appear to behave in a similar manner.

CHARLES E. S. PHILLIPS.

Shooters Hill, Kent, February 15.

Radium Débris.

THE valuable summary of "Researches Relating to Radium" in your issue of January 28 contained the following paragraph:—"From the disintegration theory it followed that the accumulation, during past ages, of the final products of the change of the radio-active elements must exist in the natural minerals in which these elements are found," also that helium was likely to be a product of the change.

It is the final products of the disintegration which are interesting, for if the disintegration has been going on for untold ages it is likely that other elements may have been produced from the atomic débris. It seems quite certain that radium belongs to Group ii. of the periodic classification, and no doubt to the calcium family. Is it not possible that this disintegration which has been going on for ages has given us one final "elementary" product in the shape of calcium? The close connection between the atomic weight of helium (4) and the atomic weight of calcium (40) suggests such an idea. Moreover, if one puts hydrogen in its position in the periodic classification, justified by its atomic weight, then helium comes into Group ii. along with the calcium and radium. Now, although it has hitherto been the rule to look upon the heavier elements as products of the condensation of some fundamental light substance, does not this atomic disintegration suggest that the lighter elements may be regarded as products of the breaking up of the heavier ones? When one looks at the list of elements, the small number of heavy elements impresses the mind, and the abundance of the lighter ones, those which one may regard as the final products in atomic disintegration, is well in evidence. The polymerisation of the original products of atomic disintegration may be responsible for some of the numerical relations among atomic weights.

However, attention need not be confined to the natural minerals in which the radio-active elements exist in order to find the products of their change, but the atomic débris should rather be sought in all the materials of the earth's crust. What we have now of radio-active elements may be residues. JOHN B. COPPOCK.

Science Schools, Stroud.

Phosphorescence of Photographic Plates.

HAVING seen in NATURE several letters on the above subject recalls to my mind some experiments made by me two years ago. I first observed it after developing X-ray plates, and mentioning the matter to Prof. Poynting, of the Birmingham University, he advised me to pursue the subject further.

I subsequently found that the same phenomena were exhibited with a photographic plate, whether previously exposed to light or not. I observe that your correspondent, Mr. Bloch, says, that he "chanced to empty some spent pyro developer and a dilute solution of alum into the sink of the dark room at the same time, when the whole liquid at once glowed with a brilliant phosphorescence."

By "spent pyro," I presume that he attributes the phosphorescence to the influence of the silver salt of the plate upon the solution.

May I point out that the phosphorescence is exhibited by the mixed pyro and soda solutions in an ordinary white developing dish, without any contact whatever with any photographic plate or paper, and without adding any other salt; but that the phosphorescence is not so brilliant, and takes a longer time before it can be seen?

The phosphorescence is distinctly seen by pouring the solution of pyro and soda into the dish, allowing it to remain a few minutes, and pouring it away so that only a few drops are left on the dish.

I tried to obtain a photograph of an object between the luminous dish and the camera, but without success.

My friend, Dr. Martin Young, of Birmingham, who is an ophthalmic surgeon, and accustomed to deal with optical phenomena of a delicate nature, being particularly sensitive to the faintest luminosity, in assisting me was able to localise the position of the dishes and even of glass measures containing the solutions in the dark room where no photographic plate had been in contact with the liquid.

We concluded that the phosphorescence was entirely due to the process of crystallisation taking place in a thin layer of liquid. WALTER J. CLARKE.

Gravelly Hill, Near Birmingham, February 9.

Hering's Theory of Heredity, and its Consequences.

UNTIL lately I supposed, with most biologists, that the phenomena of heredity and variation were facts which we were quite unable to explain. But having had occasion to study the subject once more, I have found in Prof. Hering's[1] address on "Memory as a General Function of Organised Matter," delivered to the Imperial Academy of Sciences at Vienna on May 30, 1870, the germ of a theory which simplifies everything, and throws quite a new light on the problem of variation. In fact, when carried to its full extent, it reduces our difficulties almost to the everlasting mystery of the nature and mode of action of mind, a mystery which can never be solved.

This address passed almost unobserved in England at the time of its delivery. It was noticed by Prof. Ray Lankester in NATURE of July 13, 1876 (vol. xiv. p. 237), when reviewing Prof. Haeckel's "Hypothesis of Perigenesis," but it is not mentioned in Darwin's letters. In 1878 Mr. Samuel Butler published his book "Life and Habit," in which the same theory is independently advocated, followed in 1880 by "Unconscious Memory." Owing to several causes these books did little if anything to advance the theory, but in "Unconscious Memory" Mr. Butler gave a translation of Hering's address, and subsequently another translation was published in "The Religion of Science Library" (*Open Court* Publishing Co., Chicago), which reached a second edition in 1897, so that probably it is attracting more attention in the United States than in England.

Prof. Hering's theory is as follows. Memory, he says, is the faculty of reproducing old ideas or sensations. Often it is a conscious act, and we call up a memory voluntarily; but sometimes these memories come spontaneously, even when we do not wish for them. To account for this we must assume that the original idea or sensation made some material alteration in the substance of the brain, vestiges of which remain, and the nervous substance is enabled to reproduce the idea at will. These material vestiges are not permanent, but fade away unless they are strengthened by repetition, although by constant effort we can recall memories with great precision.

However, conscious memories, whether voluntary or not, form but a small part of our life. They emerge but occasionally from the mass of unconscious memories, or habits, by means of which we carry on all the daily operations of eating, moving, talking, &c. In all these cases it is the unconscious memory which tells us what to do and guides our actions. Habitual performance of an action makes it easy, and after constant repetition it becomes unconscious or automatic. This would not be possible if the nervous system was unable to remember and reproduce former states of irritation, and when habits are transmitted from one generation to another they are transformed into instincts.

But memory is not confined to the central nervous system. The unconscious memory of the sympathetic system is as strong as that of the brain, and we can recognise automatic or reflex action even in a single ganglion. Indeed, the minute Protozoa, such as Vorticella, which have no nervous tissue, show irritability, which is only a form of reflex action, so we must acknowledge that they also have memory and instincts. Even plants have instincts. The roots grow downwards and stems upwards by instinct. It is instinct that makes the ivy grow towards the shade and the clematis towards the light.

Now we cannot draw a line between instinctive action and heredity. When a corpuscle of protoplasm divides, if the two halves separate we call it an instinctive or automatic action, if they remain together it is heredity. When a gnat bursts its larval skin and flies away, the flying may be called a voluntary action; the bursting of the skin is involuntary and instinctive, but so also is the formation of the skin.

But how can habits or structural variations be transmitted from one generation to the next? Prof. Hering gives the following explanation. The nervous system, he says, is a coherent unity, probably connected with every cell. Any irritation effected in one part is repeated by the others, and these repetitions would probably be stronger in the reproductive cells than elsewhere. The reappearance of the parent in the full-grown offspring can only be due to the reproduction of such experiences as the germ had previously taken part in while still in the reproductive organs. The offspring remembers these experiences so soon as the same or a similar irritation is offered. If the germ-cells of the parent organism are affected, however feebly, by the habits of the body, then the offspring, as it grows, will reproduce the experiences it underwent as a smaller part of the body. Therefore it accurately repeats what its ancestors have repeated through innumerable generations. When the first germ divided it bequeathed its properties to its descendants, the immediate descendants added new properties, and every new germ reproduced to a great extent the *modi operandi* of its ancestors. Each generation endows its germ with some small property which has been acquired during life, and this is added to the total legacy of the race. Thus every living being of the present day is the product of the unconscious memory of organised matter.

Such is Prof. Hering's theory of heredity and variation. I have rearranged the argument, condensing in some places and enlarging in others, but it is essentially the same as when he announced it thirty-three years ago. It has been said, on high authority, that Prof. Hering has merely substituted the term "memory" for the "polarity" of Mr. Herbert Spencer. But this is hardly correct, for Prof. Hering, by showing that heredity is a series of reflexes, each one of which acts as the stimulus to the next, has substituted a fact for a metaphysical conception, and in doing so has brought heredity into line with instinct and habit, the last of which we can understand to some extent. Of course there are difficulties in the way of accepting the

[1] Prof. Ewald Hering, F.R.S., Director of the Physiological Institute at Leipzig.

theory, but before considering them let us see how Hering's theory affects our ideas of variation.

In the first place it gives an explanation of the definite variation which we see in the development of non-adaptive or useless characters. A variation, once started, would in the future have a tendency to be reproduced, and this tendency would get stronger and stronger as the memory is reinforced by repetition, and when once established the variation would be quite definite. New variations may be indefinite, but they must either die out or become definite; and we see by Hering's theory why useless characters may be as constant as useful ones, for constancy depends upon the number of repetitions and not on the nature of the variation or on the reason for its survival. This includes, of course, use-inheritance, for according to the theory, when an organ is constantly exercised the memories of the component parts are strengthened, and in the next generation the organ is reproduced better developed than in the last. It is the same with instincts; they are the inherited modifications of mental operations, while a structural development is due to the inherited modifications of physical operations. When an organ is not used the memories of the parts are weakened, and in the next generation the organ is reproduced in a more feeble condition, until at last it is not developed at all, the memory of the operation having been lost. The process is exactly the same as the gradual loss of an instinct from disuse; both are due to forgetfulness.

With regard to the action of external causes, Hering says that each generation endows its germ with some characters acquired during life. But we cannot suppose that adaptations to new circumstances are directly produced by the action of the surrounding conditions. For example, the fur in many animals gets thicker in cold climates and some plants get spiny coverings in dry climates. These cannot have been directly produced by the action of the climate, but must be due to the action of the protoplasm resisting the climate. Dry air could not directly produce the spines on a plant any more than it could produce the water-pouches in the stomach of a camel. Neither could feeding on nectar have produced the honey-bag of a bee, for it would be absurd to suppose that sucking liquid through a tube could cause a projection to grow out of it. We might as well say that rain and wind build houses or that snowstorms make great-coats as to suppose that the action of external influences made the cell-wall or the thick fur. Evidently it is the living protoplasm which originates these adaptations to protect itself from the rough elements or to prevent itself from being poisoned or starved. But how variations originate, whether they be intelligent and purposive, or whether they be blind, haphazard gropings after some change when the protoplasm feels uncomfortable, Hering's theory does not tell us.

There are other facts connected with variation which are explained by Hering's theory. As the germ contains two different memories, derived from its two parents, these may clash and antagonise each other, and so allow an older but dormant memory to be stimulated into activity. This is atavism. Or degraded characters which have suffered from disuse can, on a renewal of the old stimulus, again be recalled, as we see in proteus, which gets dark in colour when kept in the light. Prepotency can also be explained on the supposition that the germ of one parent has stronger memories than that of the other; and the reproduction of lost parts may perhaps be due to the memory of the remaining portions trying to replace the lost portion. In the same way we see that mutilations could not produce degeneration or the loss of a part, no matter for how many generations they may be carried on, because the part develops and the stimulus has been given before the part is removed. Again, the fact that variations appear at an earlier stage in the offspring than in the parent may be taken as evidence that they are due to an excited memory which anticipates events. But I do not see how Hering's theory can explain the infertility of hybrids. Conflicting memories might lead to inaction, but I cannot see why these conflicting memories should arise until the time had come to differentiate the embryo into the form of one or other of the parent species. This would give rise not to sterility, but to abortion, while it is thought that the fœtus generally perishes at an early stage of development.

Now let us consider the obstacles to believing in Hering's theory.

In the first place it may be objected that it is impossible to suppose that the small ovum, or still smaller spermatozoïd, could contain all the memories necessary for building up the adult organism. This is an objection which applies to all hypotheses except epigenesis, and it is of considerable weight. However, the capacity of the germ-cells for storing up memories is not unlimited. It is only very few indeed of the impressions stored in the brain that are also registered in the germ-cells, and this, I think, is favourable evidence.

Next we have the difficulty of understanding the transmission of variations from different parts of the body to the germ-cells. This difficulty also is not peculiar to Hering's theory, but is common to all, and however difficult it may be to understand, we know that, with instincts, it is a fact. Darwin certainly said that it was an error to suppose that instincts were inherited habits, for they were due to natural selection. Romanes, following him, said that some instincts owed their origin to natural selection, while others were inherited habits. But natural selection, as Darwin also often said, cannot originate anything. It can only develop characters which are transmitted, and if habits—which are only mental variations—were not transmitted, natural selection could not develop them. These mental variations must have been transmitted by some physical process from the brain to the germ-cells, and adaptations of all kinds must in like manner have been transmitted, or there would have been no progress in the animal and vegetable kingdoms.

For instincts in animals must have been acquired either by inheritance or by imitation, and we have only to select instances where imitation is impossible to prove that instincts are inherited. For example, when a newly born baby cries, it is not imitating anyone in the room. It is repeating what its father and mother did in similar circumstances. It is the same with breathing. This must have commenced as a semi-conscious act which quickly passed into a habit and then became instinctive. When the crying of babies first began I do not know, but breathing has been instinctive ever since the Carboniferous period. Millions of generations, one after the other, have performed the operation, and it is now out of our power to stop it. Again, young fish never see their parents, yet they follow their habits, as also do young cuckoos and many insects. But I need not multiply examples; these are sufficient to prove that instincts are transmitted. If instincts are transmitted it must be through physical modifications made in the brain, and if this is the case there can be no doubt but that other physical modifications, not in the brain, can be transmitted also.

Prof. Hering says that the nervous system, which collects impressions from all parts of the body and transmits them to the brain, transmits them also to the germ-cells. But in plants and in animals without a nervous system the protoplasm itself must do the work, and it is therefore possible that the nervous system may not be used for this purpose in the higher animals. This is a question for future biologists to solve. But whatever the explanation may be, we must recognise as a fact that variations in external characters influence the germ-cells, and that the germ-cells reproduce these variations. If we call the analogous process in the brain memory, we must either apply the same term to the process in the germ or invent a new one.

Now we come to the last great difficulty, that of believing mind and memory to exist in the tissues of animals and plants. The best way of examining this difficulty is to ask ourselves What we mean by life? and How we recognise living matter?

As everyone knows, we recognise its presence by certain movements which are distinguished, without much difficulty, from movements due solely to physical energy. A bird flying through the air is alive, as also is a seed if, when placed under certain conditions, it commences to grow. Assimilation, or feeding, is the basis of all these movements. It supplies the materials for growth and the energy necessary for the movements.

This process of assimilation is only found in protoplasm, but it is not an essential property of that substance. We have dead protoplasm which has been killed by heat or starvation, by poison or by violence of some kind. These agencies, however, may cause disorganisation either in the structure or in the composition of the protoplasm, so that protoplasm so killed ought possibly to have another name. But this does not apply to all cases. When the oöspore of some of the lower plants—such as Chara—begins to germinate, the contents divide into two portions of unequal size, and while the smaller cell goes on developing the larger one never again moves, but its contents are gradually absorbed by the smaller cell. The larger cell of the two contains only dead protoplasm which has been separated from the living substance by the process of cell-division. Each contains part of the old nuclear plasm and part of the cytoplasm, and it is not supposed that they differ either in structure or in composition. It is the same with the polar bodies which are extruded by reproductive cells when they are maturing. They also are composed of dead protoplasm which has been pushed out by the living protoplasm remaining in the cell. The polar bodies cannot move by themselves, nor can they assimilate; they are dead protoplasm. Consequently we must assume that life is an adjunct and not a necessary quality of protoplasm.

Neither are the movements themselves life. When we speak about gravitation we do not mean the fall of bodies to the earth, nor do we call the movements of the mariner's compass magnetism. In both cases it is the *cause* of the movements which we designate as gravitation or magnetism, and it is the same with life. Now what do we know about the cause of these movements?

In the higher animals we recognise that vital movements are due to mind, that is, to intelligent action, where means are adapted to a definite purpose. We can only recognise mental action in others by the movements it produces, and it is by the nature of these movements that we judge of its presence. One great characteristic of mental action is cooperation, by means of which work is done which could not be accomplished by isolated action. This gives rise to harmonised movements either of different parts of the body or of different individuals.

Another characteristic of mental action is that it is capable of improvement by repetition. This is due to memory, which, by repetition, converts the irresolute movements, which are undertaken for the first time, into automatic or resolute movements. These automatic or reflex actions we recognise by their indefinite relation to the stimulus. The same stimulus may produce different effects in different parts of the body, or different stimuli may produce the same effect upon the same part of the body. Again, by constant repetition a stimulus may either fail to produce any effect owing to the protoplasm having got accustomed to it, or repetition may intensify the first effect. This is very different from the action of the physical and chemical forces, which act as resolutely the first time as afterwards; yet we sometimes see it stated that reflex action is purely mechanical, and that it is a proof that living matter is as much under the influence of fixed laws as is inert matter. A little consideration, however, will show us that such is not the case, for if reflexes were mechanical actions they would act with as much certainty the first time as the last. But it is not so. The truth is that in the higher animals when a new stimulus arrives at the brain it is examined by the mind and certain action is taken. When the same stimulus arrives a second time, the mind comes to a decision more quickly, and constant repetition makes the brain act unconsciously. Also reflexes are not immutable. The degree of difficulty in changing them depends upon the number of repetitions to which they have been subject. A habit may be formed and become reflex, but we can generally alter the habit if we try. Even the instincts of insects are not altogether unchangeable, and we occasionally see reason come in and alter them. It is only very old instincts, like breathing or the beating of the heart, which are quite fixed. This, again, is very different from physical law. Reflex action is only pseudo-mechanical. It is law which mind has imposed upon itself to save itself from trouble, and if the action has not gone on too long it can be varied. This, indeed, constitutes the difference between physics and physiology. In physics we have to do with fixed law only, but in physiology we find both law and custom.

Much interest has lately been aroused by the demonstration that in the ova of some animals the centrosomes can be produced and development started by the action of certain reagents, such as magnesium chloride, and this has been taken as a proof that physical can be changed into physiological energy. But the chemical reagents cannot form the centrosomes; the materials must be there and the stimulus merely starts them into action. The protoplasm of the ovum, on being stimulated, whether by the natural stimulus of fertilisation or by an artificial one, sets to work in the only way it knows, that is, by preparing for the process of mitosis. This, and the growth of the pollen-tube when stimulated by an application of sugar, are merely cases of reflex action.

These unconscious movements often have a harmonised action, as if they had originally been intelligent, and in the higher animals we rarely have any difficulty in distinguishing movements due to mind from those due to the physical energies.

In the lower animals and plants the action of conscious mind is not evident; but we recognise the presence of life by movements which correspond closely with those due to unconscious mind in the higher animals, that is, we can recognise harmonised action and changeability.

First we have movements which are called spontaneous, that is, they are not directly connected with external causes. These may be voluntary, that is, due to the will, or reflex, that is, are performed unconsciously on the application of a stimulus. What is called irritability in protoplasm is merely reflex action, and if reflexes are due to experience they imply the presence of both mind and memory.

Secondly we have, in all living protoplasm, the phenomena of growth and reproduction. Growth by assimilation is considered to be an attribute of living matter, because it is a process which, at present, cannot be imitated by chemists. But increase in size also takes place in minerals, and it is the characteristic direction of growth to which assimilation gives rise by which we recognise living substance. This direction of growth undergoes gradual changes, but new variations are inconstant; they may not be repeated, or only partly repeated. But if they are repeated, then they become constant, and will remain so for many generations, notwithstanding varying external conditions.

Now it will be noticed that these characteristics of living matter are practically the same as the characteristics of mental action in the higher animals. We have changeableness, learning by experience, cooperation and harmonised action, and we cannot help associating life with mind. Not only is it true that where there is mind there is life, but the converse is also true, where there is life there is mind. Mind seems to be the cause of the movements by which we recognise living substance. It is the "vital principle" of some physiologists. Life has no entity of its own; what we call by that name is the movements of protoplasm under the direction of mind. Or life may be said to be mind made manifest to us by the movements of protoplasm. Or life is a special kind of motion caused by the action of mind on the molecules of protoplasm, the characteristics of which are spontaneity and adjustment. This mental action is active and often conscious in the higher animals, sluggish and subconscious in the lower animals, and passive in plants, but it is there in all.

Thus we have come by a different line of argument to the same conclusion as that of Prof. Hering, namely, that mind exists in all living cells, and where there is mind we must suppose that there is the capacity for memory also. Thus we see that biology is a branch of psychology. It is the study of the growth and development of protoplasm under the influence of mind, and this influence ought never to be forgotten when studying the fundamental problems of biology.

But this is not all, for, if the theory be true, it necessarily follows that mind must be, to some extent, a free agent capable of controlling the physical energies. For if it were not so it could not superintend the process of assimilation, neither could it defend protoplasm from the action of external agencies. Mind is only subject to those laws which it has imposed upon itself. However much we may marvel, we must allow that this is a fact of experience, and as inductive science is founded on all the facts that can be obtained, the spontaneous movement of living protoplasm can no more be omitted than the absence of initiative in non-living matter. So that, although we cannot explain how mind influences protoplasm, we must acknowledge that it does do so. Variations may depend upon the amount of stimulus received by the mother cell, and they may be developed automatically by selection, but neither selection nor stimulus can originate new processes or new structures. It is impossible to suppose that the external physical agencies, when they act upon protoplasm, antagonise their actions by forming chemical or physical combinations, for this is so different from what happens with dead matter. Dead protoplasm can no longer resist the attacks of other organisms, and it is only by undergoing the process of assimilation that it can be revivified. If there is any truth in Mr. Herbert Spencer's definition of our conception of life as the continuous adjustment of internal to external relations, it follows that living protoplasm must be free to adjust itself. But whether these adjustments were intelligent and purposive or whether they were due to haphazard gropings after change is a separate problem which still requires solution. All that we can say at present is that while dead matter is subject altogether to fixed laws, living protoplasm is, to a certain extent, free to act. To it has been given the power of adaptation or antagonism to the physical laws which the rest of nature obeys implicitly. Ever since living matter appeared on the earth a constant war has been waged between dead and living matter, and mind has won, the result being biological evolution. Chemical affinity has been taken advantage of by mind to protect itself from enemies. Physical energy has been used to break down chemical affinity, and then mind has been able to lay up a store of potential energy. But it has overcome the physicochemical laws only by obeying them, and this has given rise to the illusion that it is not free but subject to fixed law, like dead matter. This, however, cannot be the case. At first mind was free to act, but constant repetition of the same experiences made it an apparent slave to the physical forces, although when attention was occasionally called into action by new external irritants it again reasserted itself. But this was followed by relapse. The cooperation and concentration of nervous matter, however, still went on until, in the brain-cortex, attention developed into consciousness, and in the large cerebrum of man, mind has once more passed into its original free state. It is this form of volition that we call free-will.

Such I believe to be the full scope of Prof. Hering's theory. I must confess that I have gone beyond his address, and I do not know that he would agree to all that I have said. But it is evident that we must either assume a freely acting mind as the mainspring of organic development, or we must try to explain it on a purely mechanical basis, a task which appears to me to be quite hopeless. F. W. HUTTON.

Canterbury Museum, Christchurch, New Zealand.

Curious Shadow Effects.

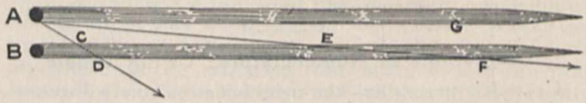
I THINK that the following is probably the explanation of the phenomenon referred to in NATURE of February 4—the seeing of more shadows than your own.

A and B are neighbouring observers; their shadows make dark tunnels in the illuminated mist.

Usually, the eye cannot penetrate far, and if A is to see his neighbour's shadow he has to look *across* it, as along ACD, and the layer CD is too thin to be noticeable. Or, if he can see further, as along AEF, the glare of the illuminated mist between A and E may prevent him from noticing the thicker dark layer EF. He sees his own shadow because he looks more or less *along* it. But under suitable conditions his eye may be able to penetrate so far that he can see the thicker layer EF of his neighbour's shadow, while yet there is not much glare near at hand, *i.e.* in the part AE, to dazzle him; the mist in this region may be very thin. [The diagram does not represent clearly the way in which the shadows "tail off" and vanish at a certain distance owing to the finite angular magnitude of the sun.]

If the angle GAE be not too great, A will see B's shadow within his own halo.

This halo I have always taken to be the ordinary rainbow. It may look small, but the true criterion is its angular



magnitude. This would not, however, explain the oval bow spoken of in NATURE, January 28. W. LARDEN.

Devonport, February 5.

IT is obvious that the bow seen by Mr. Warner and described in NATURE of January 28 (p. 296) was the "Ulloa's ring," the "Nebelbild" or "Brockengespenst" of the Germans, fully explained by Fraunhofer. The oval form is a necessary consequence of our seeing the sky as a depressed vault or segment of a hollow sphere, as I have demonstrated it in my "Meteorologische Optik," I. Abschnitt, p. 29 *ff.*; see especially p. 33, Fig 5.

I beg to answer also Mr. John A. Harvie Brown's question on shadows in the "Brocken," asked in your issue of February 4. He says:—"How was it that more than one image was visible to each of our party?" Mr. Harvie Brown states that "not one of us saw more than one set of concentric rainbow bands or circles." The answer seems to be simple. The shadows are objective, and therefore visible to everyone; the coloured circles are only subjective, and consequently one person sees only one set of rings. I know that in text-books one reads the statement, "the observer of a 'Brocken' cannot see his companion's shadow," as, for example, in Müller's "Kosmische Physik" (even in the edition of 1894), but this is evidently erroneous.

Wien, Hohe Warte. J. M. PERNTER.

THE staff of the Ben Nevis Observatory have had frequent opportunities of observing the coloured shadows formed round shadows thrown on mist or fog-banks; notes descriptive of these "glories," as we termed them, with measurements of their diameter, will be found in the extracts from the log-book printed with the other Ben Nevis observations (see *Transactions* Royal Society Edinburgh, vols. xxxiv. and xlii.). In each ring of these glories the red of the spectrum colours was outside and the blue inside, as in the primary rainbow, and as many as five successive rings of colours have been observed.

The outside diameter of the largest ring never exceeded 12°, and was more usually about half that amount. Glories are thus of the same order of size as the coronæ frequently seen round the sun or moon, and are distinctly smaller than halos, the ordinary halo having a diameter of about 44° (radius 22°), while rainbows and fog-bows are, of course, larger still.

In respect to Mr. Warner's letter, I may say that no oval-shaped glories have been seen on Ben Nevis, but other observers have described them, and a possible explanation may be that a circular ring is formed on a surface at right angles to the sun's rays, but the observer assumes that the ring is formed on a vertical surface, and therefore it appears oval to him. However, the low angle of the sun's rays at Christmas time does not differ sufficiently from the horizontal to cause in this way the elongated oval shown in Mr. Warner's sketch; there must be other factors to consider.

With regard to the shadows of other persons, our experience on Ben Nevis was that if the fog-bank was a considerable distance away, the shadows of others could be seen just as on a wall; but if the fog was close to the observers, the only shadow seen resembling a human figure was one's own. Sometimes, however, when a thin fog was close to us on one side, and bright sunshine on the other, I have seen the shadow of a man standing 10 or 20 yards away as a dim dark streak running back into the fog. The shadow, in fact, was not formed on any definite surface, but was a shading of the drops forming the fog throughout a considerable distance. Each person looking at his own shadow sees this shading end on, but he can get only a side view of his neighbour's shadow when the fog is near. When the fog-bank is far away compared with the distance between two spectators, each is looking at both shadows practically end on, and both are easily seen.

Edinburgh, February 6. R. T. OMOND.

Corrections in Nomenclature: Ca'ing Whale.

CA'. It's unco silly—the neighbours ca' me a Jacobite = *call.*

Ca'—And the young lads hae na wit to *ca'* the cat frae the cream = *drive* (*v.* "Encyclop. Dictionary").

J. A. HARVIE BROWN.

THE CENTENARY OF KANT.

A HUNDRED years have now passed since the death of Kant. On February 12 the great philosopher died at Königsberg, in East Prussia, where he spent practically his whole life, a long, laborious and ascetic one, in the single-minded and ardent service of science. That his teaching created a remarkable epoch in the history of thought, an epoch, indeed, to which we refer and by which we estimate, of necessity, all subsequent developments, will not be disputed, and so important a centenary has naturally claimed the attention of the whole cultivated world. Immanuel Kant is so much akin to some of our English writers, notably Locke and Hume—was it not Hume who, in his own words, "aroused him from his dogmatic slumbers" and, moreover, does he not himself tell us of his Scottish ancestry?—and in some respects was so much influenced by them, that England may well join with Germany in paying a tribute of reverence to his memory. Kant literature is so voluminous already, and the story of his life, so far as he had a life apart from his work, has been so well told, that little remains to be said beyond a brief reference to his intellectual affinities and to the relationship of his critical philosophy to the existing world of physical science, to compare, in other words, the *a priori* and ideal with the naturalist and *a posteriori* results. An antithesis between these two halves of thought has ever been a prominent feature in our efforts after knowledge, though of late it has grown to be regarded as a convenience in classification rather than an absolute distinction. For many of us the policeman still acts as the representative of ethics, and we are seldom transcendental except in personal instincts. It is also incontestable that

> "Until this paragon of spheres
> By philosophic thought coheres,
> The vast machine will be controlled
> By love and hunger as of old."

But in rational development nothing pleads more urgently for reconciliation in the future than these two great currents of human activity, one of which owes so much to the genius of Kant and the other to the indefatigable energy of recent research.

So many and so varied workers have been animated by the spirit of Kant, conscious or unconscious of their debt, that there is a danger of overlooking the strength of his influence. Most can raise the flower now, all have got the seed, and even such dissimilar minds as Hegel, Schopenhauer and von Hartmann are truly consequent on Kant. A whole army is the better equipped for the "celestial panoply" of that solitary epoch-maker, lifted above the merely objective events of his age to his *bestirnte Himmel* by a torrent of thought setting inwards, centripetal rather than centrifugal. So fine a mind, frailly supported by a delicate physique yet disciplined to a rigorous austerity in matter and spirit, was surely destined to fame. The philosophic habit cannot be put on like a garment. It is all or nothing. To be influenced at all is to be responsive in every fibre; and with Kant the relation of the mind to its world was the San Graal of his quest—his religion. It was for him, too, its own reward, and almost the sole one, though in time he gained more of contemporary fame than comes to some of the great ones of the earth. For, as Spinosa says so deeply, "He who loves God truly must not look to be loved by Him in return."

It is interesting to note that the manner of Kant's intellectual development, as instanced in the chronological record of his works, is from the simpler to the more complex, from the physical to the psychical. It may be pointed out in this connection how solid was the foundation of empirical knowledge upon which he based his epistemology, and this is surely the *sichere Gang der Wissenschaft.* In this long period of apprenticeship we may trace the workings of that marvellous intuitive faculty which he employed in the more abstract realms. His treatises on physical subjects traverse a wide range. In "Thoughts on the True Estimate of *Vis Viva*" he shows the Cartesians and Leibnitzians to be fighting about different things. The dispute was due to incorrectness of definition as to the meaning of force, but it is only fair to say that Kant's views, unknown to him, had been anticipated. In another essay he affirms that the earth's rotation is slowly retarded by the action of the tides. But the "General History and Theory of the Heavens" of 1755 was a more ambitious work. He was then aged thirty-one, and at the height of his speculative power; extending the cosmographical conceptions of Newton to the whole phenomenal cosmos, he introduces for the first time the conceptions of the nebular theory. Though worked out more fully in its details by Laplace at a later date, this soul-stirring thought owes its essential origin to Kant, and may well be associated with his name rather than with that of the great Frenchman. This efflorescence of Kant's comprehensive outlook has been the greatest triumph of cosmography since the publication, some two hundred years earlier, of the "De Revolutionibus Orbium Cælestium." And in his later work Kant was another and no less influential Copernicus who showed how the planet feelings circle round the constructive and illuminating mind, where erstwhile that sun of reason had been held the satellite. He too divined that Nature, in its silent unplumbed depths of space and mind, holds more than earth and man.

The growth of the body of knowledge since the death of that old man in Königsberg may be held to show more of bulk than of differentiation. Yet when we look to the fact that he forged a weapon of research, ready to the hand of all, rather than spend his labour within the meshes of a system such as those woven by Comte and Spencer, we find cause for saying that Chronos does not always devour his own children. We are all thinkers, on our several planes, and the struggle for existence forces us to acute thinking at times, but we commonly fail to shut out the seeming discord between speculative ideals and experience. The pressure of that "unconscious" which according to von Hartmann moulds our lives may seem the agent in advance of materialism, though the moral sphere is not yet wholly at its mercy. The universal practical acquiescence in the dogmas of conduct still silences theoretical doubt. In spite of the gigantic accumulation of scientific facts, no Œdipus has yet returned an answer more permanently satisfying than that which was given by Kant to the central question of the sphinx of life, as to the conditions of all and any knowledge and of the meaning of personal identity, which must always most strenuously exercise our highest faculties. If there has been any marked shifting of ground, it has been towards the region of personal experience, a return to the principle of *cogito, ergo sum*, a principle of more metaphysical treasure than Descartes himself discovered. The living and dynamic nature of the self has come to stand out in more striking relief. The self-realisation of Hegel and the will of Schopenhauer, ideas so typical of the resolute individual character of western ethics, will illustrate one of the many lines along which Kant's impulse has acted. In nothing is he more emphatic than in urging the necessity of a critical inquiry into the foundations of knowledge before attempting to deal with the opposing dogmatisms of physics and metaphysics, and it is just the validity of his own *Kritik* which has made the later times so productive of reconstructions. The parts in our vast system of knowledge have at the same time become more and more related to an organic whole. More and more has the analogy of the living organism, with its parts in the whole and its whole in the parts, become descriptive of the body corporate of thought, and it may perhaps be said that it enters into our conceptions of the whole of being. Perhaps the full result of this idea in its religious aspect has not yet been realised. Certainly the living purpose of the abstract physical law has not yet been successfully formulated either by transcendentalist or materialist.

ALFRED EARL.

THE FORMATION OF CORAL REEFS.

CORAL reefs are divided into three classes, fringing, barrier and atoll. A fringing reef forms a terrace at the low tide level, extending out from the coast of any land, while a barrier reef is a rampart at the same level, lying parallel to the coast, from which it is separated by a deep channel. An atoll is a ring-shaped reef surrounding the lagoon, a basin varying up to 50 fathoms in depth; it is thus in no way connected with any land other than may form upon it.

A typical atoll has a flat encircling reef, generally with a series of islands upon it and a number of channels leading into its lagoon. Where land exists, the reef may be a mile or more broad, but commonly averages about 500 yards. Its surface is a flat of coral limestone almost completely bare of sedentary life. Towards the ocean its edge appears as if the waves were cutting a series of canals into it, but this appearance is really due to buttresses being built out from the rock behind by the reef organisms. Beyond this edge the bottom is extremely rough, but passes gradually into a more even slope. This area, the *reef platform*, may have hollows and pockets filled with débris, but its prevailing characteristic is its almost complete covering of corals, nullipores, Foraminifera, Polyzoa, and other sedentary organisms. At about 250 yards from the edge of the reef, where its depth is about 40 fathoms, it passes somewhat abruptly into a *steep* at a slope often exceeding 50°. This continues to about 140 fathoms, after which the slope, becoming quite moderate, passes gradually into the contour of the surrounding sea. The steep has never been properly investigated, but swabs bring up loose dead masses of such organisms as cover the reef platform above. Their presence is due to the undercurrents resulting from the sea striking on the atoll, which sweep down the reef platform, giving a talus slope (Fig. 3). Again, we have little knowledge of the lower slope down to 500 fathoms, where deep-sea life probably dominates. Shoals at such depths are densely covered with corals, but off atolls the lead only occasionally brings up a cup. Probably sedentary life is far from scarce, as the fine coral mud, so deleterious to coral life, appears to be swept further out.

Lagoons vary greatly in accordance with their size and depth. A fairly open one has its bottom above the 25 fathom line either bare or covered with coarse sand, but deeper a fine mud may be found. Commonly the depth of any deep lagoon bears some proportion to the depths of the passages into it. Shoals occur anywhere in it, reaching the surface and forming broad flats. From the lagoon floor they arise abruptly, as does also the encircling reef (Fig. 3), a gradual slope to 20 fathoms or less covered with decaying coral masses, and then a perpendicular cliff to the surface.

The examination of the surface of the encircling reef shows it to have been formed by corals, bound together by other organisms. These corals form a definite class not extending below 25 fathoms in any luxuriance. They feed mainly—and many entirely—by their commensal algæ, so that they, as also the nullipores, are dependent for their growth on light and constant change of the water. They are profoundly affected by any deposition of mud, and for this reason upgrowing shoals are rare in lagoons except near passages. The enormous amount of mud formed is shown by its sinking as a deposit around atolls. The muddy water that streams out of the lagoons in stormy weather shows where it originates; but little can come from the surface of the reef, which is stationary in height, and still less from the reef platform, covered as it is by the bodies of living organisms. It is the result of the action of the boring and sand-feeding animals of the lagoons breaking up the coral skeletons and grinding them into the finest mud, much of which passes into suspension in the water. The corals on any low part of the encircling reef over which the lagoon water may pour are killed by this mud, leaving bare areas for the entrance of boring organisms, with the result that a new passage may be cut through the rim into the lagoon. That solution is also of great importance in the lagoons seems certain, for the mud at the bottom of such a lagoon as Suvadiva contains more than 2 per cent. of silica, whereas the sand of the reef has less than 0.04 per cent.

At 40 fathoms different genera of corals, not dependent on commensal algæ, dominate, and at the edge of the reef platform are the builders, their mortar consisting mainly of the encrusting Polytrema. They range from the surface, where they are almost choked out by others to 50 fathoms or more, and probably form an important connecting link between the surface builders and the true deep-sea corals, which in the tropics are seldom found above this latter depth. Their rate of growth, and also that of the surface forms, is enormous. Indeed, it would be moderate to estimate that a shoal at 25 fathoms would be built up to the surface in 1000 years, and that one at 50 fathoms would scarcely take more than twice as long.

Recent work has shown that all coral reefs can scarcely be explained on one method of formation. Four modes naturally suggest themselves.[1] (1) (Fig. 1) On any elevation on the bottom of the ocean sedentary animals naturally congregate. Their remains build up its summit to an extent out of all proportion to the upgrowth of the surrounding area, so that it ultimately approaches the surface. The deep-sea corals in warm latitudes give place to their intermediate depth allies, and these again to the reef builders, so that our peak is ultimately crowned with a surface reef. It will be readily understood from the

[1] A fuller consideration of some of the views here put forward will be found in "The Fauna and Geography of the Maldive and Laccadive Archipelagoes," pp. 12–50, 146–183, 313–346 and 376–423.

description above of a typical atoll that such a reef extends outwards on its own talus to form a great broad plateau. Boring organisms enter on its central part and cause the rock to decay. Sand-feeders follow

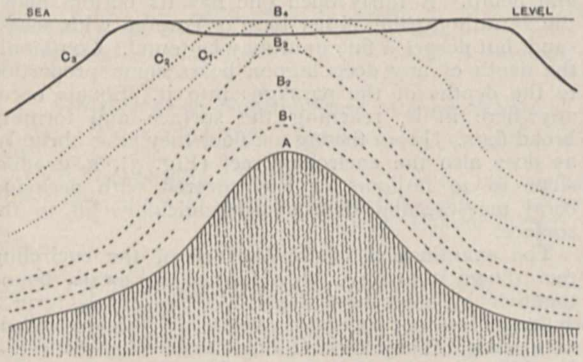


FIG. 1.—Diagram to illustrate the first method of formation of an atoll. A, Original mound on the sea floor. B 1–4, Growth of the same to form a surface reef. C 1–3, Extension outwards and formation of an atoll.

and triturate up the fragments, throwing a constant stream of fine mud into suspension in the water to be removed by the tidal and other currents. Assisted by the solubility of coral in sea-water, a lagoon is formed in the centre of the reef, and passages are cut later from it along the lines by which its muddy water escapes. The process may continue to form an atoll of the largest size, such even as Funafuti or any of the Ellice and Gilbert groups, which appear to have arisen on a single mountain range.

(2) (Figs. 2 and 3) The second method of formation depends on the power of the ocean currents to cut down land and form submarine banks. It is exemplified by the Maldive Group, the main chain of which is more than 300 miles long, and lies at right angles to the monsoon currents of the Indian Ocean. Here the action of the currents appears to have cut down a great tract of land, or at least a series of peaks, to form a plateau more than 100 fathoms in depth (Fig. 3). It is easy to see how the loose mass of cinders formed in a submarine eruption might be so cut down to 30 or even 50 fathoms, but this action, when first proposed for the Maldives, seemed extreme. It has, however, received strong support from the work of the Siboga Expedition in the East Indies. At depths below 50 fathoms it is obvious that from the first the organisms on the periphery of the bank so formed would grow up more rapidly, and so an atoll as such would directly arise (Fig. 2). The whole action might proceed extremely rapidly. Indeed, it is not unlikely that the shoal marking the site of what was once

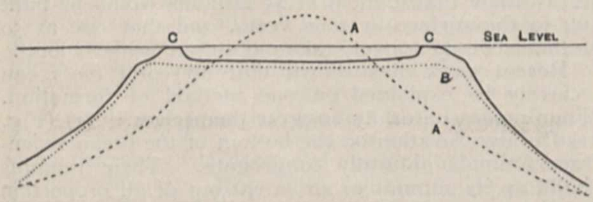


FIG. 2.—Diagram of the second method of formation of an atoll. A, Contour of the original island. B, The same cut down to form a plateau C, The atoll reef.

Falcon Island, Tonga, will by 4000 A.D. be occupied by a considerable atoll. The action on a land like the Maldives, which is of considerable linear extent and of more solid construction, would proceed more slowly and show many modifications. A certain number of channels would be retained and even deepened as the rim grew up. Each piece of rim as it formed would give a protected area behind itself around which the currents would sweep, and might thus become separated as a distinct bank or atoll. The same action might occur at two or three levels, and in this way the whole bank, instead of being crowned by one atoll ring, might be surrounded by a series of secondary atolls, their rims again formed by series of still smaller tertiary rings. This, in truth, appears to be the case in the Maldives, but the continued upgrowth of the rims of the secondary atolls is uniting the outer sides of the

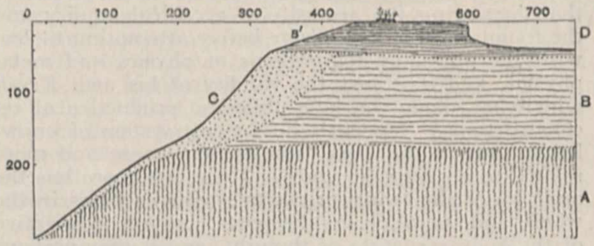


FIG. 3.—Section of th outer edge of one of the Maldive atolls. A, Foundation of primitive rock cut down by the currents. B B', Upgrowth of th rim by the deep-sea, intermediate depth and reef organisms. C, Extension outwards by means of the talus slope. D, Lagoon. (*Scale in fathoms.*)

tertiary rings, while their inner parts are being removed.

(3) (Fig. 4) A flat terrace is formed around the shore of an island by the action of the sea on the land, and is covered at its edge by reef organisms, or a fringing reef is formed. Subsequently, the edge of the terrace grows outwards and its inner part is removed as in (1), formin~ a barrier reef. Eventually, the original island, owing to similar causes, disappears, leaving an atoll. This method is of quite wide occurrence in

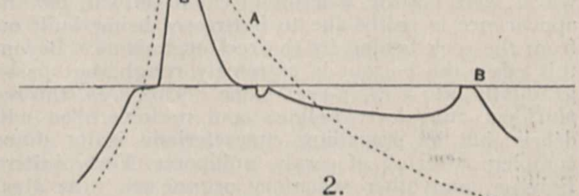


FIG. 4.—Sections across (1) Ongea Levu, Fiji, limestone, and (2) Wakaya, Fiji, volcanic, to illustrate the third method of formation. A, Supposed contour of the original land. BB, Section across the existing land and reef. (*Vertical scale many times the horizontal.*

areas where elevated coral reefs are found (Fig. 4, 1). Every stage can be followed in the limestone islands of the Fiji group. It also occurs, though much more slowly, around other islands. A good example is Wakaya, Fiji, which has to the west a broad fringing reef, half formed by a terrace cut out of the land and half by a true coral formation, and to the east a barrier reef separated by a channel $3\frac{1}{2}$ miles from the land, which still retains a definite terrace of the volcanic rock (Fig. 4, 2).

(4) Lastly, the subsidence of land might give a suitable foundation on which a reef could *build up to the surface* either as an atoll or subsequently to form one. It has no doubt constantly produced large areas where (1) and (2) could act, but, where it has directly brought about the formation of atolls, it has probably been a purely local phenomenon. In no case can the mere existence of any atoll or reef be considered as evidence of any subsidence. Certain elevated reefs appear possibly to have owed their origin to this mode of formation, but there is no definite evidence in support of it for any existing reef, though certain reefs in the East Indies and to the south-west of the Indian Ocean may have so originated.

The first three modes of formation resemble one another in that to produce the characteristic forms of reefs they depend on factors which can be clearly seen in progress at the present day. Indeed, on each atoll may be found the same influences at work as produced its structure and appearance. The topography of the numerous submerged tropical banks of the Indo-Pacific region, that reach within 50 fathoms of the surface, strongly supports (1) and (2), but the examination of others at greater depths, such as the Saya de Malha and Nazareth, is exceedingly desirable. More light, too, is imperatively demanded on the conditions and life of atoll slopes and shoals from 50 to 500 fathoms, where the characteristic deep-sea conditions would seem to prevail. The study of the fauna also down to these depths over any large region or ocean may confidently be expected to throw a flood of light on the distribution of marine forms, and thus enable us to predict with some additional degree of certainty the former distribution of land and sea.

J. STANLEY GARDINER.

PHOTO-TELEPHONY.

THE transmission of speech by light was first realised nearly a quarter of a century ago by the invention of Prof. Graham Bell's photophone, a full description of which will be found in NATURE, vol. xxiii. p. 15. The transmitting instrument contained a small silvered disc or diaphragm of thin microscope cover-glass, which was clamped around the circumference like the diaphragm of a telephone. The receiver was a large parabolic mirror, at the focus of which was fixed a selenium cell in circuit with a telephone and battery. A beam of light from the sun or an electric lamp was reflected by the silvered diaphragm to the parabolic mirror, which concentrated the rays upon the selenium cell. The speaker's voice was directed upon the back of the diaphragm, causing it to vibrate in correspondence with the sound waves; the rapid changes in the curvature of its surface which accompanied the to and fro movements of the central parts of the diaphragm varied the concentration of the light upon the selenium, and since the conductivity of the selenium varied with the illumination, sounds were produced in the telephone similar to those by which the transmitting diaphragm was agitated.

Though the performance of the photophone was for short distances surprisingly perfect, it failed for several reasons to give satisfactory results when the transmitter and the receiver were separated by more than two or three hundred yards, and for a long time all attempts to render the invention practically useful were abandoned. The resuscitation of the photophone in a modified form has resulted from the recent discovery of the "speaking arc."

A few years ago Dr. H. T. Simon, of Göttingen, having noticed the curious sounds given out by an arc lamp when one of its leads happened to be near a wire supplying intermittent currents to an induction coil, was led to try the effect of superposing a microphone current upon the current feeding the lamp. With this object he interposed the secondary coil of a suitable transformer into one of the lamp leads, while the primary coil was connected in circuit with a battery of two or three cells and an ordinary microphone, the latter being placed in a distant room. Words spoken into the microphone were distinctly repeated by the arc, which was found to constitute an excellent telephone receiver. The simple arrangement originally employed by Dr. Simon has since been modified in some details, notably by Mr. W. Duddell, who in 1900 caused an arc lamp to address a large audience in the hall of the Institution of Civil Engineers.[1] That such an effect should be produced by so small a cause as the feeble induced microphonic currents is surprising; Mr. Duddell has, however, shown experimentally that a periodic variation of the order of 1 part in 10,000 of the mean current supplying the arc will alter the vapour column sufficiently to produce sound-waves.

No change of luminosity while the arc is talking can be recognised by the eye, but if the light is caused to pass through a transverse slit upon a moving kinematograph film the developed negative shows a succession of narrow bands of varying brightness, indicating that considerable changes actually do occur in the intensity of the light.

Prof. Graham Bell suggested in 1899 that the speaking arc might be used as transmitter in phonographic work. His suggestion has been followed up with conspicuous success by Dr. Simon himself and by Mr. Ernst Ruhmer, of Berlin, the latter having been able to transmit intelligible speech across distances up to 15 kilometres. As a transmitter he uses a searchlight projector having a parabolic mirror of silvered glass at the focus of which is the speaking arc; the carbons are placed horizontally along the axis of the mirror with the positive carbon outwards. A small telescope serving as a finder may conveniently be attached to the projector. The light is received, as in the older apparatus, by another parabolic reflector having a cylindrical selenium cell fixed axially at its focus. It is chiefly to the peculiar quality of his selenium cells that Mr. Ruhmer attributes the excellence of his results. The cells are of a pattern proposed by the present writer in 1880 (NATURE, vol. xxiii. p. 59). Two thin wires serving as electrodes are wound spirally, very close together but not touching, around a cylinder of unglazed porcelain, upon which a fine double screw-thread (to receive the wires) has been formed before baking. The surface of the cylinder is covered with a thin coating of selenium, which is afterwards crystallised; thus the two wire electrodes are joined throughout their length by the sensitive substance. Great importance is attached to the mode in which the crystallisation is effected. Vitreous selenium may be crystallised either, as is usually done, by gradually heating it up to a temperature somewhat above 100° C. or by melting it at a high temperature—about 250°—and letting it gradually cool down. In the latter case the crystalline surface appears to be of a coarsely granular structure, and it has long been known to the writer that selenium thus prepared is much less affected, as regards conductivity, by changes from darkness to light than the fine-grained variety obtained by the other process. This is confirmed by Mr. Ruhmer, but he has added the further interesting observation that the coarse-grained kind—"soft" selenium he calls it—is immensely more sensitive than the other, or "hard" selenium, to *small* changes of illumination, and, moreover, that it re-

[1] A detailed description of his apparatus is given in *Journ.* Inst. Electrical Engineers, vol. xxx. p. 240.

sponds to such changes far more quickly. Hence it is particularly well suited for use in a photophonic receiver. It is found advantageous to enclose the selenium cell in an exhausted glass bulb, like that of an ordinary glow lamp.

In order that the apparatus may be serviceable when the atmosphere is too misty, or the distance too great, to admit of the transmission of speech, Mr. Ruhmer has provided an arrangement for telegraphing audible Morse signals to the receiving station. The microphone is taken out of the circuit, and an automatic current interrupter, or "buzzer," inserted in its place. When this is operating, the arc emits a loud continuous note, which can be broken up into periods corresponding to dots and dashes by a simple key in the primary circuit. Such signals are plainly heard in the receiving telephone when speech would be inaudible, and the device is superior to the heliograph in that the signals may be made more rapidly, and cannot possibly be detected by parties for whom they are not intended.

It is said that the whole of the apparatus here described is now being manufactured commercially by a leading firm in Germany.

SHELFORD BIDWELL.

NOTES.

THE centenary of the death of Immanuel Kant was celebrated on February 12 by the University and the town of Königsberg, in the presence of the Prussian Minister of Education, Dr. Studt, and various representatives of German academic corporations. A short article inspired by the occasion appears elsewhere in this issue. The proceedings began, says the Berlin correspondent of the *Times*, with the unveiling of a memorial tablet by Dr. Studt, who delivered a message from the Emperor William, and referred in the course of an address to the services which Kant had rendered to learning and to the world. The Minister further announced that he had assigned a sum equal to 500*l.* from the public resources at his disposal in support of the teachers' aid fund. The town of Königsberg has devoted a similar sum to the foundation of an annual prize for essays on philosophical subjects. On the memorial tablet which was unveiled on the wall of the Royal Castle in the Kantstrasse is inscribed the well-known saying of Kant:—"The starry sky above me, and the moral law within me." In commemoration of this anniversary a special meeting of the British Academy was held on Friday, and a paper upon Kant's work and influence was read by Dr. Shadworth Hodgson.

SOME considerable rearrangements have been made in the museums at the Royal Botanic Gardens, Kew. A new gallery 130 feet long by 16 feet wide at the back of museum No. iii. was opened on February 1. To this the entire collection of Gymnosperms (Conifers, Cycads and Gnetaceæ, including Welwitschia) has been transferred. The space in museum No. i. thus set free has been utilised in making a more effective display of its contents, which had become very crowded. The well-lighted wall-space in the new gallery has enabled the collection of maps and plans of the establishment at various periods to be brought together. Several of these have been contributed by H.M. the late Queen and by H.M.'s Office of Works, and are of considerable historical interest. A set of the fine photographs of Kew in its various aspects which were sent by the Government to the Paris Exhibition of 1900 are also shown, as well as an extensive series of photographs of coniferous trees in their native countries.

THE eighth International Geographical Congress, which will meet at Washington, D.C., in September next, will be the first international meeting of geographers in the western hemisphere. The congress will convene in Washington on Thursday, September 8, in the new home of the National Geographic Society, and will hold sessions on September 9 and 10, the latter under the auspices of the Geographic Society of Baltimore. Leaving Washington on September 12, the members, associates and guests of the congress will be entertained during that day by the Geographical Society of Philadelphia, and on September 13, 14 and 15 by the American Geographical Society in New York, where scientific sessions will be held; on September 16 they will have the opportunity of visiting Niagara Falls (*en route* westward by special train), and on September 17 will be entertained by the Geographic Society of Chicago; and on September 19 and 20 they will be invited to participate in the International Congress connected with the World's Fair in St. Louis. The subjects for treatment and discussion in the congress are classified as follows:—(1) Physical geography, including geomorphology, meteorology, hydrology, &c.; (2) mathematical geography, including geodesy and geophysics; (3) biogeography, including botany and zoology in their geographic aspects; (4) anthropogeography, including ethnology; (5) descriptive geography, including explorations and surveys; (6) geographic technology, including cartography, bibliography, &c.; (7) commercial and industrial geography; (8) history of geography; (9) geographic education. All correspondence relating to the congress and all remittances should be addressed, The Eighth International Geographic Congress, Hubbard Memorial Hall, Washington, D.C., U.S.A.

THE death is announced of M. Firmin Bocourt at the age of eighty-five years. M. Bocourt was formerly curator of the Paris Museum of Natural History, and during his life took part in important expeditions to Siam, Mexico, and to Central America.

THE *British Medical Journal* announces that the Senatus Academicus of the University of Edinburgh has awarded the Cameron prize in practical therapeutics to Prof. Niels R. Finsen, of Copenhagen, in recognition of his pioneer work in connection with the application of light rays to the treatment of disease.

AT the jubilee meeting of the Royal Scottish Arboricultural Society held in Edinburgh on Tuesday, a resolution was agreed to expressing the opinion that the Board of Agriculture should now take steps to give effect to the recommendation of the departmental committee on forestry, so far as Scotland was concerned, by providing an estate to serve as a State forest demonstration area, and also by providing experimental plots in connection with Edinburgh University. The motion also expressed the view that forestry education in the country would not be adequately provided for until these facilities were provided and a thoroughly equipped forestry school was established in Scotland.

ON Tuesday next, February 23, Mr. F. Foxwell will deliver the first of three lectures at the Royal Institution on "Japanese Life and Character," and on Thursday, February 25, Prof. H. L. Callendar will commence a course of three lectures on "Electrical Methods of Measuring Temperature." The Friday evening discourse on February 26 will be delivered by Mr. Alexander Siemens, his subject being "New Developments in Electric Railways"; on March 4 by Prof. W. Stirling, on "Breathing in Living Things"; and on March 11 by Prof. F. T. Trouton, on the "Motion of Viscous Substances."

AT the fourth monthly dinner of the London Chamber of Commerce on February 10, a discussion took place on "British Industrial Neglect of Applied Science." Sir Arthur Rücker occupied the chair; and in opening the debate said it was no doubt true that there had been in the past a certain want of appreciation on the part of English commerce, of that careful scientific training for those who were to take the leading parts in it, which was characteristic of education in some other countries. They had to ask themselves why it was that in this country the trained university man was not in the same demand in industrial circles as he was, for instance, in America; why it was that the right article was not asked for; and whose was the fault that it was not supplied. The matter of crucial importance was the fact that it was absolutely necessary to draw the educationist and the business man closer together. Among the subsequent speakers were Sir William Anson, Sir William Ramsay, Prof. Armstrong, and Prof. Meldola.

IN connection with the centenary of the Royal Philosophical Society of Glasgow, Mr. G. T. Beilby delivered a lecture on "Advances in Chemical Industry during the Nineteenth Century" in the hall of the society on February 10. Summing up the position of chemical industry, Mr. Beilby remarked that it was evident that its widely international character, and its close touch with the most recent advances in chemistry, physics, engineering, and even with certain branches of biology, was making the position of its leaders a more and more exacting one. It was therefore imperative that the men who were to take the lead in the immediate future should be prepared with an equipment which would enable them to work, either in alliance or in competition, with the best men of any other nation. Referring to Mr. Chamberlain's recent injunction to the financiers in the City of London "to think Imperially," Mr. Beilby proposed to his fellow-workers in applied science that they should strive "to think scientifically and internationally," in order that they might be prepared to measure themselves, not against the men of any narrow class or nationality, but against the best workers of the world.

THE Great Northern and City Railway was opened to traffic at the beginning of this week. We gave a few particulars of this new tube on the occasion of its completion a few weeks ago. Certain alterations in connection with the signalling arrangements which were required by the Board of Trade had, however, to be made before the railway could be thrown open to the public.

A CORRESPONDENT sends us a cutting from the *Homeopathic World* of January 1 in which it is stated that Prof. Wm. Harvey King, of New York, and Mr. Hammer have found that if a tube containing radium is immersed in water for a time, the water becomes radio-active and is capable of affecting a photographic plate. Prof. King is said to be testing the therapeutic value of water that has thus been subjected to the action of radium.

IN NATURE of October 22, 1903 (vol. lxviii. p. 599), a peculiar kind of lightning was described by Prof. W. H. Everett, its remarkable feature being that it ascended in rocket fashion from a cloud into clear sky. Referring to the observations of flashes of ordinary character described by Mr. W. A. Lee in NATURE of January 7 (p. 224), Prof. Everett writes to say there could be no mistake about the rocket-like flashes seen by Prof. P. Bruhl and himself. Prof. Bruhl, in confirming the observations, says:—"The three main characteristics of those flashes were that they were unbranched, that they passed upwards into the clear sky, and, what is probably connected therewith, their duration was undoubtedly longer than that of ordinary flashes."

A MEETING of the Nagri Sabha, Benares, for the compilation of an authoritative Hindi dictionary of scientific terms was held, the *Pioneer Mail* states, early in January. The glossaries prepared by the Sabha of the mathematical, the astronomical, the philosophical, and the chemical terminologies were revised and finished. The revision of the first three was, compáratively, an easy task, on account of the existence of suitable Sanskrit equivalents, but the discussion on the chemical glossary was more protracted. Most of the English names of elements were adopted with slight Hindised forms, as, for instance, *Karb* for carbon, *Sphur* for phosphorus. The committee could not come to an agreement as regards a suitable Hindi term for oxygen. More than seven names were suggested, but each one was considered unsuitable and was rejected. It was finally resolved to consult Drs. J. C. Bose and P. C. Rây, of Calcutta, and Prof. Deshmukh, of Bombay, on the point.

THE report of the medical officer of health for the City of London for the six weeks ending December 31 is mainly occupied with a review of the fourth report of the Royal Commission on Sewage. Dr. Collingridge is in general agreement with the remedial measures there suggested for dealing with polluted shell-fish, but considers that the controlling authority for the Thames should be the Corporation of London as Port Sanitary Authority so far as their jurisdiction over the river now extends. The remainder of the report contains the statistical data and records of the seizures of sewage-polluted shell-fish.

IN addition to the articles of a more technical character in the December (1903) number of the *Johns Hopkins Hospital Bulletin* (vol. xiv., No. 153), Dr. C. A. Herter writes pleasantly of the influence of Pasteur on medical science. He remarks that the most significant feature perhaps of Pasteur's contributions to medicine is their direct dependence on the principles of physics and chemistry, and that sound medicine must rest on sound biological conceptions. It is also announced that it is proposed to found a memorial to Major Walter Reed, to whom in a large degree is due the discovery of the mode in which yellow fever is spread by the mosquito.

OF new journals there would seem to be no end, two of the latest additions being the *Archivio di Fisiologia*, edited by Prof. Fano, of Florence, and the *Journal of Infectious Diseases*, edited by Dr. Hektoen and Mr. Jordan. The former will deal especially with experimental physiology. The *Journal of Infectious Diseases* has been established in connection with the Memorial Institute for Infectious Diseases, Chicago, by the munificence of Mr. and Mrs. Harold F. McCormick. It will be devoted to the publication of original investigations dealing with the general phenomena, causation and prevention of infective diseases. The first number (January) is a volume of 200 pages, excellently printed and well illustrated, and contains a number of papers of considerable interest and value, *e.g.* the cultivation of *Trypanosoma Brucei*, by Messrs. Novy and McNeal; spotted fever, by Messrs. Wilson and Chowning; a study of thyrotoxic serum, by Mr. Portis; changes in the bacterial flora of sewage, by Messrs. Winslow and Belcher, &c.

AN addition to the fragmentary information now existing concerning the life of Nicolò Tartaglia is discussed by M. V. Tonni-Bazza in the *Atti dei Lincei*. Tartaglia, who died in 1557 at the age of fifty-seven, is best known to modern mathematicians for the part he played in the resolution of the cubic equation, and the document in question is an application for the copyright of the work which Tartaglia issued in 1546 entitled "Quesiti et inuentioni diverse."

THE *Bulletin* of the French Physical Society contains a preliminary account of the work of the French Geodetic Expedition which was sent out in 1901 to measure a new base line in the region of the Andes. In addition to this work the expedition has undertaken a series of measurements of the intensity of gravitation at Riobamba (altitude 3000 metres). These observations confirm Bouguer's formula for reduction to sea-level, which takes account not only of the altitude, but also of the attraction of the underlying stratum of earth. If, following the views of certain geodetists, the correction due to the second cause is omitted, discordant results are obtained.

THE last addition to the "Manueli Hoepli" is a pocket-book on the mathematical theory of elasticity by Prof. Roberto Marcolongo, of Messina. The book is written for students who have received a general preliminary training in the methods of higher mathematical analysis; at the same time the introduction of the subject of elasticity proper is preceded by two chapters dealing with harmonic functions, the theory of the potential, Green's, Gauss's and Dirichlet's theorems and allied matters. The book should afford an excellent introduction to the general theory of the equations of elasticity; for the discussion of special problems the reader is referred to the larger treatises on elasticity.

THE February number of *Knowledge and Scientific News* gives an account of what appears to be the first successful achievement of artificial flight, by Messrs. Orville and Wilbur Wright. That these brothers have been successful in gliding experiments performed under gravity is well known, but they now appear to have succeeded in raising themselves from the ground by a motor-driven machine which, after running along a mono-rail for 40 feet, rose into the air, and was driven in the face of a gale blowing at about 25 miles an hour, with a velocity of about 10 miles an hour relative to the ground, or 35 miles an hour relative to the wind. In the last trial the machine flew half a mile relative to the air, or 852 feet relative to the ground. It is sincerely to be hoped that this success will not, as in so many previous instances, be followed by a fatal accident.

A BIOGRAPHICAL notice of Prof. Angelo Maffucci, whose death on November 24 has already been noted, is contributed to the *Atti dei Lincei* by Signor Foà. Maffucci was born at Calitri, in the province of Avellino, on October 17, 1847, and his family, being farmers, naturally wished him to become either a farmer or a priest, but he preferred to go to Naples and study medicine. In 1873 he gained a medal for his campaign against the cholera, and some time later he became assistant in the Institution of Pathological Anatomy under Prof. von Schrön. In 1882 he was appointed professor of pathological anatomy at Catania, and in 1884 was elected to a chair at Pisa, which he held until his death. His most important work dealt with the infection of the embryo by the tubercle bacillus, as bearing on the heredity of tuberculosis. He received the Balbi-Valier prize of the Venetian Academy and the gold medal of the Società dei Quaranta (Society of the Forty). When near his death he proposed to found a scholarship in pathological anatomy at Pisa.

IN the first part of vol. lxxvi. of the *Zeitschrift für wissenschaftliche Zoologie* Prof. E. Rohde continues the account of his investigations into the structure of the organic cell. A second article, by Mr. A. Kölliker, is devoted to the development and origin of the vitreous humour of the eye, the author arriving at the conclusion that this structure, although essentially of ectodermal origin, in the course of its development includes certain mesodermal elements. The remaining contents of this part include an account of the "Tömösvarysche organ," found at the base of the antennæ of myriopods, by Dr. C. Hennings, and an article, by Mr. C. Thesing, on spermatogenesis in cephalopods.

"CURRENT Misconceptions in Natural History" is the title of an article by Mr. J. Burroughs in the February number of the *Century Magazine*, in which the author deprecates the popular tendency to invest animals with human attributes and human modes of thought. Especially is the author convinced that animals do not consciously teach their offspring, urging the improbability of their being able to reflect upon their future any more than upon their past, or that they are solicitous about the future well-being of their young any more than about their own ancestry. With great fairness Mr. Burroughs quotes, however, a letter from President Roosevelt in which somewhat opposite opinions are expressed, the President stating his belief that "there is a large amount of *unconscious* teaching by wood-folk of their offspring." Possibly, as the author states, the divergence of view is largely owing to the difference in meaning attached by the two writers to the same words.

THE *Rapid Review*—a new magazine issued by Messrs. C. Arthur Pearson, Ltd.—contains three pages dignified by the title "The Science of the Month," in which extracts are given from published articles on the physiology of fatigue, plants and anæsthetics, and cancer, and from reports of Prof. Lankester's Royal Institution lectures on extinct animals.

MESSRS. SWAN SONNENSCHEIN AND CO., LTD., have published the "Public Schools Year Book" for 1904. This useful work of reference was founded by three public school men representing Eton, Harrow, and Winchester, and the present is its fifteenth year of publication. Among important additions to the current issue are sections dealing with the education of engineers and musicians. The annual has become indispensable to parents sending their boys to a public school, and to the masters in such institutions.

A SEVENTH edition of "Dynamo-Electric Machinery," by Prof. S. P. Thompson, F.R.S., is being published by Messrs. E. and F. N. Spon, Ltd. With the development of the subject it has become necessary to divide the work into two parts. Part i. of the new edition has been issued, and deals only with machinery for continuous currents. The concluding part, describing machinery for alternating currents, is in the press, and is expected to appear during the present year. Chapters on dynamo design, which were published in 1902 as a separate book, are now embodied in the present work.

WE are asked to announce that the preliminary work for the Technolexicon of the Society of German Engineers must be concluded by Easter of this year, so collaborators are requested to send in all outstanding contributions. This universal technical dictionary for translation purposes, in English, German, and French, the compilation of which was begun in 1901, has received help up to the present time from 363 technical societies at home and abroad; 51 of these are English, American, South African, &c., 274 German, Austrian, and German-Swiss, and 38 French, Belgian, and French-Swiss societies. No less than 2573 firms and individual collaborators have promised contributions to the dictionary. Communications referring to the dictionary should be addressed to Dr. Hubert Jansen, Berlin (NW. 7), Dorotheenstrasse 49.

A RECENT number of the *Comptes rendus* contains an important paper by Prof. Becquerel on the light emitted spontaneously by certain salts of uranium. The light emitted is out of all proportion to the feeble radio-activity of the salts, and is most marked in those salts which phosphoresce most brilliantly when exposed to light. In the case of the double sulphate of uranyl and potassium, it was found that whilst different specimens varied in phosphorescent and luminescent power, the light emitted was the same, whether the salt had been kept in the dark during eight years or had been recently exposed to the light of an arc or to the radiations of radium salts. It is of interest to note that the author is of opinion that the study of uranium and thorium would have led, though perhaps somewhat slowly, to the recognition of most of the facts which have been brought to light by the investigation of radium and polonium.

IN the *Sitzungsberichte* of the Prussian Academy Prof. Richarz and Dr. Schenck direct attention to some very striking "analogies between radio-activity and the behaviour of ozone." Freshly prepared ozone and ozone that has been decomposed by deozonisers have the power of causing condensation in a steam jet, and impart conductivity to the air in a similar manner to those metallic salts which emit Becquerel radiation. The photographic effect of radio-active substances has also been observed in the case of ozone, and although it does not act upon barium platinicyanide or zinc oxide, it causes hexagonal zinc blende to fluoresce brightly, and this is regarded as evidence that massive ions are produced comparable with the α rays of radium and the canal rays of the vacuum tube. Platinum that has been in contact with ozone exhibits induced radio-activity, and it is suggested that the slight conductivity normally observed in the atmosphere and certain of the effects produced by radio-active bodies may perhaps be due to the formation and decomposition of ozone or hydrogen peroxide.

AN ingenious apparatus for measuring the electrical conductivity of aqueous solutions at high temperatures is described by Messrs. Noyes and Coolidge in the *Zeitschrift für physikalische Chemie*. The conditions to be satisfied were that the vessel should withstand, without leakage, pressures up to the critical pressure of water, that the lining of the vessel should be entirely unacted on by aqueous solutions, that the electrodes should be efficiently insulated from the walls of the vessel at temperatures exceeding 300° C., and that the temperature should be maintained constant within 0·1° C. The desired result was accomplished by using a steel bomb lined with platinum and closed by a washer of pure gold wire. The electrodes were of steel covered with platinum foil, and were bolted into the top and bottom of the bomb, from which they were insulated externally by means of mica and internally by means of rings of quartz-crystal made tight by gold washers. The whole apparatus was heated in a vapour bath, and conductivity measurements could be made with an accuracy of 0·25 per cent. up to 300° C., whilst the fouling of the solutions was inappreciable even at 1/2000 normal.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. F. Glockler; two Yellow-winged Parrakeets (*Brotogerys virescens*) from Brazil, a Senegal Parrot (*Poocephalus senegalus*) from West Africa, two Golden Eagles (*Aquila chrysaëtus*), European, presented by Mr. Charles E. Lister; a Royal Python (*Python regius*) from West Africa, presented by Mr. Cecil T. Reaney; a Simpae Monkey (*Semnopithecus melanophus*) from Sumatra, an Indian Brush-tailed Porcupine (*Atherura fasciculata*) from Siam, a Great-billed Weaver-bird (*Ploceus megarhynchus*) from India, deposited.

OUR ASTRONOMICAL COLUMN.

EPHEMERIS FOR THE MINOR PLANET (7), IRIS.—The following is an extract from an ephemeris for the minor planet Iris published by Dr. J. Riem in No. 3926 of the *Astronomische Nachrichten*. It will be remembered that Prof. Wendell recently announced the discovery of a variation in the brightness of this planet, having a range of 0·5 to 1·0 magnitudes :—

1904	α h. m. s.	δ ° ′	log r	log Δ
Feb. 17	6 36 26	+17 41·5	0·332	0·136
,, 21	6 37 12	+17 41·3	0·334	0·150
,, 25	6 38 30	+17 41·1	0·336	0·164
,, 29	6 40 19	+17 40·9	0·338	0·179
Mar. 4	6 42 36	+17 40·4	0·340	0·194
,, 8	6 45 17	+17 39·6	0·342	0·208

Magnitude, February 5=7·9, March 8=8·5.

OBSERVATIONS OF MARS DURING 1903.—The general results of the observations of Mars made by Mr. Denning during 1903 are published in No. 3926 of the *Astronomische Nachrichten*. A 10-inch reflector with powers of 252, 312, 332, 450 and 488 was used, and the power 312 was found to be the most effective.

The streaks, or canals, on the planet's surface appeared to be, without doubt, objective features, but no "doubling" was observed. Decided changes were observed to take place in the appearance of some of the markings, but Mr. Denning attributes these apparent changes to the drifting of vaporous condensations over the permanent markings rather than to any real modifications of the latter. Many brilliantly luminous areas were observed, and although they exhibited decided changes, Mr. Denning believes them to be permanent features, and urges that more definite observations of their latitudes and longitudes should be made and recorded. A curious feature of these bright markings is that they appear brighter when on the edge of the planet's disc than they do at its centre, behaving, in this respect, like faculæ on the sun's disc. One rotation period for the planet satisfies the observations of all the markings, thus proving them to be definite features of the planet's surface rather than drifting vapours such as are seen when observing Jupiter and Saturn.

Comparing the recent results with those obtained in February, 1869, Mr. Denning has determined the rotation period of Mars to be 24h. 37m. 22·7s. As this is the mean of 12,136 rotations, it should be a very accurate value. Six drawings of the Martian surface, made on different dates during 1903, accompany Mr. Denning's communication.

A CATALOGUE OF 829 SOUTH POLAR STARS.—No. 21 of the *Contributions from the Observatory of Columbia University* is devoted to a catalogue of 829 stars, all within 2° of the South Pole, compiled by Prof. Harold Jacoby, acting director of the observatory.

The star places in the catalogue have been obtained from measures of twelve plates taken at the Cape Observatory. Four of these plates overlap and cover the region within 1° of the pole; the remaining eight contain regions symmetrically arranged about the inner four at different hour angles, so that they cover the whole region within 2° of the pole. In measuring these plates the star places, as determined from each plate, were corrected for refraction, &c., and then plotted on one large chart, so that the unknown stars common to any two or more plates overlapped. The effects of errors of observation, and the uncertainty due to the possibly different scale-values of each plate, were then eliminated, and the whole chart was oriented from the known positions of some of the included stars as determined by Sir David Gill at the Cape Observatory. The relative positions thus determined should be very accurate, and are given in the catalogue for the epoch 1895, together with the catalogue number, the magnitude, the south polar distance, the C.P.D. number, and the exact precessional corrections for each star.

THE CLIMATOLOGY OF 1903.—As in former years, the meteorologist of the Juvisy Observatory, M. J. Loisel, has published the detailed results of the observations made at that observatory during the past year in the *Bulletin de la Société astronomique de France* (February).

The results are graphically depicted by a series of curves, one set of which shows and compares the rainfall, the direction of the wind, the temperature, pressure and hygrometric state of the atmosphere, the number of hours of sunshine, the state of the sky, and the declination and phase of the moon for each day. A set of tables comparing each of the four seasons with the corresponding season for each year since 1886 shows that, on the whole, the winter was warm, the spring dry, the summer cold, and the autumn warm during 1903 as compared with the mean conditions. The curve depicting the amount of the effective insolation shows that during 1903 there were two maxima, one in May the other in July, instead of one in July as shown on the curve for 1902. A comparison of the total solar radiations observed during 1902 and 1903 gives 146,115 and 140,175 calories respectively.

MERIDIAN-CIRCLE OBSERVATIONS AT THE LICK OBSERVATORY.—The results of the meridian-circle observations made at the Lick Observatory during the period August, 1896, to March, 1901, by Mr. Richard H. Tucker have just been published in one volume (*Publications* of the Lick Observatory, vol. vi., 1903). The results include about 11,700 full observations, and 2700 observations in one coordinate only, for the determination of 4500 stars.

The first part of the work consists of the results of the observations for declination of 361 latitude stars previously observed by Prof. Doolittle at South Bethlehem, Pa, and includes 107 stars from the "Standard Catalogue" of Lewis Boss. The resulting declinations are compared, where the stars are common to the catalogues, with those given in Boss's catalogue and the Berliner Jahrbuch.

The second part of the volume is devoted to the observations of 21 circumpolar stars, all above declination +82°, in compliance with a request of Dr. Auwers. Part iii. gives the results of the observations of 50 zodiacal stars, made during 1898 at the request of Sir David Gill to furnish places for his heliometer measures of the major planets.

The volume also contains a description of the observations, and their reduction and final results, of 3088 southern stars contained in the catalogue observed by Piazzi, at Palermo, during the period 1792 to 1813.

The stars in the first and second lists of the Astrophotographic Conference, of comparison stars for Eros, were observed at Lick, and the results are given and discussed in the fifth section of the volume.

The observations are concluded with the results obtained in some miscellaneous observations made during the period 1897 to 1901. These include 49 comparison stars for various purposes, 20 proper-motion stars observed for Prof. J. G. Porter, of Cincinnati, and several meridian-circle observations of Eros, Nova Persei, and two comets.

M. BLONDLOT'S n-RAY EXPERIMENTS.[1]

IN his experiments on the rapidity of propagation of the Röntgen rays, the French academician, M. R. Blondlot, discovered a new kind of rays, which he called *n*-rays, after the place Nancy, in which they were first observed.[2] These rays are said to be emitted by an Auer burner, or better still by a Nernst lamp of 200 watt power. Like the Röntgen rays, they are said to pass through aluminium with ease, but on the other hand to be absorbed by the slightest film of water, like the longer heat-waves. Although they are stated to be absorbed by cold platinum, they readily pierce red-hot platinum.

[1] Translation of "Notes in Elucidation of the Most Recent Researches of M. R. Blondlot on the *n*-Rays." By O. Lummer. Read at the sitting of the German Physical Society, November 27, 1903.

[2] R. Blondlot, "Sur de nouvelles actions produites par les rayons *n*; généralisation des phénomènes précédemment observés" (*C. R.*, cxxxvii., 684, 1903). "Sur l'emmagasinement des rayons *n* par certains corps" (*C. R.*, cxxxvii., 729, 1903).

Blondlot has recently found that these *n*-rays are emitted by the wire of the Nernst lamp even after this has been extinguished for several hours, and that, moreover, flints which have been exposed to the sun's rays have a distinct effect in the sense of the *n*-rays.

In all these observations of Blondlot the action of the *n*-rays consists in general of a brightening of a source of light under these rays, or rather of a darkening when the rays are cut off by interposing either the hand or a lead screen between the source of light and the source of the *n*-rays. The analysing source of light may be a small spark, a bluish flame, a phosphorescent surface, a dark platinum plate at dull red heat, or the surface of paper feebly illumined by a source of light. The dimensions of all these analysing sources of light are very small (the illumined paper, for instance, being 2 mm. by 16 mm. in size), and the observation is carried on in a dark room.

Although the change in brightness is said to be considerable, neither Blondlot (*C. R.*, cxxxvii., 167, 1903), Rubens (Ebenda) nor others (*Phys. Zeitsch.*, iv., 732 and 733, 1903) have hitherto succeeded in demonstrating objectively the corresponding transformation of energy. At the same time the phenomena observed subjectively by Blondlot could not be perceived by Rubens and others in repeating the latest experiments with slightly illuminated or phosphorescent surfaces.

Without wishing, for the present, to dispute the objective existence of these *n*-rays, I should like in what follows to bring forward the fact that a whole set of Blondlot's experiments may be almost exactly imitated in their effects *without employing any source of illumination whatever*, and that the changes in form, brightness, and colour respectively of the analysing luminous surface observed by Blondlot under a stream of rays, and the interception of a diaphragm (Abblendung) may be referred to processes taking place in the eye itself, and, in fact, to the *contest between the rods and cones of the retina in seeing in the dark*.

It has been known for some time that the layer of rods and cones in the retina is the structure which is sensitive to light whereby this form of energy, from without, is transformed into nerve-stimulation. While, however, experiments on sharpness of vision have led to the assumption that the power of vision is due to the agency of the cones alone, the almost identical anatomical structure of the rods admits of the conclusion that they also play their part in vision. But on the ground of more recent physiological researches on vision in dim light, and the influence of the visual purple contained in the rods on colour-perception, we have been enabled to distinguish, more and more clearly, the respective modes of action of these two elements of the retina and to ascribe to them their different functions. A. König[1] had already ascribed to the rods the colourless vision of the totally colour blind in every degree of brightness, the non-perception of colour in a very dim light of those otherwise able to perceive colours, and the perception of blue. J. v. Kries[2] went further, and disposed of the still existing difficulties and contradictions by putting forward the hypothesis that the cones form our colour-perceiving "light apparatus" ("Hellapparat") and the rods our totally colour blind "dark apparatus" ("Dunkelapparat"). According to this theory of Kries the cones render vision possible in a very bright light, and their stimulation by light-waves arouses in the brain the perception of colour, while the purple containing rods are totally colour blind, and only come into action in a very dim light, and are endowed with the property of considerably increasing their sensitiveness in the dark. These properties of the rods are called by Kries "adaptability to the darkness" (Dunkeladaptation). Before the cones perceive coloured light, the rods bring about in the brain the impression of colourless light.

We know from the anatomy of the eye[3] that the fovea centralis contains cones only and no rods, and that the rest of the retina has rods as well as cones, the former predominating towards the periphery, and it is also well known

[1] "Über den menschlichen Sehpurpur und seine Bedeutung beim Sehen (*Sitzber.* d. Berl. Akad d. Wissensch., S. 577, 1894).

[2] "Über die Funktion der Netzhautstänchen (*Zeitsch.* f. Psych. u. Physiol. d. Sinnesorgane, ix., 81–123, 1894).

[3] R. Greef, "Die mikroskopische Anatomie des Sehnerven und der Netzhaut." Aus dem "Handbuch der Augenheilkunde" von Graefe u. Samisch. 2 Aufl., I. Bd., V. Kap. (Berlin, 1901.)

that the fovea centralis is the special point of vision when looking at an object and fixing our eyes upon it. *Hence it follows that in gazing at an object, i.e. direct vision (foveal), the rods are excluded, and it is only in indirect vision (peripheral) that they come into action.* Thus then in dim light these two elements enter into a sharp contest which, if the light is dim enough, results in favour of the colour-blind rods, so that everything then resolves itself into greys, *i.e.* colourless shades of light.

By the help of this theory one gets a natural explanation of phenomena hitherto unexplained, as, for example, Purkinje's phenomenon, the change of position of the "neutral point" in the spectrum as light decreases in the case of those who confound red with green, and the dependence of colour identification on the absolute intensity of light. In my work "Grauglut und Rotglut" I was able to show[1] that the remarkable "shadow-like" (gespensterhaft) appearance of the grey and red glow can be explained by attributing to the two light-perceiving elements the part assigned to them by v. Kries.

If in a dark room we observe the gradual rise in temperature of a body from that of the room up to glowing temperature, then, according to my view, the eye perceives two sudden changes or "leaps," first from dark to shadowy grey ("grey glow"), and later from grey glow to coloured glow (red glow). In each case the "leap" arises from stepping over the threshold of stimulation of the optic nerve, but the efficient organs are not the same in the two cases; the grey glow corresponds to the threshold of stimulation of the rods, the red glow to the threshold of stimulation of the cones. *Accordingly we must conceive of the grey glow as a sensation of the retinal rods and of the red glow as the sensation of the retinal cones.*

The "shadow-like" character of the rod-vision is not apparent until we observe a sufficiently small surface the retinal image of which does not exceed in area that of the spot of clearest vision, *i.e.* the fovea centralis, and the increase of brightness of which we follow in the dark from zero upwards. For this purpose it is best to make use of a platinum plate brought to a glow by means of electricity and limited by a diaphragm, the development of light thus being observed in the dark by a well-rested eye. When the platinum plate has reached a temperature of about 400° C., at first only the rods of the eye searching in the dark are stimulated, and the perception of colourless light (grey glow) is aroused in the brain.

Being accustomed to gaze at what sends us light we turn our eyes in the direction from which we believe the light rays come. As, however, the cones have not yet been stimulated, the fovea centralis sends no message of light to the brain; accordingly we cannot see the spot gazed at. Thereby we are confronted by the remarkable fact that we see something which we are not gazing at, whilst it becomes invisible when we wish to fix our eyes upon it. And as we can see nothing by direct vision, we involuntarily move our eyes away, whereby the rays again fall on extra-foveal retinal spots; we again receive the impression of light, and our search after the place from which the remarkable light comes begins over again. Thus there arises in us the impression of a light which darts to and fro, which is sometimes present, then again evades us, mocking us, like a will-o'-the-wisp. It is only when the brightness is of a sufficient intensity to stimulate the cones also and enable them to send a message of light to the brain that this unusual condition comes to an end, and then we see what we gaze at, just as we have been accustomed to do, and the thing seen no longer escapes the searching gaze.

In the case of glow this does not occur until the body has reached a temperature somewhat above 500° C.; not until then are the cones stimulated, and we then perceive colour as well as brightness, in other words, the "grey glow" is transformed into "red glow."

But at a still higher temperature (up to 700° C. and above) the rods enter into vigorous competition with the cones, and the light red colour seen in gazing at the platinum plate changes in indirect vision into a peculiar colourless white, the "rod white," while at the same time the brightness of the platinum plate increases considerably.

[1] O. Lummer, "Über Grauglut und Rotglut" (*Wied. Ann.*, lxii., 14–29, 1897; *Verh.* Phys. Ges. Berlin, xvi., 121–127, 1897).

In some of Blondlot's experiments one finds oneself in precisely the same position as in the observation of the "shadowy vision" just described. One perceives a very small slightly luminous surface, *e.g.* a dull red glowing platinum plate, in the dark and fixes one's gaze upon it. Before bringing one's undivided attention to bear on it, it is seen by the extra-foveal parts of the retina, because the eye involuntarily endeavours to gather as much light as possible, thus consequently both rods and cones take part in the vision. As soon, however, as the lead screen or the hand is interposed between the source of illumination and the luminous platinum surface, the observer, in order to see the change in it, will fix his gaze as directly as possible on the platinum plate, thereby excluding the rods. The necessary consequence will be that the platinum plate will appear reddish and less bright, and the rod-white of the peripheral parts of the retina be lost. But this fixing of the gaze requires time and effort. The darkening and the red colouring observed will also require a certain amount of time, and as soon as the hand or the screen is removed the eye will return as quickly as possible to extra-foveal observation, in which it receives more light. After the removal of the screen, therefore, the brightness of the platinum plate increases, and provided the brightness of the luminous surface under observation is very dim, there will be an immediate diminution in the distinctness of the outlines on darkening it while the gaze is fixed on it, in fact, there will eventually be a complete disappearance of the platinum plate provided the energy sinks below the threshold of stimulation of the cones and the surface is small enough.

As a proof that the phenomena here described (which were not only observed by myself subjectively, but were produced in my lecture before a large audience) resemble to an extraordinary degree the more recent observations described by Blondlot, I will quote, word for word, two sentences from his article of November 2, 1903 (*C. R.*, cxxxvii., 685, 1903). After describing the order of procedure in the observation of a feebly illumined strip of paper, he goes on to say:—"If one now intercepts the rays by interposing a lead plate or the hand, one sees the small rectangle of paper grow dark to its contour and lose its distinctness; the removal of the screen causes the brightness and the distinctness to reappear, the light diffused by the strip of paper being then increased by the action of the *n*-rays."[1]

In the case in which Blondlot observes the transparently luminous paper mirrored on a needle and then illumines the needle with the *n*-rays, he describes the process in the following words:—"It was then easy to prove that the action of these rays strengthens the image, for if one succeeds in intercepting them, this image becomes dark and reddish. I have repeated this experiment with equal success by employing instead of the knitting-needle a plane bronze mirror."[2]

In this article it is also stated:—"All these actions of the *n*-rays on light require an appreciable time for their production and disappearance";[3] this is on a parallel with the appearances of grey and red glow during vision in the dark. The experiments described in this article do not deal with the behaviour of different substances under exposure to the *n*-rays. It is unnecessary to say that seeing in the dark can in no wise explain why some substances transmit the *n*-rays and others do not. But it may be asserted briefly that neither brightening, darkening, nor change in colour will take place if during the experiment with the above mentioned source of light one gazes continuously at the analysing luminous surface so that the image always falls on the fovea centralis and the cones alone come into action. As a matter of fact, Prof. Rubens, as he kindly informed me in answer to my question, took his observations in this way, and could perceive no brightening even

[1] "Si maintenant on intercepte les rayons en interposant une lame de plomb ou la main, on voit le petit rectangle de papier s'assombrir, et ses contours perdre leur netteté; l'éloignement de l'écran fait reparaître l'éclat et la netteté; la lumière diffusée par la bande de papier est donc accrue par l'action des rayons *n*."

[2] "Il fut alors facile de constater que l'action de ces rayons renforce l'image, car si l'on vient à les intercepter, cette image s'assombrit et devient rougeâtre. J'ai répété cette expérience avec le même succès en employant, au lieu de l'aiguille à tricoter, un miroir plan en bronze."

[3] "Toutes ces actions des rayons *n* sur la lumière exigent un temps appréciable pour se produire et pour disparaitre."

when a very powerful Nernst lamp was employed. Moreover, this sustained gaze is always accompanied by great fatigue, for reasons already adduced, and especially so in observing a very feebly luminous surface of small area in a dark room. The sustained gaze at small bright objects, as is well known, is, in fact, the most effectual way of inducing hypnotic sleep.

But although one cannot imitate all M. Blondlot's experiments by purely subjective perceptual processes without employing some source of illumination, I have thought it advisable to direct attention to these more recent physiological discoveries, the more so as M. Blondlot pays no attention to them in any of his publications, and does not state with what visual apparatus one ought to observe, nor does he give warning of the illusions one may fall into in carrying out his experiments. But the foregoing statements will at least serve to remind all those who take the trouble to repeat M. Blondlot's experiments that in vision in the dark changes in brightness, form and colour may arise from a purely subjective source. These purely subjective changes, however, do not depend upon any optical illusion, but, like the "shadow-like" appearances of the "grey glow" and the "red glow," are brought into existence by the competition between the two elementary structures of the visual organ, and correspond to objective processes in the retina.

As soon as the phenomena observed by M. Blondlot shall have been incontestably proved by means of objective instruments of precision, these few remarks on the *n*-rays will be only of secondary importance.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—At a meeting held at The Museums, Cambridge, on February 8, Prof. Newton, F.R.S., being in the chair, it was decided to take steps to perpetuate the memory of the late Mr. J. S. Budgett. Since his return from his last expedition to Africa, Mr. Budgett had made some important observations on the material collected by him, but a large part of the valuable material which he gave his life to obtain was necessarily untouched by him. It is proposed that this should be worked out by some of his friends, and the results published, with the observations and drawings which he had himself made. The work would be edited by Prof. J. Graham Kerr, and suitably illustrated. It is also proposed, if the funds available are sufficient, to add to the volume a reprint of all Mr. Budgett's former writings, so that the volume will become a memorial of his life's work. Subscriptions towards the cost of preparing this volume should be sent to Mr. A. E. Shipley, Christ's College, Cambridge.

A VERBATIM report of the conference of teachers, held under the auspices of the London Technical Education Board on January 7–9, appears in the *London Technical Education Gazette*—the official circular of the Board—for January and February.

AT a joint meeting of the academical and university councils of Paris, some interesting remarks were made by M. Liard arising out of the recent changes according to which professors of secondary education were last year, for the first time, allowed to sit on juries for the baccalaureate. An opportunity has been given to these professors of expressing an opinion on the work submitted to them, and they all agree in considering that the subjects studied seem to appeal to the memory rather than to the faculties of observation, reflection and judgment.

THE Childhood Society, the object of which is the scientific study of the mental and physical conditions of children, has arranged a course of four public lectures to be given at the Sanitary Institute, commencing on Thursday, February 25. The lectures will be as follows:—"Some Elementary Aims in Education," by Mr. Hamilton Hall; "Protection of Feeble-minded Children during and after School Age," by Prof. W. A. Potts; "Physiology in the Curricula of Primary and Secondary Schools," by Dr. D. Sommerville; and "Child Punishments," by Dr. H. R. Jones.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 26, 1903.—"On the Distribution of Stress and Strain in the Cross-section of a Beam." By John **Morrow**, M.Sc. (Vict.), Lecturer in Engineering, University College, Bristol.

The author describes some experiments on the measurement of lateral or transverse strains in specimens of wrought and cast iron when subjected to bending. The instrument used for the determination of the displacements of the sides of a beam consists essentially of two cranked levers pivoted together. At one extremity these are in contact with the points on the specimen between which the change of length is required, while the relative motion of the other ends is measured optically by means of a fixed and a tilting mirror. This method of measurement allows of great precision and delicacy of reading. In this case the lateral displacements were observed to the nearest 1/400000 of a centimetre.

The beams used were about 3 cm. broad and 6·5 cm. deep, and they were supported on knife-edges about 90 cm. apart. Measurements of the transverse extensions or contractions were made at seven different points in the depth of the beam, while the applied bending couple was increased by definite increments of about 9347 kg.cm. each.

The actual strains proved to be appreciably smaller than those which might be expected from the Bernoulli-Eulerian theory.

The relations obtaining between the lateral and linear strains, for the materials in question, were found from independent experiments in direct tension and compression, and by a comparison of these with the transverse strains in the beams, the amount and distribution of the stresses over the cross-sections of the beams were inferred.

The results for cast iron specimens showed that, at the lower loads, the longitudinal stress varies as the distance from the neutral axis, but that in amount it is less than would be expected from theoretical considerations. As the load is increased, however, the strain diagrams become more and more curved in the direction of a decreasing strain at greater distances from the neutral axis, and this is accompanied by a displacement of the neutral surface towards the compression side of the beam.

It is well known that the existing theory does not give a completely satisfactory account of the actions in a beam. This paper is therefore important, not only for its own results, but because it opens up a new method of experimentally approaching this and the allied subjects, and so facilitates further research on similar lines.

February 4.—"Conjugation of Resting Nuclei in an Epithelioma of the Mouse." By E. F. **Bashford**, M.D., and J. A. **Murray**, M.B., B.Sc. Communicated by Prof. J. Rose Bradford, F.R.S.

In a previous communication the authors directed attention to the fact that the power of cell proliferation, which has been proved to occur in an epithelioma of the mouse (Jensen), is a phenomenon unparalleled in the mammalia. A mass of tumour, 16 lb. in weight, has been produced by artificially transplanting portions of the original growth and its descendants.

In seeking to throw light on this fact, the authors have studied carefully the phenomena which follow the transplantations of portions of the tissue to new sites, and have found that the tumours which arise are the genealogical descendants of the cells introduced. They have studied the growth of the tumours which arise at successive stages of twenty-four hours. In a tumour removed on the eighth day, and less than half a split pea in size, conjugation of resting nuclei has been observed. To take a specific case, the nuclei of two adjacent cells are continuous through the cell wall by a tube-like bridge, in the middle of which a strand of nucleolar substance with fusiform swellings in either cell is visible. The cells of this particular case are adjacent to the stroma, and close to the outer surface of the young tumour.

February 11.—"On the Compressibilities of Oxygen, Hydrogen, Nitrogen, and Carbonic Oxide between One Atmosphere and Half an Atmosphere of Pressure, and on the Atomic Weights of the Elements Concerned.—Preliminary Notice." By Lord **Rayleigh,** O.M., F.R.S.

The observations now referred to were conducted with an apparatus designed upon the same lines as that already described.[1] It must suffice to mention that the only important modification lay in the fact that the two single volumes, which, when employed together, constitute the double volume, were used separately and alternately, so as to eliminate in each set of measurements any question as to what the ratio of these volumes exactly is. It is hoped to give a full description of the method when it has been extended to the examination of other gases, such as nitrous oxide and carbonic anhydride. The temperatures ranged from 10°–15°, and care was taken that in each measurement the mean temperatures should be almost exactly the same for the single and for the double volume.

The results were reduced much as previously explained, and give for the values of B, which, according to Boyle's law, should be unity,

Oxygen	1·00040
Hydrogen	0·99976
Nitrogen	1·00017
Carbonic oxide	1·00028

B here denotes the quotient of the value of pv at the half atmosphere by the corresponding value at the whole atmosphere. That it would be less than unity in the case of hydrogen, and exceed unity for the other gases, is what would be anticipated from their behaviour at higher pressures.

If we measure p in atmospheres, and assume, as has usually been done, *e.g.* by Regnault and Van der Waals, that at small pressures the equation of an isothermal is

$$pv = PV(1 + ap),$$

where PV is the value of the product in a state of infinite rarefaction, then

$$a = 2(1 - B).$$

Probably the chief interest of a knowledge of the coefficient a is the application to deduce a correction to the relative densities of gases as observed at atmospheric pressure, so as to determine what would be the relative densities in a state of great rarefaction, to which alone Avogadro's law is applicable.[2]

Taking oxygen as a standard, we see that the small correcting factor to be introduced in order to pass from the ratio of densities at one atmosphere to that at great rarefaction is $(1+a)/(1+a_0)$, or $1+2\ (B_0-B)$, the suffix o relating to oxygen, that is, as follows:—

Hydrogen	1·00128
Nitrogen	1·00046
Carbonic oxide	1·00024

The double of the first number, viz. 2·0026, represents, according to Avogadro's law, the volume of hydrogen which combines with one volume of oxygen at atomspheric pressure to form water. Direct determinations by Scott gave 2·00245, and Morley, in his later work, found 2·0027, so that there is here a good agreement.

The following table gives the densities of the various gases, referred to oxygen = 16, at atmospheric pressure and at very small pressure, as deduced from my own observations.[3]

Gas.	Atmospheric pressure.	Very small pressure.
Hydrogen	1·0075	1·0088
Nitrogen	14·003	14·009
Carbonic oxide ...	14·000	14·003

From the researches of M. Leduc and Prof. Morley, it is probable that the above numbers for hydrogen are a little, perhaps one thousandth part, too high.

1 "On the Law of the Pressure of Gases between 75 and 150 Millimetres of Mercury" (*Phil. Trans.*, A, vol cxcviii., pp. 417–30, 1902).

2 The application to oxygen and hydrogen was made in my paper, "On the Relative Densities of Oxygen and Hydrogen" (Roy. Soc. *Proc.*, vol. l., p. 448, 1892; 'Scientific Papers," vol iii., p. 525.

3 Roy. Soc. *Proc.*, vol. liii., p. 134, 1893; vol. lxii., p. 204, 1897; "Scientific Papers," vol. iv., pp. 39, 352.

The uncorrected number (14·003) for nitrogen has already been given,[1] and contrasted with the 14·05 obtained by Stas. This question deserves the attention of chemists. If Avogadro's law be strictly true, it seems impossible that the atomic weight of nitrogen can be 14·05.

From the molecular weight of CO, viz. 28,006, we deduce, as the atomic weight of carbon, 12·006.

It should be mentioned that D. Berthelot[2] has, meanwhile, calculated very similar numbers, based upon the observations of Leduc.

Challenger Society, January 27.—Dr. E. J. Allen in the chair.—On behalf of the Marine Biological Association, Dr. **Allen** exhibited a chart showing the positions of freeing and recapture of marked plaice in the North Sea, and their probable lines of migration.—Dr. **Fowler** contributed notes on the vertical distribution of two Biscayan Chætognatha—*Sagitta serratodentata*, apparently seeking the surface by day, but deserting it for deeper water, down to 100 fathoms, by night or after rain; *Krohnia hamata*, represented merely by small and immature specimens between 50 and 500 fathoms, larger specimens occurring only between 500 and 2000 fathoms; none were captured between the surface and 50 fathoms. This observation tends to strengthen the theory of the continuity of the Subarctic and Subantarctic plankton by way of the mesoplankton.

Zoological Society, February 2.—H.G. the Duke of Bedford, K.G., president, in the chair.—Mr. R. **Lydekker** read a paper, illustrated by coloured lantern-slides, on the subspecies of the giraffe (*Giraffa camelopardalis*). The author enumerated ten subspecies, and pointed out the distinguishing characters of each.—A paper was read by Messrs. Oldfield **Thomas,** F.R.S., and Harold **Schwann** which contained an account of a collection of mammals from Namaqualand presented to the British Museum by Mr. C. D. Rudd. The collection consisted of 160 specimens, referable to 28 species or subspecies, of which one new species and three new subspecies were described in the paper.—Mr. F. E. **Beddard,** F.R.S., read a paper on the arteries of the base of the brain in certain mammals, based on observations he had made on individuals that had died in the society's menagerie.—Mr. G. A. **Boulenger,** F.R.S., read a paper which contained the descriptions of three new species of fishes discovered by the late Mr. J. S. Budgett in the Niger.—Mr. **Boulenger** also described the type specimen of the silurid fish, *Clarias laeviceps*, Gill, which had been entrusted to him by the Smithsonian Institution.

Faraday Society, February 2.—Dr. J. W. Swan, F.R.S., president, in the chair.—Notes on the welding of aluminium: S. O. **Cowper-Coles.** After referring to various machines and processes for welding aluminium, the author went on to describe his own process, which requires no flux or solder, and does not necessitate the hammering of the joint when in the pasty state, the process being especially suitable for wire, rods, and tubes.—Some applications of the theory of electrolysis to the separation of metals from one another: M. **Hollard.** The only principle hitherto involved in electrolytic separations has been based on the method of successive potentials, each metal depositing at the potential proper to that metal. In practice this principle has only been applied to metals (copper and silver, silver and bismuth, mercury and bismuth) the polarisation potentials of which are lower than that of hydrogen. Metals having polarisation potentials higher than that of hydrogen cannot be separated by gradual increase of the E.M.F., on account of the extremely small fraction of the current then used to precipitate the metal, hydrogen ions carrying most of the current. The author has therefore made use of three other applications of the theory of electrolysis, depending on (1) reduction of the resistance of the bath by suppressing the formation of gas at the anode; (2) influence of the nature of the kathode; (3) formation of complex salts.—Mr. G. Watson **Gray** read a short preliminary note describing an explosion of some high grade ferro-silicon that occurred spontaneously a short time ago at Liverpool. The gases evolved on boiling a specimen in distilled water were

1 Rayleigh and Ramsay, *Phil. Trans.*, A, vol. clxxxvi., p. 187, 1895.

2 *Comptes rendus*, 1898.

found to contain PH_3 and AsH_3. The former was in the greater proportion, and to that probably the explosions were due.

Mineralogical Society, February 2.—Dr. Hugo Müller, president, in the chair.—Mr. Harold **Hilton** contributed a paper on the gnomonic net. This net consists of lines giving equal longitudes and latitudes for every ten degrees on a plane touching a point on the equator, the former being hyperbolæ and the latter straight lines. The author pointed out how the net could be used for the graphical determination of angles between poles on the sphere.—Mr. G. T. **Prior** described a new sulphostannite of lead from Bolivia, to which he gave the name Teallite, in honour of the Director of the Geological Survey. The mineral in its graphite-like appearance resembles franckeite and cylindrite, but differs from them in not containing antimony. It has the simple formula $PbSnS_2$, and is orthorhombic with angles c(001) ∧ o(111) = 62°, c(001) ∧ p(221) = 75°, and m(110) ∧ m'''(1$\bar{1}$0) = 86°. It has a perfect cleavage parallel to c(001) and a specific gravity of 6·36. In connection with the investigation of this mineral new analyses were made of franckeite and cylindrite.—Mr. W. F. **Ferrier** gave an account of his discovery of the deposits of corundum in Canada, and Prof. H. A. **Miers** described a visit to the Rashleigh collection of minerals now deposited in the Museum of the Royal Institution of Cornwall at Truro.

Chemical Society, February 4.—Dr. W. A. Tilden, F.R.S., president, in the chair.—It was announced that the council proposed to send a congratulatory address to Prof. Mendeléeff on the occasion of his seventieth birthday, Tuesday, February 9, which was also the date of his official retirement.—The following papers were read:—The constitution of epinephrine: H. A. D. **Jowett**. The hæmostatic constituent of suprarenal gland secretion was first isolated by Abel and Crawfurd, and was subsequently obtained by Takamine, who named it adrenalin, and by von Furth, who called it suprarenine. The author finds that this substance has the composition $C_9H_{13}O_3N$, and that when fully methylated and oxidised it furnishes trimethylamine and veratric acid, whence he suggests that it should be represented by the formula

$$C_6H_3(OH)_2.CH(CH_2OH).NHMe(1:2:4)$$

or

$$C_6H_3(OH)_2.CH(OH).CH_2.NHMe(1:2:4),$$

the latter being the more probable.—Studies on the electrolytic oxidation of phenols, part i.: A. G. and F. M. **Perkin**. By the oxidation of pyrogallol, purpurogallin was obtained, whilst gallic acid furnished purpurogallincarboxylic acid.—Action of nitrogen peroxide on 1-nitrocamphene: M. O. **Forster** and F. M. G. **Micklethwait**. In this reaction a number of complex compounds were obtained the constitutions of which have not yet been determined.—The tautomeric character of the acyl thiocyanates: R. E. **Doran**. A study of the conditions under which acetyl thiocyanate reacts as such or as the tautomeric thiocarbimide.—Resolution of α-β-dihydroxybutyric acid into its optically active constituents: R. S. **Morrell** and E. K. **Hanson**. The physical characters of the two optically active acids which were obtained by fractional crystallisation of the quinidine salt of the racemic acid are described.—Aromatic compounds obtained from the hydroaromatic series, part i., the action of bromine on 3:5-dichloro-1:1-dimethyl-$\Delta^{2:4}$-dihydrobenzene: A. W. **Crossley**. A description of the derivatives obtained.—The action of nitrogen sulphide on organic substances: F. E. **Francis** and O. C. M. **Davis**. An enumeration of the cyanidins obtained by the action of nitrogen sulphide on aromatic aldehydes.—Dibenzoylchloroimide: F. D. **Chattaway**. The author claims priority, over Stieglitz and Earle, in the description of this compound and some of its derivatives.

Mathematical Society, February 11.—Prof. H. Lamb, president, and temporarily Prof. E. B. Elliott, vice-president, in the chair.—The following papers were communicated:—On the roots of the equation $\frac{1}{\Gamma(x+1)}$ = const.: G. H. **Hardy**. When the constant on the right hand side is zero, the rate of increase of the *n*th root approximates to that of *n* when *n* is large, and this result constitutes an exception to a general law which regulates the relation of the rate of increase of the roots to that of the function. It is shown that when the constant is not zero the rate of increase of the *n*th root is that of $n/\log n$, and the exception is removed. The significance of the result in relation to the theory of integral functions is discussed.—Some extensions of Abel's theorem on power series on the circle of convergence: G. H. **Hardy**. The extension is to double series. When a double power series converges on the locus that corresponds to the circle of convergence of a simple series, either (*a*) when summed first by rows, or (*b*) when summed first by columns, or (*c*) when the two suffixes are simultaneously increased, its sum is equal to the limit of the function at the corresponding point of the locus, provided the limiting operations are performed in ways that correspond to the three specified methods of summation.—On group-velocity: Prof. H. **Lamb**. The paper contains a new proof of the relation between wave-velocity and group-velocity, and the possibility of a negative group-velocity is discussed. If the group-velocity were negative, the waves and the groups would travel in opposite directions. Such a possibility has been suggested in connection with very intense absorption. Examples are given of mechanical systems free from dissipation which possess the required property. In such systems the disturbance that travels away from any source, when analysed into harmonic waves, is found to consist of waves travelling towards the source, but the groups by which the energy is propagated travel away from the source. The reflection and refraction of waves at the boundary of a medium in which the relation between wave-velocity and wave-length is compatible with a negative group-velocity are discussed, and the ratio of amplitudes of incident and reflected waves is found.—On a certain double integral: Prof. A. C. **Dixon**.—On an appropriate form of conductor for a moving point singularity: Prof. A. W. **Conway**.—On the irreducibility of perpetuant types: P. W. **Wood**.—On the representation of $\int_0^\infty \mathrm{cn}\ xt\ e^{-t}\ dt$ and other like integrals by means of continued fractions: Prof. L. J. **Rogers**. The paper deals with a generalisation of the so-called "addition theorem" for Bessel functions of zero order. A series of functions $f_1, f_2, \ldots$ can be determined from a given function f so that $f(x+y) = Af(x)f(y) + Bf_1(x)f_1(y) + Cf_2(x)f_2(y) + \ldots$ The determinants that arise in the process of obtaining these functions are closely related to the process of converting a series into a continued fraction. It is generally difficult to complete the latter process, but the relation between the two processes leads to a simplification.

CAMBRIDGE.

Philosophical Society, January 18.—Dr. Baker, president, in the chair.—On differences between the spectra at anode and kathode in certain gases, and on probable reasons for those differences: Prof. **Liveing**, F.R.S. The author found that in hydrogen at 7 mm. pressure the light at the anode gives only the second spectrum of hydrogen, at lower pressure the kathode glow shows only the first spectrum, and by further reduction of pressure the second spectrum is driven quite up to the anode and is then seen only in a bright spot upon the anode. The behaviour of the two banded spectra of nitrogen is exactly similar. In pure oxygen the anode is dark, but the kathode glow emits all the three spectra described by Schuster. The anode spectrum of the halogens is a continuous one, while the kathode glow gives a spectrum of lines, and the gas along the whole line of the discharge emits rays which, like kathode rays, make the tube fluoresce. The vapours of such metals as could be readily observed in glass tubes give each but one spectrum, the same in all parts of the tube. The spectra of the two oxides of carbon are indistinguishable from each other, and are the same at both electrodes. Cyanogen gives in the kathode glow the well-known blue and violet shaded bands, and at the same time the bands at the red end shaded the reverse way, but no trace of either the carbonic oxide or of the candle-flame spectrum in any part of the tube. The appearance of the positive column in all cases agrees well with Prof. Thomson's theory that the light arises from the association of ions, and has its origin in the positive ions, which in elements having diatomic molecules probably have not the same constitution as those molecules, but in elements with monatomic molecules may, when deionised, at once reproduce such molecules. The kathode glow the author ascribes to fluorescence, the gas acting as a screen to the kathode rays, and its molecules responding to the stimulus without being themselves permanently affected. This opinion rests on the way in which the glow maps out the course of the kathode rays, and on the observation that the spectral lines of the glow are in most cases reversible, and therefore probably have their origin in unaltered molecules of the several gases. In conclusion, the study of the kathode glow suggests that the solar chromosphere and corona are a huge kathode glow.—On a soluble colloidal form of ferric and of other phosphates: W. J. **Sell**, F.R.S.—On the distribution and spectra of metallic vapours in electric sparks: H. **Ramage**.—On the variation with wave-length of the double refraction in strained glass: L. N. G. **Filon**.—On the reflection of sound: Rev. H. J. **Sharpe**.

February 1.—Dr. Baker, president, in the chair.—Free-living fresh-water New Zealand nematodes: N. A. **Cobb**. Four new species, all belonging to known genera, are described. The specimens were dredged from the lakes, at depths ranging from 200 feet to 1150 feet.—Some High Andine and Antarctic Umbelliferæ: A. W. **Hill**. The communication dealt with the genera Crantzia (Nutt.) and Azorella (Lmk.), which are widely distributed in the southern hemisphere.—On the relative amount of ionisation produced in air and hydrogen by Röntgen rays: R. K. **McClung**. The object of the experiments described in this paper was to determine, if possible, the cause of the great discrepancy which exists between the results obtained by various experimenters who have previously worked on this subject. The results obtained by the various investigators differ very widely from one another. Experiments were made with various Röntgen ray bulbs in order to see whether the source of the rays had any influence upon the relative amounts of ionisation, and it was found that the source of the rays influenced the result to a very marked degree. Quite large variations in the ratio of the ionisation in hydrogen to that in air were obtained according to the bulb used. As different bulbs, of course, give out rays of different quality, it is evident from the experiments that the ionisation in hydrogen as compared with that in air depends upon the type of rays used. Further experiments are at present in progress to determine to what extent this variation depends upon the state of the vacuum in the Röntgen ray bulb. These experiments are as yet quite incomplete, but the indications are that the relative ionisation in the two gases does depend to some extent on the pressure of the gas in the bulb. Further experiments are to be made on this subject.

DUBLIN

Royal Dublin Society, January 19.—Mr. S. Geoghegan in the chair.—Prof. A. W. **Conway** read a paper on the reflection of electric waves from a moving plane conductor.—Prof. J. A. **McClelland** read two papers, (1) on the emanation given off by radium, (2) the comparison of capacities in electrical work (an application of radio-active substances). The first of these two papers contains an account of experiments made to test whether the emanation given off by radium is charged or not. The emanation is carried into a partially exhausted vessel by a current of air, the vessel being insulated and joined to a sensitive electrometer. No charge was detected. The ionisation produced in the vessel by the emanation is measured, and it is shown that if each emanation particle had a charge equal to or greater than the charge on the gaseous ion, a measurable deflection must have been observed, otherwise the ionisation produced by each emanation particle must have been greater than what is possible. The conclusion is therefore that the emanation is not charged. The substance of the second paper is as follows:—A *very steady* current can be obtained between two plates, one of which is kept at a high potential, by placing between the plates a quantity of uranium nitrate. This small steady current is used to charge the capacities to be compared to a given potential measured by an electrometer, and the time of charging is accurately measured in each case. The two capacities are therefore compared by simply observing two intervals of time. Numbers are given to show the accuracy of the method and the wide range of capacities to which it is applicable. In particular it is shown that capacities as small as one micro-microforad can easily be detected and measured by this method.—Prof. G. A. J. Cole communicated a paper by Mr. J. R. **Kilroe** on soil separations by the centrifugal method.

PARIS.

Academy of Sciences, February 8.—M. Mascart in the chair.—The general law of distribution of rays in band spectra: H. **Deslandres**. Since the spectra obtained with a concave grating are too feeble for the purpose of verifying the author's hypotheses, he has used a plane grating with an astronomical mirror of silvered glass of 2·5 metres focal distance. This arrangement has given all the bands of the second group of nitrogen excellently defined. The law of distribution deduced is that, in general, each band, expressed in vibration numbers, is divisible into series of connected rays, each series being such that the successive intervals are in arithmetical progression.—A new electrical device for extinguishing the high frequency arc: M. **d'Arsonval**. In the production of high frequency currents for therapeutical use it is necessary to prevent the formation of an arc between the spark gap. By the use of a subsidiary condenser this result is obtained very simply.—Protective arrangements for electrical machines supplying high frequency generators: MM. **d'Arsonval** and **Gaiffe**. Numerous cases of breakdown of transformers and coils used in the production of high frequency currents are common, and one possible cause of this is the return of waves from the spark gap to the transformer. An arrangement of condensers and resistances is described by which this effect is stopped without any loss of power.—The action of phenyl-magnesium bromide upon anthraquinone. Symmetrical γ-dihydroxyl-γ-diphenyl-dihydro-anthracene: A. **Haller** and A. **Guyot**. Anthraquinone reacts in the normal manner with the phenyl magnesium compound, but the yield of the carbinol is poor, on account of the slight solubility of the ketone in ether.—On the mechanism of the transmission of the *n*-rays through wires of different substances: E. **Bichat**. The transmission of the *n*-rays by a wire is regarded as being analogous to the experiment in which light is transmitted from one end to the other of a curved glass tube, by successive reflections. In support of this view, experiments on wires of different materials show that the transmission only takes place if the material of the wire is transparent for these rays. Thus the effect is not produced by a wire of lead, but the rays are transmitted by wires of copper, aluminium and zinc, all of which have been shown to allow of the passage of the *n*-rays.—On the determination of the displacement of a battleship: J. A. **Normand**.—On the true value of the major axis of a cometary orbit when far removed from the sun, and the supposed hyberbolic character of the comet 1890 II.: Louis **Fabry**. The author interprets the calculations of M. Strömgren as leading to an elliptical orbit for the comet 1890 II.—Remarks on differential equations of which the general integral is an entire function: Émile **Borel**.—On certain θ-functions, and on some hyperelliptic surfaces to which they lead: M. **Traynard**.—On entire series with entire coefficients: M. **Fatou**.—On the zeros of a class of multiform transcendentals: Georges **Remoundos**.—On the flame spectra of the alkaline metals: C. **de Watteville**. Photographs of the spectra of lithium, sodium, and potassium show that the rays fall into two groups, those which are equally strong in all parts of the flame, and those which are more intense in the lower part of the flame, that is to say, in that portion which emits the Swan spectrum. It is found that the rays in the former class are those which belong to the principal series of the element considered, whilst those of the second group belong to the secondary series of rays. The differences of the spectra would appear to be due to thermal causes only.—On the function which represents the magnification of objects seen through a transparent cone: C. **Chabrié**.—On the magnetic effect of convection currents: C. **Gutton**. By means of the increase of luminosity of a phosphorescent screen it is possible to demonstrate the magnetic effect of convection currents. This method is free from the experimental difficulties which arise from the use of astatic couples, but does not lend itself to quantitative measurements.—A new theory of influence machines: V. **Schaffers.**—On the relation which exists between sudden variations of the reluctance of a magnetised steel bar submitted to traction and the formation of Lüders's lines: L. **Fraichet.** During the time that new lines are being formed on the test piece, the variation of the reluctance is discontinuous, and when the variation of reluctance becomes continuous no new lines are observed.—Remarks on the subject of a note on osmosis by M. A. Guillemin: A. **Ponsot.**—On the use of the alternating current in electrolysis: André **Brochet** and Joseph **Petit.**—On the reduction phenomena produced by the action of alternating currents: F. **Pearce** and Ch. **Couchet.** Ferric alum is reduced nearly quantitatively by an alternating current when iron electrodes are used; alkaline nitrates are reduced to nitrites with electrodes of cadmium and zinc. The reduction of other inorganic salts is mentioned, and also the production of aniline from nitrobenzene.—The production of the sulphides of phosphorus in the cold: R. **Boulouch.**—Observations relating to the action of heat and light on mixtures of phosphorus sesquisulphide and sulphur in solution in carbon bisulphide: E. **Dervin.**—The action of carbonic acid upon solutions of sodium nitrite: C. **Marie** and R. **Marquis.** In opposition to the statements of M. Louis Meunier, the authors maintain that nitrous acid is set free by the action of carbon dioxide upon a solution of sodium nitrite.—On the constitution and properties of vanadium steels: Léon **Guillet.**—On the diureides: homo-allantoic ether: L. J. **Simon.**—On the phosphoric esters of glycol: P. **Carré.**—On the nature of starch: L. **Maquenne.**—The biochemical synthesis of olein and some esters: Henri **Pottevin.**—The formation of turpene compounds in the chlorophyll organs: Eug. **Charabot** and Alex. **Hébert.**—On the presence of an oxidising-reducing diastase in plants: J. E. **Abelous** and J. **Aloy.**—The geographical distribution of the marine Bryozoa and the theory of bipolarity: L. **Calvet.**—The influence of temperature on the duration of the phases of indirect division: J. **Jolly.**—On the assimilation of alcohols and aldehydes by *Sterigmatocystis nigra*: Henri **Coupin.** Certain alcohols, such as ethyl alcohol, glycerol, and mannite can be assimilated by the moulds, others (methyl alcohol, glycol) are indifferent, whilst a third class (amyl, propyl, butyl) are toxic.—On a special function of the mycorhizome of the lateral roots of vanilla: H. Jacob **de Cordemoy.**—On the stratification of the Montagne Noire: J. **Bergeron.**—Geological observations in the neighbourhood of Thonon-les-Bains: H. **Douxami.**—*Palaeoblattina Douvillei*—an insect or a trilobite: M. **Agnus.**

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 18.

ROYAL SOCIETY, at 4.30.—Further Researches on the Temperature Classification of Stars: Sir J. Norman Lockyer, K.C.B., F.R.S.—Theory of Amphoteric Electrolytes: Prof. J. Walker, F.R.S.—Note on the Formation of Solids at Low Temperatures, particularly with regard to Solid Hydrogen: Prof. M. W. Travers.—Atmospherical Radio-activity in High Latitudes: G. C. Simpson.

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

LINNEAN SOCIETY, at 8.—Mendel's Laws as Illustrated by Wheat Hybrids: R. H. Biffen.—Heredity and Variation as seen in *Primula sinensis*: W. Bateson, F.R.S.—Formation of Secondary Wood in Psilotum: L. A. Boodle.

FRIDAY, FEBRUARY 19.

ROYAL INSTITUTION, at 9.—Condensation Nuclei: C. T. R. Wilson, F.R.S.

GEOLOGICAL SOCIETY, at 8.—Anniversary Meeting.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Annual General Meeting; followed by Discussion on Heat Treatment of Steel.—The Motion of Gases in Pipes, and the Use of Gauges to Determine the Delivery: R. Threlfall, F.R.S.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Etiology of Scurvy: Dr. Myer Coplans.

SATURDAY, FEBRUARY 20.

ROYAL INSTITUTION, at 3.—The Life and Work of Stokes: Lord Rayleigh.

MONDAY, FEBRUARY 22.

SOCIETY OF ARTS, at 8.—Modern Book Printing: Charles T. Jacobi.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Duty Free Alcohol: Thomas T. Tyrer.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A Pioneer Expedition to Angola: Capt. Boyd A. Cuninghame.—A Journey in Northern Uganda: Major P. H. G. Powell-Cotton.

VICTORIA INSTITUTE, at 4.30.—Observations on the Irrigation of India: Charles W. Odling.

TUESDAY, FEBRUARY 23.

ROYAL INSTITUTION, at 5.—Japanese Life and Character: Prof. E. Foxwell.

ANTHROPOLOGICAL INSTITUTE, at 8.15.—The Fijians in Peace and War: W. L. Allardyce, C.M.G.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Construction of Railway-Wagons in Steel: J. D. Twinberrow.—The Construction of Iron and Steel Railway Wagons: A. L. Shackleford.—Iron and Steel Railway-Wagons of High Capacity: J. T. Jepson.

WEDNESDAY, FEBRUARY 24.

SOCIETY OF ARTS, at 8.—Mahogany and other Fancy Woods available for Constructive and Decorative Purposes: Frank Tiffany.

SOCIETY FOR THE PROTECTION OF BIRDS, at 3.—Annual Meeting.

GEOLOGICAL SOCIETY, at 8.—Eocene and Later Formations surrounding the Dardanelles: Lieut.-Col. Thomas English, with Appendices by Dr. John Smith Flett, R. Holland, and R. B. Newton.—The Derby Earthquakes of March 24 and May 3, 1903: Dr. C. Davison.

THURSDAY, FEBRUARY 25.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The Electromotive Phenomena in Mammalian Non-medullated Nerve: Dr. N. H. Alcock.—Further Observations on the *Rôle* of the Blood-Fluids in connection with Phagocytosis: Dr. A. E. Wright and Capt. S. R. Douglas.—A Contribution to the Pharmacology of Indian Cobra-venom: Major R. H. Elliot.

ROYAL INSTITUTION, at 5.—Electrical Methods of Measuring Temperature: Prof. H. L. Callendar, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Transatlantic Engineering Schools and Engineering: Dr. R. M. Walmsley. (Adjourned Discussion.)

FRIDAY, FEBRUARY 26.

ROYAL INSTITUTION, at 9.—New Developments in Electric Railways: Alex. Siemens.

PHYSICAL SOCIETY, at 5.

SATURDAY, FEBRUARY 27.

ROYAL INSTITUTION, at 3.—The Life and Work of Stokes: Lord Rayleigh.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Boiler-house Design: L. G. Crawford.

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