THURSDAY, FEBRUARY 19, 1903.

ELECTRIC RADIATION FROM WIRES.

Electric Waves. Being an Adams Prize Essay in the University of Cambridge. By H. M. Macdonald, M.A., F.R.S., Fellow of Clare College. Pp. xiii + 200. (Cambridge: University Press, 1902.) Price 10*s*.

THE essay under review consists essentially of two parts. In one of them the author aims at a restatement of electrodynamic theory in a manner which will avoid what he considers to be the difficulties of the existing dynamical expositions. The other part contains new developments relating to the mode of propagation of electric radiation, its emission and absorption by resonating wire circuits, and the dynamical laws of its diffraction by obstacles.

In illustration of the power of the mathematical analysis that is developed in the latter part, it may be mentioned that the general dynamical problem of diffraction at the edge of a perfectly conducting (*i.e.* totally reflecting) prism is solved in a few pages at the end of the book (Appendix D) by a method which admits of extension to any transparent or metallic prism the optical constants of which are known. The only case of diffraction in which a rigorous dynamical solution had been previously obtained is that of the straight edge of a perfectly conducting plate, which is the special case of a prism of vanishing angle; this had been reached through intricate analysis by Poincaré and by Sommerfeld, and the result is now often reproduced as a new departure in mathematical physics applied to problems in theoretical optics. The very elegant treatment in terms of Bessel functions that is brought to bear by Mr. Macdonald will remind readers of a previous successful application of essentially the same analysis, namely to the verification of Mr. W. D. Niven's beautiful functional solution of the problem of electric distribution on the general type of conductor bounded by two intersecting spheres, which was published some years ago in the *Proceedings* of the Mathematical Society. Features of much interest are bound to arise in the theoretical character of the diffraction at the edge of a transparent or metallic prism of known index; it is to be hoped that the author will not be deterred by some inevitable complexity of computation from following out in detail this natural extension of his results.

When disruptive electric disturbances take place in a material system, their energy is, in the ordinary course, dissipated by electric radiation into space, in so far as it is not degraded into heat by resistance. That any other state of affairs could exist has not been hitherto contemplated, though it has been known by experience that an electric vibrating system like the ring resonator of Hertz could go on oscillating for very many thousands of periods without much loss. The author claims that it is possible theoretically to have electric vibrating systems absolutely permanent, which would last for ever so far as radiation is concerned; that if electric waves are introduced into a nearly complete wire circuit, and if the ends are then connected so as to make the circuit a complete ring, a portion of the wave-motion will settle down into a steady state in the circuit and run round and round for ever, assuming, of course, that the circuit is perfectly conducting; that as such waves can only enter through the ends, so the only way of dissipating them is by cutting the circuit and allowing them to escape from the ends. This, even if it is not valid for thick anchor rings, is certainly practically correct for thin wires; and such systems in which electric oscillations are going on thus radiate mainly from the ends or points of the wires. The nature of the beam of radiation which issues from the end of a straight wire is here investigated theoretically, the form obtained for the wave-fronts around the end being shown to be in close accord with the observations of Birkeland and Sarasin. Fortified with this theoretical analysis, we can form a more vivid and confident idea of how exposed metallic points like those of lightning conductors may gather up stray radiations in the surrounding space, which may then be passed down around a system of properly attuned loops forming nearly closed circuits in the lower part of the wire, in each of which a selected period can be intensified by resonance and tapped off through a relay system into an appropriate recorder; and we can even imagine that the direction from which an incident train of disturbances comes may be estimated from the orientation of the plane of the resonating loop which responds to it most intensely.

The whole theoretical discussion is founded on, and in turn elucidates, an extension of the ancient electric dogma of the power of points into the new field of electric radiation. Closed electric circuits can be placed in relation of radiation and absorption with the surrounding æther, after the manner of radiating atoms in temperature equilibrium, by narrow breaks or attached spikes. The subject is far from being exhausted; for example, the more complex and probably far more difficult problem suggests itself to compare the radiation that must escape from a sharp bend in the wire carrying the waves with the radiation issuing from its open end. From the standpoint of present interests, the theoretical elucidation of the circumstances on which depend the free periods of resonators of the Hertz pattern formed of simple wire rings with or without knobs at the ends, to which close attention is also devoted in the book, is hardly as important as this other related question of the theoretical conditions governing the emission and absorption of radiation from wire circuits and networks.

The periods of free electric surging in the dielectric sheets of various forms of condensers are also discussed; the correction for the open edge of a flat condenser is determined, expressed in the form that by adding a slip of certain breadth to the plates all round the edge the electric field between them may be taken as uniform right up to it. The result comes, of course, from application of the general principles of the mode of analysis applied in acoustics by Helmholtz in 1859 to the correction for the open ends of organ pipes.

As developed by our author, the key to the discussion of the oscillations and their free periods, in open wire circuits, lies in the determination of the radiation from the end part of a straight wire when standing electric

waves are surging along its surface. This provides a knowledge of the ratio in which the distance of the open end from the nearest node falls short of half a wave; and, the other successive nodes being practically equidistant, it thus affords a knowledge of the free periods in terms of the length of the wire. Finite curvature of the wire does not sensibly affect things; this was elucidated very clearly by Pocklington in 1897,[1] and his analytical device for replacing the electrification and electric flow on the wire by a series of changing electric doublets situated along it, the fields of disturbance of which are simply expressible, is here largely employed. Consider, in fact, a system of doublets of moment σ (in the magnetic sense) per unit length distributed along the length s of the wire; they are equivalent to a current of intensity $d\sigma/dt$, a charge of line-density $-d\sigma/dx$, and two point-charges $-\sigma_1$ and $+\sigma_2$ at the ends; as the true current vanishes at the ends, σ must be constant there, and so will vanish too. This kind of theory leads very directly, in § 67, to the character of the forced oscillation on the wire that is established by an impressed magnetic field in the surrounding region, which is symmetrical and therefore ranged in circles around the wire as axis. Each infinitesimal ring of impressed alternating magnetic force is propagated out directly into wider rings until it meets the point of the wire under consideration, but *in addition* it travels to the open end of the wire and thence down its length, the signs being such that the two parts cancel at the end; the amplitudes of these two interfering systems of rays of magnetic force are not attenuated with increase of the distance traversed, because each point of the wire is equidistant from all elements of the source. It is their interference that constitutes the standing waves on the wire. We have here rings of magnetic disturbance radiated from the outside sources, converging on the wire through its open end, and travelling down it; it would appear that the author's restriction to symmetry may largely be dispensed with. The conditions are now reversed, and a system of standing oscillations on the wire pouring out radiation into space is contemplated; that occurs only through open ends, the oscillatory surging on the perfectly conducting wire elsewhere being capable of adjusting itself locally, like waves on a musical cord, without having to constrain any radiation. If we know the distribution of the radiation from the open end of a straight wire, over the infinite sphere, we can, by reversal of the motions and treating the infinite spherical surface as a region of sources of disturbance, deduce by the previous analysis the positions of the nodes on the wire. In applying this method, the author considers (§ 78), for reasons not obvious, that an open end radiates uniformly over the hemisphere in front of it.[2] In the discussion of the Hertzian wire resonator which follows, the two contiguous ends are taken to constitute a Hertzian oscillating doublet, and this determines the required distribution of radiation at infinite distance; the reversed radiation is supposed to affect the two ends independently. One feels more confidence here than in the previous case of a single end; and the results are, in fact, in very close agreement with experimental measurements by Sarasin and de la Rive. The modification arising from arming the ends with small balls or plates is also gone into.

The author's verification of the known form of the wave-fronts near the open end of a wire, namely confocal paraboloids with focus at that end, also comes from the reversed motion as above. It appears that this result holds whatever be the distribution of the radiation over the infinite sphere, the magnetic force around the end being of the form $A\tan\frac{1}{2}\theta$. The author adverts to the transverse wave-fronts travelling along the wire towards the end and finally bending round near the end into paraboloids as it is approached; the wave-front may be considered as detained on the wire because the magnetic force is cyclic around the wire and could not be cyclic if the front escaped into free space. In fact, the value of the magnetic force above given obviously satisfies this necessary condition, its circulation $2\pi r\sin\theta.A\tan\frac{1}{2}\theta$ being equal to $4\pi Ar$ along the wire and equal to zero along its prolongation; the current in the wire near the end is thus Ar. We have, therefore, only to show that the characteristic equation of a magnetic field disposed in circles around the wire is satisfied; and this is so, for by the Amperean relation it leads to a longitudinal component Z of electric force proportional to r^{-1}, which is of the right form, being near the end practically $e^{i\kappa r}/r$, which satisfies the equation $\nabla^2Z+\kappa^2Z=0$. The transverse component of the electric force is similarly found to be proportional to $-r^{-1}\tan\frac{1}{2}\theta$; thus the resultant force is in the direction bisecting the angle between r and the direction of the wire produced, and is therefore tangential to parabolic wave-fronts as above stated, being wholly transverse close to the wire. There is some temptation to imagine the wings of the parabolic part as advancing towards each other and forming a narrow neck which is finally nipped through, the main part of the front then going off as a plane sheet of radiation, while the other part retreats back into the wire and gives rise to a reflected wave, somewhat in the manner described by Hertz ("Electric Waves," p. 144) for the case of an oscillating doublet.[1] For free oscillations on a wire with two ends, the radiation is, however, sideways.

The circumstance that the general features of some of the author's conclusions can be traced by simple reasoning, as he himself indicates, does not, of course, detract from their value or novelty; it rather tends to confirm the validity of the powerful mathematical analysis to the results of which they are a first approximation, and should stimulate similar inquiry as regards the other part of his results. That this type of analysis is yet destined to point the way into the heart of other important problems in mathematical physics there can be no doubt; now that spherical and ellipsoidal forms have received such

[1] *Proc.* Camb. Phil. Soc. In this powerful paper, the radiation from a complete circular wire comes in evidence, in a second-order approximation, through a very slight damping of the free oscillations. On the view above described, there should be no such effect; yet, on the other hand, the electricities can be separated to the two sides of the ring by an electric field, and should surge back in vibratory manner when released.

[2] It appears that the assumption of a considerably different law would not much affect the result.

[1] Mr. Macdonald informs me that this view is supported by the graph of his second approximation in § 77.

abundant attention, it is much to have a method that can deal in comparative simplicity with edges and prisms and cones.

The evidence is closing in more and more rigorously that the medium which transmits electrical and radiant effects must either completely accompany matter in bulk in its movements or else be entirely independent of such movements. If we adopt the latter hypothesis, to which theoretical considerations strongly point, and we still consider the æther to be something possessing translatory inertia, the nature of its kinetic energy will be entirely at our disposal as regards interpretation.

The author's order of exposition, in the theoretical chapters of this book, first develops the equations for the free æther, in terms of a vector potential; these are naturally purely vibrational; then the disturbance of electricity, which is really the exciting source of the phenomena, is introduced by adding the electric flux $-4\pi(u, v, w)$ to the expression $c^{-2}\frac{d^2}{dt^2}(F, G, H)$, which by these equations of propagation is equated to $\nabla^2(F, G, H)$. In other words, the elements of current are each of them introduced as a simple intrinsic pole of the vector potential, which in other respects obeys the purely vibrational equations for the æther of empty space. These equations, as solved by the Poisson analysis suitable for such cases, represent disturbances travelling out from the poles in the known manner of simple compact propagation, at any rate in all cases where the phenomena are periodic. The electric flux thus introduced is here named the convection current, presumably because it is afterwards going to be considered as arising solely from the motion of electric charges or ions; in the analysis of Appendix C it is the motion of a volume density. The significant remark now follows that

"the assumption is implicitly involved that Maxwell's æthereal displacement current is independent of the motion of the æther, if there is such a motion."

Does this mean that it belongs to the æther, but yet is disconnected from it so that it is left behind if the æther moves on? One is tempted to amend the last phrase and make it read, "therefore there is no such motion."

However this may be, practically it comes to the same thing; in the next chapter, the æthereal part of the total current is taken not to depend on the motion of the æther, but the convection current does depend on the motion of the matter. This leads, as is known, to Fresnel's formula for velocity of optical propagation in moving material media, and to the law of astronomical aberration of light; and the author's *dictum*, above quoted, has already *postulated* that it is not to affect the phenomena whether the æther moves or not.

The reluctance shown by the author to considering the æther as stationary in space is based mainly, it appears, on the ground that a field of magnetic force must be concerned with motion in the æther, so that if that medium were otherwise at rest, waves of radiation would be convected by a magnetic field. This is known not to be the case to any recognisable extent; and it is here explained that the magnetic motions are only a part of the disturbance, there being other latent motions in the æther which may exactly compensate. But, on the other hand, the objection is not essential; for magnetic energy may not be energy of simple translation, while if it is so, the velocity need not be of detectable magnitude provided the inertia is sufficiently great. And in the latter case these other latent motions would surely be themselves magnetic. This consideration points to retaining the most precise and directly presentable scheme, until it is definitely proved to be too narrow.

In the body of the book, the mathematical analysis is developed from the foundation of the circuital laws of Ampère and Faraday, as translated into simple analytical form, and rendered self-consistent by the introduction of displacement currents, originally by Maxwell. In Appendix C, these relations are fitted into a purely dynamical frame. They are derived from potential and kinetic energy functions

$$T = \tfrac{1}{2}\int\int\int\left(F\frac{df}{dt} + G\frac{dg}{dt} + H\frac{dh}{dt}\right)dx\,dy\,dz,$$

$$W = \tfrac{1}{2}\int\int\int(Xf + Yg + Zh)dx\,dy\,dz;$$

but the other Maxwellian expression, more like ordinary kinetic energy,

$$T = \frac{1}{8\pi}\int\int\int(\alpha^2 + \beta^2 + \gamma^2)dx\,dy\,dz,$$

is considered to be unwarranted. This must mean that the kinetic energy is distributed in the medium according to the first form of integral, and that the second, though it gives the right total amount throughout all space, does not express its correct distribution in space. This is a question as to matter of fact. Not to press the point that the element of energy given by it is not essentially positive, the first specification might be thought to imply that (F, G, H) can be expressed in terms of the local conditions alone; but the only formula for this vector that is given is a volume integral depending on the state of the whole electric field. One result of the change is, of course, that the Poynting vector for the flux of energy must be modified, so that near the vibrator the paths of rays would be altered; when the waves become plane it does not matter.

If we turn to the mathematically analogous (but physically different) hydrodynamic theory by way of illustration, the kinetic energy of a fluid containing vortex lines can be expressed in terms of the vorticity by a cognate integral involving the vortex distribution alone, and the behaviour of the vortexes might be deduced from it, abstraction being made altogether of the fluid in which they exist. So the phenomena of the electric currents would be developed with abstraction altogether of the æther in which they subsist; except that, unfortunately, when the field is not steady, all the æther has to be filled with fictitious æthereal current which is not electric flux at all, *or else* all effects of true electric flux have to be considered as propagated in time. This is, in fact, the course of the actual historical development of the theoretical electrodynamics of ordinary steady

electric currents in the hands of Ampère and his successors; no mention need be made of the æther until electric radiation begins to play a sensible part, either in the establishment of the field or in the draining off of its energy, or until motion of the electric charges is contemplated. In the latter case, it would appear that we have either to take the æther to be at rest or to say with our author that it behaves as if it were so.

The analogy has here been drawn (which Mr. Macdonald doubtless would not allow) between the analysis of the interactions of electric currents in an æther which is intangible and that of vortical smoke-rings in an atmosphere which is invisible. In each case, one would try to avoid assuming unnecessary properties of the medium. And it is only fair to admit that the properties of electric currents have actually been discovered in this way, while without discussing the fluid we should hardly have made much progress with the more fugitive vortexes.

The process of arriving at wider and wider points of view by successive stages of generalisation from an initial hypothesis is a familiar and fruitful one in theoretical physics; though in these latter times the logical and philosophical merits of the converse process of discarding from our knowledge all colorable images or analogies, in favour of bare mathematical expression of the relations of the unknown quantities which are symbols for entities on which we do not wish to dogmatise at all—of which we, in fact, know intrinsically no more than we do about the most common objects around us—has also been amply enforced. Yet in successful instances of this latter procedure, the retort seems open that the hypothesis or analogy has not been dispensed with until it has effectively disclosed of what type the said relations were to be. It very likely arises from want of familiarity with Mr. Macdonald's point of view that a doubt suggests itself as to whether we have not here a case, if not of kicking away the ladder before the passenger has arrived at the top, at any rate of removing the supporting framework before the ties and struts of the permanent structure have become entirely consolidated.

Much in these remarks has assumed a critical form, because after pointing out the excellences that can be enjoyed by consulting the work itself, it would appear that a reviewer could do best service by discussing the matters that are not so clear. Other more detailed topics might be specified which require further consideration. For instance, students of the modern subject of the relation of radiation to temperature would perhaps be puzzled by § 82, which professes to give a new proof of the Stefan-Boltzmann law; the transformation of linear scale of the system æther *plus* matter, there employed, is a very tempting one, but, unfortunately, the free periods do not seem to correspond. It may be put forward as a reasonable generalisation, subject to only a few striking exceptions, that a book which can be acclaimed as free of discrepancies or obscurities is also to a large extent free of new contributions to knowledge. In the present case, the obvious advances are so important that close attention to the work throughout its whole range cannot safely be neglected.

J. LARMOR.

A STUDY IN ALPINE GEOLOGY.

Das Sonnwendgebirge im Unterinnthal. Ein Typus Alpinen Gebirgsbaues. By Dr Franz Wähner. First part. Pp. xii + 350; with 96 illustrations in the text, 19 plates and map. (Leipzig and Vienna: F. Deuticke, 1903.) Price 35 marks.

OF all the labour that has been expended on the fascinating problems of Alpine geology, none, perhaps, has been more fortunate in the manner of its presentation than the work under consideration. A lucid style, fine large type and a wealth of illustration contribute to the enjoyment of an interesting thesis. The weight and bulk of the volume, however, constitute a drawback.

The limited area dealt with by the author comprises the Haiderjoch, Rosan and the Sonnwendjoch; and the formations range from the Triassic Werfen beds to the Upper Jurassic Aptychenkalk; but it is with the rocks about the middle of this series that he is mainly concerned. These are classified in the following, descending, order:—Hornsteinkalk (upper Jura), Hornstein-Breccie, Radiolariengesteine, Rother Liaskalk [Weisser Riffkalk, Ober-rhätischer Mergelkalk, Weisser Riffkalk (lower part)], Kössen beds.

It will be recognised at once that this is an abbreviation of Pilcher's sequence. The main mass of the Weisser Riffkalk, which has all the characters of a true coral reef, has presented a difficulty to the author from the fact that he has found, in the lower parts, undoubted Rhætic fossils, and in other parts, which he considers are higher portions of the same group, Lias fossils have been discovered.

"We are so accustomed to regard the term 'Oberer Dachsteinkalk' as applied to a Rhætic rock that it does not seem wise to use it for a group which is in part Rhætic, in part Liassic."

He therefore proposes "Weisser Riffkalk" as a local term, suggestive of the salient character of the group.

Before presenting the results of his own researches, Dr. Wähner devotes the first 78 pages to the discussion of the geological literature of the Sonnwend district. Commencing with Uttinger in 1819, he passes in review practically all that has been written on the subject up to 1900 (in the preface he comments on Ampferrer's paper of 1902). On each paper he makes a few brief explanatory or critical remarks. To Dr. Diener, however, he allots some fifteen pages, occupied almost wholly in destructive criticism—"a heap of errors," he says in one place; and he is so irritated by what he regards as Diener's incorrect observations and loose writing that he waxes ironical: "I regret I cannot give any figure of this interesting spot," says Diener, which causes the author to remark,

"The reader endeavours to keep calm; perhaps D. had no time to make a sketch—but, on second thoughts, a better view is, that what Diener desires (*will*) to see, nobody *can* draw" (p. 40).

With much of the painstaking work of Pilcher, the author is in agreement, but he considers the

estimate of the number and thickness of the Lias and Jura deposits to be too great. In spite of Pilcher's care in selecting a traverse apparently free from complications, Wähner contends that thrusting and over-folding have produced a repetition of the beds.

In the chapter on stratigraphy, each member is dealt with in order. Incidentally, several points of interest are raised, such as the discovery in the Weisser Riffkalk of a true Coralline, to which the name *Cheilosporites Tirolensis* (Wähner) is assigned on account of its affinities with the modern Cheilosporum; there is also a doubtful Hydrozoan which more nearly resembles the Palæozoic Stromatoporoids than the Upper Jurassic Ellipsachinias and Sphæractinias, but is none the less morphologically nearest to the Triassic Spongiomorphidæ. Calcareous algæ, hydrozoa and corals contribute to the upbuilding of the reefs, but Dr. Wähner finds the last-named organisms predominating.

The greatest interest attaches to the "Radiolariengesteine" and the "Hornstein-Breccie." Dr. Wähner, in common with his predecessors, had been accustomed to regard the structure of this area as being far simpler than he now finds it. He demonstrates a large amount of thrusting and folding ("Aufwolbung"), the greater part of the movement having acted about the Hornstein-Breccie, the rocks above being comparatively little influenced. On all sides there are signs of pressure—brecciation, suture structure—and the term "Druckbreccien" is suggested as an expansion of Brögger's "Breccias *in situ*" for this widespread occurrence. The Hornstein-Breccie is proved to be a true "dislocation-breccia," and to contain blocks both of older and younger rocks.

In his anxiety to leave no doubt as to the tectonic origin of this breccia, the author appears to have somewhat laboured certain points that seemed to tell in his favour; for instance, he insists on the abyssal character of the over- and under-lying rocks because of the abundance of Radiolaria in them, especially the occurrence of a few Nassellarian forms—an argument that is not very safe, nor, in view of the other good evidence, is it very necessary. Again, the statement that the cloudy centres of some calcite crystals in the more or less marmorised limestones represent the finest powder of the crushed rock may be quite correct; but the same thing may be observed in semi-crystalline limestones of various ages, which have suffered no such considerable crushing, though it is true that the crystals more often exclude the impurities during their growth.

The author and his supporters, the *Gesellschaft z. förderung deutscher Wissenschaft, Kunst, u. Literatur in Böhmen*, may be congratulated on the production of an excellent piece of work. The continuation will be looked for with interest; it is to be hoped that Dr. Wähner, in addition to the half-promised geological map, will also furnish a series of photomicrographs of the numerous rock-sections he has examined. J. A. H.

SHERBORN'S INDEX ANIMALIUM.

Index Animalium sive Index nominum quae ab A.D. MDCCLVIII *generibus et speciebus animalium imposita sunt, Societatibus Eruditorum adjuvantibus, a Carolo Davies Sherborn confectus. Sectio prima, a kalendis Januariis* MDCCLVIII *usque ad finem Decembris* MDCCC, *Cantabrigiae. E. typographico Academico* MDCCCCII. 1 vol. Pp. lix + 1195. (Cambridge: University Press, 1902.) Price 25*s.* net.

DARWIN was so convinced of the pressing want of a dictionary of the names of plants that he devoted by his will a considerable sum of money to be employed in compiling such a work. This gigantic task, which was completed in 1895 by Mr. B. Daydon Jackson, and published by the University of Oxford under the title of "Index Kewensis," has been of enormous utility to working botanists. It was obvious that our zoologists would not be content without a similar convenience in their branch of natural science, and in 1890, accordingly, Mr. C. Davies Sherborn commenced his labours on the present work. His scheme for its preparation was set out in a letter published in this journal (NATURE, vol. xlii. p. 54, May 15, 1890) and in "La Feuille des Jeunes Naturalistes," and suggestions for the improvement of the plan were at the same time invited from many working naturalists. After these had been studied, the scope of the proposed "Index Animalium" was finally defined as follows:—

(1) To provide a complete list of all the generic and specific names that have been applied to animals since January 1, 1758, when Linnæus inaugurated the binomial system.

(2) To give, as far as possible, an exact date for every quotation of a name.

(3) To give a reference to every name sufficiently exact to be intelligible to the specialist and the layman, so that they may know where to look for it.

Mr. Sherborn commenced regular work on July 1, 1890 After two years, an unfortunate breakdown in health, which interrupted more than once his assiduous labours, caused him to lose altogether three years, so that the actual time spent on the preparation of the present volume has been about eight years.

In 1892, the importance of the work was brought to the knowledge of the British Association, and a committee was appointed to assist its progress. The late Sir William Flower was its chairman, and Dr. Sclater, Dr. Henry Woodward and Mr. W. L. Sclater were other members. The committee has been reappointed every year, Dr. Woodward succeeding Sir W. Flower as chairman, and Dr. F. A. Bather becoming secretary when Mr. W. L. Sclater went abroad. The British Association has consistently supported the finances of the committee, and valuable contributions have been received from the Zoological Society of London and from the Government-grant fund of the Royal Society. Great assistance to the work has also been furnished by the permission of the authorities of the Natural History Museum to find storage and cabinets for the MS. of the work in the library at South Kensington, where the author has carried on most of his labours.

In 1897, in pursuance of a suggestion made by Dr.

Sclater, it was determined by the committee that in view of the long time that must elapse before the completion of the whole work, it should be divided into three portions—the first to contain names given from the beginning of 1758 to the end of 1800, the second those given from 1801 to 1850 inclusive, and the third those published in the latter half of the last century. We have now, therefore, before us the first o these three portions, from 1758 to 1800 inclusive. It is contained in one volume of 1195 closely printed pages, with about fifty-eight names in each page.

As the Clarendon Press had published the "Index Kewensis," it was supposed that the University of Oxford would gladly undertake the present work, and the first offer of it was made to Oxford. It was found, however, that such stringent terms were required there as could not be acceded to, and the sister University, being more liberally disposed, has thus obtained he honour of introducing to science the "Index Zoologicus."

OUR BOOK SHELF.

Vergleichende chemische Physiologie der niederen Tiere. By Dr. Otto von Fürth, Privatdocent and Assistant in the Chemico-physiological Institute of the University of Strassburg. Pp. xiv + 670. (Jena: Gustav Fischer, 1902.) Price 16 marks.

DR. OTTO V. FÜRTH has shown himself one of the ablest of the younger workers in the subject of chemical physiology, and he is already well known for his admirable researches on the subject of muscle-plasma and the chemistry of the suprarenal capsules. He has also contributed to physiological journals several interesting papers on the chemistry of invertebrates, which he has investigated during a stay at the zoological station at Naples. During his residence there, he appears to have inhaled with the sea breezes the proper invertebrate atmosphere for the carrying into execution of the present ambitious volume. Although the book is entitled the "Chemical Physiology of the Lower Animals," it relates mainly to the invertebrates, and at the end of each chapter is a brief summary contrasting these with the Vertebrata. Vertebrate physiology is fairly fully treated in all text-books of human physiology, and so the book meets what was a distinct want. Max Verworn, it is true, in his "General Physiology" approaches the subject by the study of the cell and of simple organisms, but the ground covered by v. Fürth's book is quite distinct from this.

The general scope of the book may be indicated by a brief enumeration of the subjects treated. After a few general chapters on the chemistry of the compounds met with in the animal kingdom and on the chemical composition of protoplasm, the first main heading is the blood, and this fluid in echinoderms, worms, molluscs, crustaceans, insects and tunicates is described. Breathing, nutrition and excretion are then treated under similar headings. Then the various animal poisons, and special secretions like mucin, the ink of cephalopods, silk, wax, &c., are described. The skeletal tissues, the pigments and the muscular tissues form the subjects of the next chapters, and at the end is an account of the genital secretions, under which, *inter alia*, a description of Loeb's experiments on artificial parthenogenesis is given.

It may be a matter of surprise to many well-informed physiologists what a large mass of material existed in relation to what has been regarded as the comparatively neglected subject of invertebrate physiology, and what interesting reading it makes when collected into an organic whole. Another general reflection will be what a vast field for research is still open to fill up the gaps in our knowledge.

The diligence the author has evinced in writing his book is beyond all praise. His lists of bibliographical references will prove most useful to future students of this branch of science Unlike many of his countrymen, he has consulted, not only those papers which are written in his own language, but he has been cosmopolitan in his reading. His aim, as just stated, has been an ambitious one, and we congratulate him most heartily on a decided success.

Thermodynamique et Chimie. Leçons élémentaires à l'usage des Chimistes. Par P. Duhem. Pp. ix +496. (Paris: A. Hermann, 1902.) Price 12*s*.

THE second law of thermodynamics has had a curious history. It originated out of attempts to estimate the motive power of fire, it subsequently led to the notion of the thermodynamical potential, this in turn gave birth to the phase rule, and now it is in the domain of chemistry that the law obtains its most fertile applications. Prof. Duhem has already published a treatise in four volumes on thermodynamic chemistry, which has been reviewed in these columns ("Traité élémentaire de Mécanique chimique fondée sur le Thermodynamique." Paris, 1897-99), but a demand has arisen among chemists for a more elementary treatise, assuming but little knowledge of mathematics. As the author points out, the philosopher, the mathematician, the physicist and the chemist—he might have added the engineer—require separate treatises on thermodynamics.

Prof. Duhem confines himself to "three-day methods," that is, to methods formerly included in the syllabus of the first three days of the Cambridge Tripos—or, in other words, he uses neither calculus nor coordinate geometry, unless graphical representations are regarded as implying coordinate geometry. After an elementary introduction to the properties of the thermodynamic potential, he considers the phase rule, the properties of invariant, univariant, bivariant and multivariant systems, the displacement of the equilibrium state for variations of temperature and pressure, the properties of perfect gases, and the dynamics of false equilibria and explosions. The work appears to afford an excellent account of the large field of chemical investigation first started by Gibbs, Moutier and others which has led to such important results in the hands of van der Waals, Bakhuis Roozboom, van 't Hoff, Sainte Claire Deville, and a large army of still more recent workers.

G. H. B.

Das Problem der geschlechtsbestimmenden Ursachen. By Dr. M. von Lenhossék, Professor of Anatomy in the University of Budapest. Pp. 99; 2 figs. (Jena: Gustav Fischer, 1903, published 1902.) Price 2 marks.

PROF. M. VON LENHOSSÉK gives us an admirably clear and scientific deliverance on the much-discussed problem of the factors which determine the sex of offspring. He takes account of most of the data and most of the theories, and comes to the conclusion that the determination is in the hands of the maternal parent and that the decision is given *prior to fertilisation*. He does not seem even to allow—what seems to us almost proved by the experiments of Yung and others—that the original bias may be altered in early stages of development. We adhere to the eclectic position that the determination of sex depends upon numerous variable factors, operative before, in and after fertilisation. The author's references to the literature on the subject are so numerous that we may point out the omission of any recognition of Starkweather, Hensen, Geddes and Thomson, Henneberg, Beard and Van Lint. J. A. T.

The Schoolmaster's Yearbook for 1903. *A Reference Book of Secondary Education in England and Wales.* Pp. lix + 351 + Part II. (unpaged) + 107. (London : Swan Sonnenschein and Co., Ltd.). Price 5*s.* net.

THIS is the first annual issue of what is likely to prove a useful work of reference for schoolmasters. It is divided into three parts, the first of which supplies general information concerning educational administrative authorities, educational associations, courses of training for teachers in secondary schools, and many similar subjects. The second part constitutes a directory of schoolmasters and others engaged in secondary education, while the third includes a number of miscellaneous articles and reviews. The first two sections will be useful to all who are interested in education, and if the editor adopts next year a larger number of abbreviations and gives only the important particulars about governing bodies and educational associations, he will increase considerably the value of the publication. The third part seems out of place ; the articles it includes are more suitable for an educational periodical than an annual of this kind. The second part is an excellent first step towards the compilation of a register of teachers.

The Globe Geography Readers. By Vincent T. Murché. Introductory. Pp. 119. Price 1*s.* Junior. Pp. vi + 194. Price 1*s.* 4*d.* (London : Macmillan and Co., Ltd., 1902.)

THE plan of these books is sensible, and there is abundant evidence throughout that the author is intimately acquainted with the needs and limitations of young children. The information to be gained from the lessons is based upon observations and experiments of a kind which children can perform for themselves, and the conversational style will prove attractive to young readers. No lesson is overburdened with facts, and the author has been successful in proceeding always from the known to the unknown. We suspect that fathers of the kind introduced in these books, and uncles with sound geographical knowledge and a keen desire to instruct their nephews on every possible occasion, are rare in real life. It is a pity, too, that Mr. Murché refers to volcanoes as "mountains that blaze and smoke," and says that "flames and smoke burst out from the crater." The coloured plate of a volcano during an eruption shows a large number of volcanic bombs, though these products of an eruption are really very rare. The abundant illustrations add much to the value of what should prove to be two widely used books.

The Nature Student's Note Book. Part i. Nature Notes and Diary. By the Rev. Canon Steward, M.A. (Oxon.) Part ii. Tables for Classification of Plants, Animals and Insects in Full Detail. By Alice E. Mitchell. Pp. 152. (Westminster : Archibald Constable and Co., Ltd.)

THE teacher already possessed of a good working knowledge of biology and other branches of science included in nature-study will find Canon Steward's monthly notes useful as a reminder of which plants and animals are available for study at different times of the year; but the book is scarcely likely to be of much assistance to a non-scientific teacher who wishes to become a student of nature, with a view to introduce his pupils to the same study. It is questionable, too, if the introduction of gardening instructions into the notes will serve any good educational purpose. Miss Mitchell's tables are a little too technical for nature-study, and some of her definitions are not strictly accurate.

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 late Sir G. G. Stokes.

THE eulogy of Stokes by Lord Kelvin contributed to your columns in terms so appropriately simple, a eulogy so sincere, as we all know, and more authoritative than could be pronounced by anyone else in the world, furnishes an incident that must impress the minds of all true lovers of science. It is not my purpose to intrude where I have no business, but I do feel most keenly the strong call there is to English men of science to see that the hidden work of Stokes does not remain any longer concealed. There is not the least doubt that his greatness and true worth escaped the observation of contemporaries outside the circle of real scientific workers, and there has been one conspicuous occasion quite recently when the order of his merit has been signally ignored.

About ten years ago the attention of Stokes was attracted to some work in which I was engaged, and this started a correspondence. I had no previous personal acquaintance with him, and I am sure he had no previous scientific acquaintance with me, but notwithstanding this he immediately placed the vast powers of his mind at my disposal, and assisted me with encouragement and advice that from my best friend would have been liberal in amount, whilst in value they could have been equalled from no other source. The abundance, lucidity and punctuality of his correspondence were amazing. I have had as many as three letters from him in one day, and on a particular occasion a telegram in addition, to say that he feared he had expressed himself in one of the letters with too much confidence. I was naturally not a little proud of this connection with a great man, but if my pride had tended to assume the form of vanity, that would have been frustrated by the discovery I was ever afterwards making of the apparently endless number of scientific workers who have received from Stokes the same unstinted help.

I wish, therefore, to express the hope that in any memoir of Stokes that is published there should be some attempt to gather the unostentatious testimony that would be so cheerfully given by those who are so much beholden to the great and good man who has passed from among us. It seems to me to be at the least a duty to scientific history to help our posterity to see clearly that the order of Stokes's merit as a man and a philosopher was that of Faraday and Newton. CHEMICUS.

The Holy Shroud of Turin.

IN your issue of February 5, Mr. Worthington G. Smith says "the painter was so incompetent to deceive that he made the two head-tops touch." There is some mistake here. M. Vignon's reproductions of Signor Pia's photographs show quite a large space—nearly equal to the height of the head—between the two head-tops. From Mr. Smith's diagram I infer that he has mistaken one of the water-stain outlines for the head-top of the back view figure. If so, I do not wonder at his thinking the painter "incompetent."

The hypothesis of a painted positive turned negative, to which most of your correspondents seem to incline, presents one difficulty which I have not as yet seen noticed. No one would paint a shaded positive by way of simulating a supposed soiling of the shroud by the presence of the body within it; the intention must have been to make a *picture*—to represent a miraculous impression, perhaps, but still a *pictorial* one, else why a positive? Then, such a picture would naturally be shaded for a more or less side light, so that the originally light and now dark portions would be more or less on one side of the various limbs and features, instead of in their centres as they actually show on the shroud. R. E. FROUDE.

Gosport, February 8.

The Principle of Activity and Lagrange's Equations. Rotation of a Rigid Body.

THERE are some people who understand by Newton's second law of motion nothing more than the three equations of motion for a body which can be treated as a particle, viz., $m\ddot{x}=X$, &c. (or rather the equivalent equations for impulsive forces). Such people, however, would probably not seriously object to any dynamical truth whatsoever, from the conservation of energy to the principle of varying action, being read into this law, if only he who does so would explain clearly his own interpretation of Newton's statement. I, for one, am a little curious to have stated fully the principle which justifies Mr. Heaviside in his letter in your issue of January 29 in deducing from the solitary equation

$$\dot{T}=\Big(\frac{d}{dt}\cdot\frac{dT}{dv_1}-\frac{dT}{dx_1}\Big)v_1+\ \dots$$

that "*by Newton*, the force on x_1 is the coefficient of v_1."

It is a sufficient indication either of an incorrect premiss or of bad logic, however obscure an argument may be, if the conclusion be wrong; one does not readily see from Mr. Heaviside's letter how he could object to his method being applied directly to the motion of a rigid body with one point fixed, in which case, as is well known, taking

$$2T=A\omega_1^2+B\omega_2^2+C\omega_3^2$$

it leads to a wrong expression for the external couple round the axis of x, viz. $A\dot{\omega}_1$ instead of the correct one, $A\dot{\omega}_1-(B-C)\omega_2\omega_3$.

W. MCF. ORR.

Royal College of Science, Dublin, February 2.

PROF. ORR'S opening remarks perhaps indicate that the want of appreciation of Newton's dynamics is even greater than I supposed. My authority for Newton is that stiff but thoroughgoing work, Thomson and Tait. On comparison, I find that Prof. Orr's "some people" seem to overlook the vitally important third law, without which there could be no dynamics resembling the reality, and also the remarkable associated scholium "Si æstimatur . . .," enunciating the principle of activity, which is of such universal and convenient application, both by practicians and by some theorists. In my short outline of the beginning of the theory of Lagrange's equations, my argument "by Newton" referred to the activity principle.

The example of failure given by Prof. Orr is remarkable in more than one way. If the three coordinates specified the configuration, then the equations of motion would come out in the way indicated. It is clear, therefore, from the failure that in the concrete example of a rotating rigid body, the coordinates employed, which are the time-integrals of the angular velocities about three moving axes, are not proper Lagrangian coordinates within the meaning of the Act. If we use coordinates which do fix the configuration (Thomson and Tait, § 319), there is no failure.

But it is quite easy to avoid the usual complicated trigonometrical work, and obtain the proper equations of motion by allowing for the motion of the axes. Thus, if $\mathbf{a}$ is the angular velocity, the angular momentum is

$$\mathbf{i}\frac{dT}{da_1}+\ \dots\ =Aa_1\mathbf{i}+Ba_2\mathbf{j}+Ca_3\mathbf{k},$$

and the torque is its time differentiant, that is,

$$\mathbf{F}=A\dot{a}_1\mathbf{i}+B\dot{a}_2\mathbf{j}+C\dot{a}_3\mathbf{k}+Aa_1\frac{d\mathbf{i}}{dt}+Ba_2\frac{d\mathbf{j}}{dt}+Ca_3\frac{d\mathbf{k}}{dt}.$$

Here $\mathbf{i}$, $\mathbf{j}$, $\mathbf{k}$ are unit vectors specifying the directions of the principal axes. They only vary by the rotation, so $d\mathbf{i}/dt=V\mathbf{a}\mathbf{i}$, &c., and this makes

$$\mathbf{F}=Aa_1(\mathbf{j}a_3-\mathbf{k}a_2)+Ba_2(\mathbf{k}a_1-\mathbf{i}a_3)+Ca_3(\mathbf{i}a_2-\mathbf{j}a_3)+A\dot{a}_1\mathbf{i}+\ \dots$$
$$=\mathbf{i}\{Aa_1-a_2a_3(B-C)\}+\mathbf{j}\{\dots\}+\mathbf{k}\{\dots\}.$$

This exhibits Euler's three well-known equations of motion round the three principal moving axes.

In general, $T=\frac{1}{2}\mathbf{a}M\mathbf{a}$, where M is a vectorial matrix (or linear vector operator), fixed in the body. Then the momentum is $M\mathbf{a}$, and the torque is

$$\mathbf{F}=M\dot{\mathbf{a}}+\dot{M}\mathbf{a}=M\dot{\mathbf{a}}+(V\mathbf{a}M)\mathbf{a}.$$

This allows M to be specified with respect to any axes fixed in the rotating body. Of course, the principal axes are the best. I may refer to my "Elec. Pa.," vol. ii., p. 547, footnote, for details of a similar calculation relating to the torque (and activity thereof) produced in an eolotropic dielectric under electric stress.

The following concisely exhibits the necessity of allowing for variation of M, and how it is done in the general case of n independent variables:—Let $T=\frac{1}{2}\mathbf{v}M\mathbf{v}=\frac{1}{2}\mathbf{p}\mathbf{v}$. Then $\mathbf{v}$ is a "vector" or complex of n velocities, and $\mathbf{p}=M\mathbf{v}$ is the corresponding momentum, whilst M is a symmetrical matrix. By differentiation to t,

$$\dot{T}=\mathbf{v}(M\dot{\mathbf{v}}+\tfrac{1}{2}\dot{M}\mathbf{v})=\mathbf{F}\mathbf{v}\quad\text{(Hamilton)},$$

or

$$T=\mathbf{v}(\dot{\mathbf{p}}-\tfrac{1}{2}\dot{M}\mathbf{v})=\mathbf{F}\mathbf{v}\quad\text{(Lagrange)}.$$

Here $\mathbf{F}$ is the force on the system, in the same sense as $\mathbf{v}$ is the velocity of the system. For M substitute $v(dM/dx)$, to come to the usual forms by breaking up into n components. But the above are more general, because M may vary independently of x. Activity should be the leading idea.

OLIVER HEAVISIDE.

Insects and Petal-less Flowers.

I WAS much interested by Mr. Bulman's account of Prof. Plateau's experiments in the matter of insects' visits to petal-less flowers in the issue of NATURE for February 5 (p. 319), wherein it is stated that Prof. Plateau contends that insects "are not attracted by the brilliant colours of the blossoms, but rather by the perception in some other way—probably by scent—that there is honey or pollen."

It has not been my good fortune to read Prof. Plateau's own account of the experiments which led him to the above conclusion, but it certainly appears to me, from your correspondent's summary, that he is generalising from an observation which has only a strictly limited application.

We are told that in the case of thirty poppies artificially deprived of their petals, as compared with seventy intact poppies, the average visits were as 4·5 is to 2·4, the most striking case instanced being that of the Dipterous insect *Melanostoma mellina*, the visits of which were as 4 is to 0.

The experiment and its result does not, to my mind, in the least tend to bear out the theory it is advanced to support, though your correspondent gives the method his approval.

I do not wish to doubt the possibility of smell playing a part in attracting insects, but I certainly cannot see that the artificial removal of the coloured petals proves that colour has no influence. We are fond of attributing great intelligence and power of perception to the bee, and yet in this case the insect is not even given credit for being able to recognise what are known to it, from possibly long experience, as the essential parts of the flower! Because we buy well advertised goods, and still continue to buy them when their proved virtue renders advertisement a thing of the past, is it proof that the advertisement played no part in determining our choice? The answer is obvious.

The greater number of insects visiting the poppies shorn of their petals might easily be accounted for, especially in the case of the Diptera, by the presence of some attractive substance in the sap exuded from the cut tissues, and probably by the resulting greater accessibility.

As a contrast to this experiment I would mention that of Lord Avebury, which loses none of its significance through being described in a popular magazine (the *London*, Christmas number). Quantities of honey were taken and laid on glass slips, and a marked bee was trained to come to a certain spot for it. The honey was supplied on slips of six different colours—blue, red, yellow, orange, green and white—and on one plain slip. Lord Avebury so arranged matters that the bee was persuaded to visit each and every slip before returning to the hive, the method being as follows:—

Seven slips in a row on lawn; the bee arrives and alights on (say) blue; it is allowed to remain for a few seconds and then driven off, the blue slip being withdrawn; it then goes to (say) white; after a few seconds at white the bee is again driven off, and goes to (say) yellow, the white slip being also withdrawn; after having visited all the slips in this way, and being at last deprived of every one, the bee goes back to the hive.

During the bee's absence the glasses are replaced, but in different order, and on the insect's return it is again noted which slip receives first attention.

Out of a hundred such complete rounds Lord Avebury

found his bee went to the blue glass *first* thirty-one times, and *last* only four times, while the plain glass came in for first notice only five times, and last twenty-four times. The other colours occupied intermediate positions in the bee's favour.

Here we have a case of which the bee could not possibly have had previous experience, and where every precaution was taken to avoid any undue advantage of position, &c., being given to any particular colour, with a result going far to prove that all other conditions being alike, colour does play an important part in deciding an insect's choice.

I would suggest that the correct method of settling the question would be to cut away, not the petals, but the stamens, &c. Then if insects continued to visit flowers so mutilated we should have grounds for thinking that petals exercise some attraction, or *vice versâ*.

E. ERNEST LOWE.

Municipal Museum and Art Gallery, Plymouth, February 9.

Science and the Education Act of 1902.

IN two letters to you last year, I drew the attention of scientific men and of others interested in the welfare of our country and empire to the inferior position which scientific studies continue to hold in the education of the youth of this country (see NATURE, vol. lxvi. pp. 350, 459). One hoped that the Education Act of 1902 would do something to remedy present defects. That hope, it is to be feared, is in a poor way of being realised, so far as any inference can be drawn from the composition of the "Education Committee" recently appointed by the Council of a county so near to the metropolis as Hertfordshire. The whole thing is little better than a jumble, the sort of thing one would expect from the manipulation of a county-directory in a solicitor's office. So little did the County Council appear from the newspaper report to realise the gravity of the task before them that they adopted *en bloc* and without criticism the list prepared for them by the Clerk of the Peace, whose first-hand knowledge of education can only be at the best extremely limited. The committee-list bristles with names of county respectability, including a noble earl, a few M.P.'s, a fair sprinkling of J.P.'s, and among the C.C.'s elected very few appear to have taken a degree at any university, while one solitary name appears as a representative of science in that of Sir John Evans, F.R.S., who might have been a little more vigilant in this matter.

Outside the Council, we find the name of the Dean of St. Albans, a scholarly, clear-sighted, large-minded man, an acquisition to any committee; then the names of the two *classical* head-masters of Haileybury and Berkhampstead, men of the type referred to in my previous letters (*supra*), who cannot be expected to appreciate the importance of scientific education, but whose position in the educational world will give adventitious value to their opinions among the rank and file of the educational ignoramuses. In a list of some twenty-one, one solitary name, that of the young head-master of a not very important school in this neighbourhood, appears as a representative of science. It does not appear that a single representative of the Army or Navy or a single graduate in science or medicine finds a place on the committee; and such men resident in the county as my neighbour the principal of the Diocesan Training College (who is zealously engaged in attempting to train elementary teachers on scientific lines), or the official secretary of University College, or myself (with a record of more than a quarter of a century of public-school and scientific work) seem to have been the last people to be thought of.

In the light of the above facts, can it be unfair to say that the cause of progressive education in the county of Herts has drifted? And if this can happen in a county so near London, what is likely to happen in the more remote counties, where provincial ideas prevail more strongly? Is it not time that the leading scientific societies, led by the Royal Society or by the British Association, should draw up a memorandum impressing upon the county and borough councils of the country the serious call made to them by the Education Act to do their best to strengthen the sinews of the intellectual war, which (*nolens volens*) this country must be prepared to carry on? Had there been a single man of light and leading in the Cabinet, such instructions might have been included in the Act or its preamble as to render such action unnecessary. But so beclouded were the minds of our legislators in the long, dreary strife of bigotry and partisanship of last autumn that they seem to have lost sight of higher intellectual issues altogether. Let us hope that in the great provincial centres such an important point as the due representation of scientific education on the educational committees will not be lost sight of. A. IRVING.

Hockerill, Bishop's Stortford, February 6.

RADIO-ACTIVITY OF ORDINARY MATERIALS.

IT is now well recognised that the air in any ordinary vessel possesses the power of conducting electricity, although to a very slight extent. It has been usual to refer to the effect as the "spontaneous ionisation" of the air. This name suggests that the conductivity is in some way an essential property of the air, just as the electrical conductivity of metals is inseparably connected with the nature of those bodies. Mr. C. T. R. Wilson, however, has found (*Proc.* Roy. Soc., vol. lxix. p. 277) that, when other gases are substituted for air, the relative ionisations are in nearly the same ratio as those which I observed for the same gases under the action of Becquerel radiation (*Phil. Trans.*, 1901, p. 507). Further, Mr. J. Patterson (*Proc.* Camb. Phil. Soc., vol. xii. p. 44) has found that, when a large vessel is used, the amount of ionisation is not proportional to the pressure, but tends towards a limit, when further increase of pressure no longer affects it. This is exactly the behaviour that might be expected if the effect was due to a feeble radio-activity of the walls of the vessel, the radiation being easily absorbed by the air.

I have recently carried out a series of experiments with a view to decide whether the nature of the walls of the vessel had any influence on the rate of discharge of a charged body inside it.

The various materials were made into cylinders, 13 cm. long and 3·4 cm. in diameter. A central wire, charged, and connected with an electroscope, formed the leaking system. The electroscope was exhausted, so as to avoid any leakage through the air in it, and, before each experiment, the insulation, which was of lead-glass tube, dried by the exhaustion of the vessel in presence of phosphoric anhydride, was tested. No leakage could be detected. On admitting dried air, a small leakage immediately set in, and its amount could be measured by timing the movement of the gold leaf over the scale division of a microscope with micrometer eyepiece focussed upon the leaf.

The leakage in scale divisions per hour, with various materials surrounding the charged wire, is given below:—

Tin foil	3·3
Ditto, another sample	2·3
Glass coated with phosphoric acid	1·3
Silver, chemically deposited on glass	1·6
Zinc	1·2
Lead	2·2
Copper (clean)	2·3
Ditto, thoroughly oxidised	1·7
Platinum (various samples)	2·0, 2·9, 3·9
Aluminium	1·4

It appears, then, that there are very marked differences in the rate of the leak, when different materials constitute the walls of the vessel. There can therefore be little doubt that the greater part—if not the whole—of the observed ionisation of air is not spontaneous at all, but due to Becquerel rays from the vessel.

It is, I think, interesting to find that the phenomena of radio-activity, which have generally been regarded as rare and exceptional, are really everywhere present.

The rate of leak with various pieces of tin foil from the same stock was always the same, as nearly as the experiments could show—that is, to within about 6 per

cent. But, as may be seen in the table, a piece from another stock gave a different amount of leakage. The same holds good for platinum, one specimen tried being twice as active as another. It was found that ignition did not affect the radio-activity of a given specimen of platinum.

In order to compare the activity of the substances mentioned above with that of uranium, a small crystal of uranium nitrate, measuring 12×4 mm., was cemented to the inside of one of the cylinders; the rate of leak due to it was found to be thirteen times that due to the most active cylinder of platinum. The area of the uranium was only 1/240th part that of the platinum, so that its activity for an equal area would be no less than 3000 times greater. It is possible that the radio-activity of ordinary materials may be due to traces of the more active substances. This would explain the varying activities of different samples of the same metal. Only an infinitesimal proportion of radium would be required. Radium is 100,000 times more active than uranium, and uranium 3000 times more active than the most active common material that I have experimented with. So that one part of radium in three hundred million would suffice to account for the observed effects.

R. J. STRUTT.

OYSTERS AND TYPHOID FEVER.

THE recent outbreaks of typhoid fever at Winchester and at Southampton have again directed public attention to the risk of typhoid infection due to the laying down of edible forms of shell-fish in sewage-polluted waters.

So long ago as 1895, in a report made by Dr. Bulstrode to the Local Government Board, it was pointed out that few of the oyster layings, fattening beds or storage ponds round the English and Welsh coasts could be regarded as free from possible sewage contamination. In consequence of this report, the Local Government Board in 1899 introduced a Bill providing that the various county and borough councils should ascertain from time to time the sanitary conditions of the oyster layings and empowering these bodies to take action if sewage pollution were proved. This Bill, which dealt only with oysters, after having been read a second time, was withdrawn. Apparently nothing has since been done, matters have been allowed to drift, and in consequence several outbreaks of disease have occurred, with loss of valuable lives, and an important industry is threatened with temporary ruin.

In 1901, the medical officer of health for Westminster reported on certain cases of typhoid fever seemingly due to contaminated cockles, from some of which a bacillus, having all the characters of the typhoid bacillus, was isolated at the Jenner Institute of Preventive Medicine.

Dr. Nash, the medical officer of health for Southend-on-Sea, reported upon the incidence of typhoid fever in that borough during 1901, and found that in no less than twenty-one out of thirty-seven cases of the disease there was a history of the eating of shell-fish (generally oysters and cockles) within a month of the onset of the disease, *i.e.* within the incubation period. From a report by Dr. Allan, medical officer of health for the City of Westminster, mussels also seem to be implicated.

Attacks of illness, attributable to the eating of shell-fish, in the Borough of Wandsworth and the City of Westminster having been brought to the notice of the Corporation of the City of London, the last-named body has taken action. The responsibility of the City Corporation in this matter is great, for not only are the majority of the cockles and many of the oysters implicated exposed for sale in the City, but the former shell-fish is mostly obtained and relaid within the City's jurisdiction. The City Corporation has therefore caused a number of samples to be bacterioscopically examined by Dr. Klein, and his reports show that a larger or smaller proportion of the samples examined from *every* district shows evidence of sewage contamination, and from certain cockles the typhoid bacillus has actually been isolated.

The question then arose as to dealing with an obviously infected and dangerous source of food supply. Under the Public Health (London) Act 1891, it is possible to obtain a justice's order to destroy such unwholesome food, but the necessary examination to establish the fact involves a lapse of several days, and before the results of such examination could be known, the whole quantity of the sample implicated would have been consumed. In the circumstances, the facts were reported to the Worshipful Company of Fishmongers, which has extensive powers over the fishing industry throughout the country, and the Company's inspectors are now engaged in a survey of the various sites of the shell-fish fisheries and are taking steps to stop the sale of contaminated molluscs.

It might have been thought that sea-water would be prejudicial to the typhoid bacillus, but such does not appear to be the case. The experiments of Dr. Klein and of Prof. Boyce have shown that although the organism does not multiply, it retains its vitality in sea-water for at least three or four weeks. In the infected oyster it lives for two to three weeks or more, and even when washed in pure running sea-water, the infective properties may be retained for several days.

As regards cockles, these are "cooked" before consumption, and thorough cooking would be fatal to the typhoid bacillus. But it seems that the "cooking" of cockles is a very perfunctory process, and consists in simply plunging nets filled with the molluscs into boiling water, so that many might (and obviously do) escape the full action of the heat; actual boiling renders them tough and uneatable.

Legislative enactments and periodical inspections are obviously necessary to protect the public from the risk of infection from sewage contaminated shell-fish, and should be welcomed by the merchants and their employés whose livelihood depends upon this important industry. So far back as 1894, the value of the oysters alone landed by English dredgers in that year amounted to 84,271*l.*

R. T. HEWLETT.

MR. MARCONI AND THE POST OFFICE.

THE fact that the message from the King to President Roosevelt, in reply to the latter's wireless telegram of greeting, had to be sent to America by cable occasioned at the time much comment and correspondence in the daily papers on the attitude of the Post Office towards Mr. Marconi; the subject cropped up again last week on the return of Mr. Marconi to this country after his successful expedition to America. There is some little difficulty in ascertaining the real state of the case, as two or three different explanations have been put forward in the papers, but the truth of the matter seems to be precisely what we stated in our notes columns four weeks ago. In an interview with a representative of the *Daily Express*, Mr. Marconi made the following statements:—

"We asked the Post Office authorities whether they would allow us to connect our station at Poldhu by wire with Mullion—at our own expense, mind you—but they refused absolutely and entirely."

"The message (that from the King) was not received at our offices until after Mullion Post Office had closed for the night, and one cannot very well keep a King's message

lying about for twelve hours. I think it would have been much more discourteous to the King to have kept his message waiting for a day than it was to send it by cable."

It seems, therefore, that the King, having sent his reply to the London office of the Wireless Telegraph Company, the company could not send it on to Poldhu for transmission to America on account of the fact that it was impossible at night to wire from London to Poldhu: they were compelled, in consequence, to send the message by cable, the cable companies possessing the advantage of a direct connection between the Post Office lines and the shore ends of their cables. It is a similar connection for which the Marconi Company asks and offers to pay, but which the Post Office declines to grant.

In these circumstances it is not surprising that Mr. Marconi's feelings towards the Post Office are rather bitter, and that he proposes to make no further additions to the Poldhu Station until the authorities have decided what they intend to do. He now proposes to go to Italy and build a huge station there, probably at Rome, partly, no doubt, because, as he says, "Abroad I can get everything I want. Here in England I can get nothing." This is a little sweeping, for all England has not been so backward in supporting Mr. Marconi's enterprise as the officials of the Post Office. The attitude of the Post Office, however, certainly seems inexcusable, and we do not see by what reasonable arguments it can be supported. It has been urged that, until Mr. Marconi has been able to convince a jury of Government officials and independent experts that his system is capable of satisfying stringent tests of trustworthiness for a definite period under definite conditions, the Post Office is fully justified in withholding its recognition and support. This argument seems to us unsound. If the Post Office is not satisfied that Transatlantic wireless telegraphy is trustworthy, let it, by all means, send its own messages by cable; but is this any reason why the man in the street—or the King—who wishes to benefit by any advantages in tariff or otherwise, which the Marconi Company may offer, and who is willing to run the risk of his message getting lost on the way, or read by Mr. Maskelyne at Porthcurnow, should be denied the necessary facilities? Or is it any reason why the more enlightened Governments of Canada and the United States should be penalised by having their messages delayed, as we suppose must now occur if they arrive by night?

It seems to us that the correct thing for the Post Office to do is to grant the Wireless Telegraph Co. the facilities for which it asks without delay, lest the Post Office be accused, with some justice, of blocking the progress of an enterprise of great promise. Whether Transatlantic wireless telegraphy will prove of commercial value or not time will show; the shareholders may be relied upon to put an end to it soon enough if it neither pays nor gives prospect of paying. Should it, as some sanguine people think, prove better than the submarine cable, and ultimately supplant it, the cable companies will have to suffer that the world at large may gain; it will not be the first time in history that the old order has given place to the new. But none of these questions, commercial or technical, seems to us to be the concern of the Post Office, which should only desire to facilitate a new means of communication in which, rightly or wrongly, a large portion of the general public have considerable confidence.

In the meantime, the development of wireless telegraphy progresses rapidly in other directions, and especially in the direction in which we have always maintained it would be most serviceable, namely, in increasing the safety and relieving the monotony of travelling by sea. Reports are continually appearing in the papers of ships communicating with one another, or with the shore, for some time prior to their arrival. Reuter's Agency has been experimenting in transmitting news to ships, and last week the *Minneapolis*, thirty-six hours before its arrival, was put in possession of all the latest news, much to the satisfaction of the passengers. Reuter's Agency, it is said, looks forward to the time when it will be able to maintain a daily news service right across the Atlantic. The day is possibly not far distant when it will be possible for all ships to keep in constant communication with land, and if this result is attained, wireless telegraphy will have scored a great and lasting success; but to derive the greatest benefit from such an achievement in this, as in the Transatlantic service, the Post Office must cooperate and not oppose progress. We trust someone will ask Mr. Balfour if it is the intention of the Government to bar all scientific progress.

MAURICE SOLOMON.

THE CONSTITUTION OF THE NEW EDUCATION COMMITTEES.

VARIOUS applications have been made to the Board of Education for suggestions with respect to the constitution of education committees under the new Education Act, and the framing of schemes for the purpose. With a view to assist councils who have not as yet framed schemes for themselves and desire assistance, the Board of Education issued on February 12 a memorandum making suggestions as to the main matters which should be provided for by the scheme. The Act itself lays it down that every scheme shall provide for the appointment by the council of at least a majority of the committee, and the persons so appointed shall be persons who are members of the council, unless, in the case of a county, the council shall otherwise determine; for the appointment by the council, on the nomination or recommendation, where it appears desirable, of other bodies (including associations of voluntary schools), or persons of experience in education, and of persons acquainted with the needs of the various kinds of schools in the area for which the council acts; for the inclusion of women, as well as men, among the members of the committee; and for the appointment, if desirable, of members of school boards existing at the time of the passing of the Education Act as members of the first committee.

The memorandum referred to contains a model scheme, which goes a long way towards elucidating what, in the opinion of the Board of Education, is to be understood exactly by the words "nomination or recommendation" in the Act. This part of the model scheme reads as follows:—

Nominated members, one nominated by each of the following bodies, *e.g.*:—
The council of the University of ;
Recommended members, one recommended by each of the following bodies, *e.g.*:—
The Chamber of Commerce of ;
The Agricultural Society of ;
The Association of ;
The Governing Body of the ;
An electing body consisting of .
Members appointed after consultation with:—
The

It is of great importance that the Board of Education appears to contemplate that the right of nomination will belong to universities alone, while other associations and institutions can merely recommend persons for appointment by the council. Moreover, the memorandum refers to the representation of the interests of University education, and as we believe this is the first time in which the work of Universities has been mentioned as coming within the sphere of the Act, it is important to direct particular attention to this point.

The reference to University education occurs in the part of the memorandum which interprets what is meant by the words "persons of experience in education and of persons acquainted with the needs of the various kinds of schools." The interests which are always to be represented either among the members appointed from the council or among members appointed from outside the council are thus enumerated:—University education; the secondary education of boys and girls in its higher and lower grades; technical instruction and commercial and industrial education, having special regard to the industries of a particular district; the training of teachers; and elementary education in council schools and in voluntary schools.

The Board of Education evidently does not intend that the councils concerned with the appointment of education committees shall be allowed to lose sight of the needs of higher and secondary education. It is earnestly to be desired that men of science in all parts of the country will be willing to become members of these education committees, so that councils everywhere may be kept informed as to what must be done if, as a nation, we are to make up the leeway in our educational affairs as compared with those of, say, Germany and the United States.

NOTES.

THE Bakerian lecture of the Royal Society on Thursday next, February 26, will be delivered by Mr. C. T. Heycock, F.R.S., and Mr. F. H. Neville, F.R.S., on "Solid Solution and Chemical Transformation in the Bronzes."

WE regret to see the announcement that Mr. F. C. Penrose, F.R.S., died on Sunday last at the age of eighty-five. From an obituary notice in the *Times* we learn that Mr. Penrose was born at Bracebridge, near Lincoln, and, after four years at Bedford Grammar School, entered the foundation at Winchester College. At Cambridge he was a senior optime in the Mathematical Tripos in 1842, and for three years thereafter he held the appointment of Travelling Bachelor to the University. In 1851 he brought out, for the Society of Dilettanti, a work entitled "The Principles of Athenian Architecture," of which a second edition has been published. In the following year he was appointed Surveyor of the Fabric of St. Paul's Cathedral, a post which he held until 1897. He published in 1869 "A Method of Predicting Occultations of Stars and Solar Eclipses by Graphical Construction," of which a new edition was issued last year; and during 1893 he contributed to the *Transactions* of the Royal Society a paper on the astronomical significance of the orientation of Greek temples, which was followed by a supplement on the same subject in 1897. His last work was an endeavour to determine the age of Stonehenge by utilising the orientation theory combined with accurate measurement of the direction of the axis of the building. It is rarely that the scientific and artistic temperaments are found so closely united in one man. His death is a loss both to science and art, which will be widely felt.

AT the Cambridge Philosophical Society on February 2, the president, Dr. Baker, proposed from the chair, "That the Cambridge Philosophical Society desires to express its sense of the great loss sustained by the University and the Society in the death of Sir George Gabriel Stokes, to whom the Society was bound by so many ties of obligation and reverence." This was seconded by Prof. Thomson, and carried unanimously. The Society then adjourned, as a mark of respect to Stokes's memory.

AT a conference of botanists of Vienna held on December 9, 1902, the organising committee was elected for the International Botanical Conference which is to be held at Vienna in 1905. The officers of the committee are as follows:—Honorary presidents: Dr. Guillaume de Hartel, Minister of Public Instruction; Dr. Charles de Giovanelli, Minister of Agriculture; Prof. Edouard Suess. Presidents: Prof. Richard de Wettstein and Prof. Jules Wiesner. Vice-presidents: Prof. Edouard Hackel and Prof. Hans Molisch. General secretary: Dr. Alexander Zahlbruckner. Secretaries: Dr. Charles Linsbauer and Dr. Frédéric Vierhapper. Treasurer: Dr. Léopolde de Portheim. All communications concerning the congress should be addressed to the general secretary, Dr. A. Zahlbruckner, Vienne, I., Burgring 7.

THE biennial Hunterian Oration was delivered on the afternoon of February 14 by Sir Henry Howse, president of the Royal College of Science, in the theatre of the college. He devoted the greater part of his oration to interesting biographical incidents concerning John Hunter, who was elected a fellow of the Royal Society in 1767, and appointed surgeon-extraordinary to the King in 1776. The collection of the objects in his museum was Hunter's chief interest through many years of his life, and at his death there were 14,000 specimens in the museum, on which Hunter spent 70,000*l*. A banquet took place in the evening in the library of the college, at which the honorary fellowship of the college was conferred on Lord Roberts, who, in his reply, referred to the outbreaks of enteric fever at Bloemfontein and Kroonstad during the late war, and expressed his admiration for the way in which the medical officers managed to meet all emergencies with a minimum of appliances.

THE Rumford Committee of the American Academy of Arts and Sciences has made the following grants in aid of investigations in light and heat:—250 dollars to Dr. Ralph S. Minor, of Little Falls, N. Y., for a research on the dispersion and absorption of substances for ultra-violet radiation; 100 dollars to Dr. Sidney D. Townley, of Berkeley, Cal., for the construction of a stellar photometer of a type devised by Prof. E. C. Pickering and already in use in the study of the light of variable stars; 200 dollars to Prof. Edwin B. Frost, for the construction of a special lens for use in connection with the stellar spectrograph of the Yerkes Observatory to aid in the study of the radial velocities of faint stars; 250 dollars to Profs. E. F. Nichols and G. F. Hull, of Dartmouth College, for their research on the relative motion of the earth and the ether; 300 dollars to Prof. G. E. Hale, of the Yerkes Observatory, for the purchase of a Rowland concave grating to be used in the photographic study of the spectra of the brightest stars.

AT a meeting of the Royal Commission for the Exhibition of 1851, held on February 10, the Prince of Wales was unanimously elected president of the Commission in succession to His Majesty the King, who had held that position since the year 1870. In taking the chair, the Prince of Wales remarked:—"The history of the Commission seems a somewhat curious one. Originally appointed merely to carry out the great Exhibition of 1851, it was afterwards charged with the duty of disposing of the sum of 180,000*l*., the profit resulting from that Exhibition, a task which, in ordinary circumstances, might have been speedily completed. But the happy investment of the bulk of the money in the Kensington Gore estate gave the Commission a permanent character. The acquisition of the estate and its subsequent great increase in value has enabled the Commissioners to afford considerably more help in the promotion of science and the arts than could have been anticipated from the sum of money originally at their disposal. Without going into detail, the Commissioners are aware that

their body, by granting sites for public institutions (in most cases gratuitously, in others on very liberal terms), by grants of money in aid of those institutions, and by scientific and educational scholarships administered by the Commission, have already carried out to a very large extent the trust of their charter."

PROF. H. G. SEELEY, F.R.S., has been elected a foreign correspondent of the Imperial Academy of Sciences, St. Petersburg.

PROF. FREDERICK W. PUTNAM, curator of the Peabody Museum, has been awarded the Lucy Wharton Drexel medal of the Franklin Institute of Philadelphia for his work in American archæology.

WE learn from *Science* that Dr. W. A. Cannon has been appointed resident investigator of the Desert Botanical Laboratory of the Carnegie Institution. Mr. Frederick V. Coville and Dr. D. T. MacDougal, of the advisory board of the laboratory, started on January 24 on a tour of inspection of the region west of the Pecos River, in Texas, along the Mexican boundary, for the purpose of fixing upon a site for the laboratory.

ON Tuesday next, February 24, Sir William Abney will deliver the first of a course of three lectures at the Royal Institution on "Recent Advances in Photographic Science." On February 26 Prof. L. C. Miall begins a course of three lectures on "Insect Contrivances," and on Saturday, February 28, Lord Rayleigh delivers the first of six lectures on "Light; its Origin and Nature." The Friday evening discourse on February 27 will be delivered by Mr. A. Liebmann on "Perfumes; Natural and Artificial"; on March 6 by Prof. J. G. McKendrick, on "Studies in Experimental Phonetics"; and on March 13 by Prof. Karl Pearson, on "Character Reading from External Signs."

THE Carnegie Institution has made a grant of four thousand dollars to the Yerkes Observatory, to be expended under the direction of Prof. George E. Hale, for certain researches in astronomy and astrophysics. These will comprise:—(1) A photographic investigation of stellar parallaxes; (2) investigations in stellar photometry; (3) a detailed study of several hundred photographs of the sun, taken with the spectroheliograph at the Kenwood Observatory in the years 1891–1896; (4) certain investigations in solar and stellar spectroscopy, to be undertaken by Prof. Hale as soon as the new horizontal reflecting telescope, recently injured by fire, has been completed.

THE funeral of the late Mr. James Glaisher, F.R.S., at Shirley, near Croydon, on February 11, was attended by a representative gathering of scientific men, as well as by many personal friends. Major MacMahon represented the Royal Society, and, on behalf of other societies and institutions, there were present, among others, Mr. F. W. Dyson, chief assistant of the Royal Observatory, Greenwich; Sir Charles Wilson, chairman of the executive committee of the Palestine Exploration Fund; Mr. W. Ellis, late of the Royal Observatory; Mr. W. Marriott, assistant secretary of the Royal Meteorological Society; Mr. Baldwin Latham and Mr. A. H. Baynes. Among the floral tributes were wreaths from Mr. W. N. Shaw, Secretary to the Meteorological Council; the Palestine Exploration Fund, the Aëronautical Society of Great Britain and the Aëronautical Society of Germany.

THE *Etoile Belge* states that an international exhibition will be opened at Liège in April, 1905. The exhibition, which will include a scientific section, is due to private initiative, but it has received the patronage of King Leopold, and has been promised the support of the Belgian Government.

IN their twelfth annual report, the committee of the Society for the Protection of Birds is able to announce a decided advance in the object for which it is striving. The Wild Birds Protection Act of 1902 has considerably aided the Society's efforts by making it lawful to confiscate the booty of offenders. The committee also notes with approbation the action of the Government of India in prohibiting the exportation of native birds' skins, except for natural history purposes. It cannot, of course, be hoped, observes the committee, that the action of a single Government will at once prevent ladies from wearing plumes in their hats, but it is nevertheless a step in the right direction. South America now appears to be one of the worst offenders in regard to bird-destruction, and it is, unfortunately, a region where there is, at present at all events, but little hope of repressive legislation being introduced. While noticing that in this country the Church has done little or nothing to aid the crusade, the report announces with satisfaction that the periodical Press has all along been on the side of the movement. "The fact of this great unfailing support, and the steady growth of this Society, inspires a hope that eventually the object which the first founders of the Society set before them thirteen years ago—namely, the suppression of this destructive fashion and trade—may be attained."

A PARAGRAPH appeared a short time ago in the *Times* recording some of the ornithological results of Mr. B. Alexander's recent expedition to Fernando Po. Mr. Alexander reached the island last December, and proceeded to explore the highlands of its northern portion, ascending Clarence Peak, which was found to be wooded to a height of between 10,000 and 11,000 feet. The novelties included in his bird-collection were described by himself at a meeting of the British Ornithologists' Club held on January 21, and are briefly described in *Bulletin* No. 44 of that body. The collection comprises nearly 400 specimens, referable to some sixty-eight species, of which no less than thirty-three are described as new. Nor is this all, for two of the species are assigned to new genera, under the names of Urolais and Poliolais. It is remarkable that the majority of the Fernando Po birds display little affinity to those of the adjacent West African lowlands, but are more nearly related to East African mountain types from Kilimanjaro and Mount Elgon. In addition to its peculiar birds, Fernando Po appears to possess a fauna and flora of great abundance and interest, the number of species of ferns at high altitudes being especially noticeable.

THE Geneva correspondent of the *Daily Mail* states that Count Zeppelin has just completed an automobile-launch which possesses the peculiarity of having its propellers in the air. According to the inventor, the launch will be of the greatest use in tropical lakes and rivers encumbered with aquatic plants, which, obstructing the screw, render an ordinary steam launch useless. The launch is extremely light, has a draught of only ten inches, and it skims the water at a rate varying from fourteen to sixteen miles an hour.

WE have received the first part of the new volume (vol. iii.) of the *Journal of Hygiene*, which contains several important papers. Dr. Jordan discusses the kinds of bacteria and their variation in river water. Dr. Longcope gives a study of the bacteriolytic action of human blood in disease, and Dr. Walker surveys the various factors in bacteriolytic action, from which he deduces the fact that the complement or addiment is a product of disintegration of leucocytes.

A NEW drug laboratory has, says the *British Medical Journal*, recently been established in the Chemical Bureau at Washington, with the object of investigating adulterations, testing drugs and establishing uniformity in the standard of medical substances for future State and national legislation. The American Pharmaceutical Association has passed resolutions approving of the new bureau.

THE Glamorgan Sea Fisheries Committee, having decided to conduct an independent inquiry into the allegations respecting the pollution of Mumbles oysters, deputed Prof. Herdman to make the necessary investigations, and his report has now been published. Samples of the oysters and of the water were subjected to careful bacteriological investigation by Dr. Griffith, under Prof. Herdman's direction, and the final conclusion arrived at was that the shore, the water and the oysters all gave evidence of being polluted with sewage. Of the oysters, some were much more polluted than others.

AT the meeting of the Institution of Civil Engineers on February 10, Mr. David Carnegie read a paper on the manufacture and efficiency of armour-piercing projectiles. The modern projectile is, he pointed out, composed of steel containing carbon, associated with one or more of the following metals:—nickel, chromium, manganese and molybdenum. Typical proportions per cent. of elements other than iron in shells which are air-hardened are:—carbon 0·80, silicon 0·2, sulphur 0·04, phosphorus 0·04, manganese 0·12, nickel 2·00 and chromium 2·00. In present-day methods of hardening, three mediums are used, viz. water, oil and air, and the choice of the method used is determined by the composition of the material to be hardened. Carbon steels are generally hardened in water, or partly in water and partly in oil; nickel steels in water, in oil, or in air under pressure; and steels having self-hardening properties by simply heating and allowing to cool in air.

THE passage in Mr. Swinburne's presidential address to the Institution of Electrical Engineers in which he criticised the prevailing notions of the meaning and definition of the term "entropy" has given rise to an animated correspondence on the subject in the columns of the electrical and engineering papers, particularly in those of the *Electrician*. No apology is needed for directing the attention of readers of NATURE to a controversy in which such distinguished men as Lord Kelvin, Sir Oliver Lodge, Prof. Poincaré and Prof. Planck have taken part, as well as the original disputants —Mr. Swinburne and Prof. Perry. The discussion does not seem to be ended yet, but we trust that when it is concluded Mr. Swinburne will not allow it to remain scattered in the columns of various journals, but will, as he himself has led us to hope, collect and republish the letters and articles. The collected statements of the views of so many authorities would be of great assistance to all students trying to grasp the full import of the second law of thermodynamics.

THE paper on high temperature electrochemistry read by Messrs. R. S. Hutton and J. E. Petavel before the Manchester Section of the Institution of Electrical Engineers last November contains a most interesting and suggestive account of electric furnace work. The paper is divided into two parts, the first of which deals with the equipment of an experimental electrometallurgical laboratory. A description of the apparatus available at Owens College is given; the authors are certainly to be congratulated on having the opportunity of working in a laboratory so well equipped as this. Amongst other special apparatus may be noted a furnace capable of working with currents up to 1000 amperes under pressures up to 200 atmospheres. This furnace, which has been provided out of funds from the Government Grant Committee of the Royal Society, is intended to be used for research on the effect of gaseous pressure on high temperature chemical reactions. The second part of the paper consists of notes on technical processes, and in it the authors direct attention to the more important features of the various electric furnace processes in commercial operation at the present time.

MODERN tendencies in the utilisation of power formed the subject of the address given by Prof. J. J. Flather to the Engineering and Mechanical Science Section of the American Association for the Advancement of Science. In the first part of the address the question of the distribution of power in workshops is considered, and the author deals at some length with the relative merits of electricity, compressed air and hydraulic pressure under various conditions. In the latter part of the paper Prof. Flather deals with some of the larger questions of power generation and transmission. He points out that the competition between oil, gas and steam engines, and steam turbines is likely to lead to the further development and perfecting of each for the purposes for which it is specially suitable. The paper contains some interesting data showing what has already been accomplished in the way of generating power by large gas engines and steam turbines.

THE November issue of the *Proceedings* of the Philadelphia Academy contains an important paper, by Mr. W. H. Dall, on the American representatives of the bivalve group, Carditaceæ.

IN the February number of the *Irish Naturalist* Prof. G. Wilson gives additional information with regard to the proposed marine laboratory for Ulster, to which allusion was made in the January issue of that journal. All concerned are agreed as to the need of such an institution, especially in connection with the Irish sea-fisheries, and the one difficulty in the way is the acquisition of the necessary funds.

A NOTABLE addition to the British (Natural History) Museum is a fine specimen—skin and skeleton—of the great Indian rhinoceros (*Rhinoceros unicornis*), presented by H.H. the Maharajah of Kuch-Behar. The mounted skin is placed for the present in the entrance hall.

OUR German contemporary, *Naturwissenschaftliche Wochenschrift*, contains an illustrated article, by Dr. M. von Linden, on Eimer's theory of the evolution of colour-markings in animals. On this theory, it will be remembered, longitudinal striping is regarded as the first stage; from this spots are developed by a breaking-up process, and these again may coalesce to form vertical stripes.

SOME weeks ago we noticed an article, by Prof. C. H. Eigenmann, on the development of American eels, in which attention was called to the practice of giving separate specific names to the larval "leptocephali." We have just received two papers on the life-history of American eels, issued in 1901 by the U.S. Fish and Fishery Commission, one by Mr. Eigenmann and the other by Messrs. Eigenmann and Kennedy. In the second of these it is confessed that the practice of naming leptocephali is an anachronism, although it is considered permissible in cases where the adult form cannot be identified.

DR. CAMILLO BOSCO contributes to the *Atti dei Lincei*, xi. 12, a study of the cranium of a beaver of the Quaternary period, found in the gravels of Maspino, near Arezzo, and

now in the palæontological museum at Florence. This skull was referred by Forsyth Major and Rütimeyer to *Castor fiber*. It is much more closely related to the European than to the Canadian beaver, particularly in the shape of the nasal parts, the zygomatic arches, the breadth of the frontal and nasal regions, and the parietal crests; it differs, however, from both forms in the palate, which is much broader behind than before, the incisors, which are broader, and the molars, which decrease rapidly in size from the first to the last, and on the surface of which the folds of enamel are slightly sinuous. At the same time, the fact that the nasal bones have retained the same form and breadth during the geological intervals which have elapsed from the time of the Maspino beaver and the Pliocene specimen of Valdarno Superiore affords an argument in favour of the specific separation of *Castor fiber*, L., from *C. canadensis*, Kuhl.

M. L. HOULLEVIGUE describes in the *Journal de Physique* for January some interesting results obtained by depositing thin films of metal on glass and other surfaces by kathodic rays in a bell glass receiver. With deposits of palladium the moisture of the breath was sufficient to break up the film, and the same was to a less degree the case with platinum. In the case of copper, crystals of oxide commenced to form at the edges, and soon extended inwards, but the process was arrested before reaching the middle part, which was the thinnest portion of the pellicule. An attempt was made, extending over seven days, to obtain a carbon film, but the only deposit obtained was probably due to the copper of the support. The electric resistance of a film of bismuth obtained by projection was found to be insensible to a magnetic field. On the other hand, transparent laminæ of iron, placed normally to the field of a Ruhmkorff coil, afforded a ready illustration of magneto-optic rotation. In connection with this work, M. Ed. van Aubel calls attention to the investigations of Wright, Kundt, Patterson and J. J. Thomson.

"FACTORISATION of large numbers" is the subject of a paper read by Mr. F. J. Vaes, of Rotterdam, to the Amsterdam Academy of Sciences last year. The method which forms the starting-point of Mr. Vaes's paper consists in the expression of the given number as the difference of two squares. Taking, say, the number 513667, the next greater square is 717^2, and he writes $513667=717^2-422$. Then he increases the first and second terms of the difference in succession by $2.717+1$, $2.717+3$ . . ., that is, 1435, 1437, 1439 . . .; the results are thus 718^2-1857, 719^2-3294 . . . and when the second term is a perfect square, the factorisation will be completed. However, the work may be shortened by observing that a perfect square cannot end in 2, 3, 7 or 8, and further, the author gives a table of all the groups of four figures in which a square can end, by which further abbreviation appears possible. It is obvious that the process stops when the original number $2n+1$ is expressed in the form $(n+1)^2-n^2$, and if a square has not been obtained previously, the number will be known to be prime.

REFERRING to Dr. E. H. Barton's letter, published in our last issue, describing a simple sensitive flame, Prof. W. F. Barrett, F.R.S., directs attention to a lecture delivered by him before the Royal Dublin Society on January 3, 1868, in which he thinks he used such a flame to demonstrate the reflection and refraction of sound.

THE short nature-studies written by Prof. L. C. Miall, F.R.S., and published under the title "The History of Aquatic Insects" by Messrs. Macmillan and Co., Ltd., in 1895, have been issued in a cheaper form at 3*s*. 6*d*. Advantage has been taken of the reissue to make a few emendations and additions. In its new form the book will doubtless secure a wide popularity in the classes for nature-study which are being instituted in many parts of the country.

MESSRS. GEORGE BELL AND SONS have published separately, at 2*s*. net, under the title "Webster's Pictorial Dictionary," the three thousand or more illustrations in "Webster's International Dictionary of the English Language." The pictures have been classified and arranged according to subjects. As was, perhaps, to have been expected, a very large proportion of the figures illustrate scientific subjects, and exceptional prominence seems to have been given to botanical and zoological terms.

A SECOND edition of "An Elementary Course of Infinitesimal Calculus," by Prof. Horace Lamb, F.R.S., has been issued by the Cambridge University Press. The book was first published in 1897, and a review of it appeared in NATURE for July 28, 1898. In the new edition the book has been carefully revised, and several errors have been corrected, principally in the examples. A few paragraphs in the latter portion of the book, relating to infinite series, have been amplified.

THE seventh volume of *The South-eastern Naturalist*, being the *Transactions* of the South-eastern Union of Scientific Societies for 1902, has been received. Amongst other interesting contents, the volume contains the presidential address, by Dr. Jonathan Hutchinson, F.R.S., on leprosy in the Middle Ages, and the following papers:—Miss A. L. Smith, on mycorhiza, the root-fungus; Mr. E. R. Harrison, on eolithic flint implements; Prof. G. S. Boulger, on the preservation of our indigenous flora; Mr. E. A. Martin, on the protection of plants; Mr. Sibert Saunders, on the marine aquarium, without circulation or change of water; and Mr. W. Whitaker, F.R.S., on Kentish wells and deep borings in the neighbourhood of Canterbury. The report of this union of scientific societies, with which the publication begins, is of a highly satisfactory character, and the record of the work accomplished, or now being done, by members of the affiliated societies shows a very creditable activity on the part of the union.

THE International Oxy-Generator Syndicate, Ltd., has submitted to us for examination a simple and convenient form of apparatus for the manufacture of oxygen, known as the "'Ever Ready' Portable Automatic Oxygen Generator." The apparatus consists of a steel tube used as a retort, a spirit lamp for heating the retort, a purifying tank for washing and cooling the gas, an automatic travelling stage, a collapsible gas holder for storing the gas, and all the necessary connections. The whole of the parts pack easily into a case of moderate size, and there are no complications to get out of order or to puzzle the novice. The oxygen is obtained in the usual manner by heating a mixture of potassium chlorate and manganese dioxide. As a means of avoiding the difficulties of procuring cylinders of compressed oxygen in out-of-the-way places, this generator should prove very useful.

IN the *Proceedings* of the American Academy of Arts and Sciences, vol. xxxviii. No. 5, T. W. Richards has published a simple method of gas-analysis which requires only the simplest apparatus and yet is capable of yielding results accurate enough for many ordinary purposes. The actual measurement consists in a determination of the pressure, the volume of the gas being kept constant. As an elementary exercise for students, the use

of such a simple apparatus possesses many advantages over the ordinary gas apparatus employed in practice.

THE epidiascope, a new optical lantern, which we have examined at the London branch of Mr. Carl Zeiss, of Jena, is primarily intended for the projection on the screen of opaque bodies, such as insects, coins, fossils, diagrams, &c., in their natural colours. It is equally serviceable for projection of transparent objects, *e.g.* lantern slides, and microscopic preparations can likewise be shown with considerable magnification. The source of light is an arc-lamp of 30 or 50 amperes, at the focus of a parabolic reflector; the light is either thrown upon, or transmitted through, the object by a system of condensers and mirrors. The images are brilliant and well-defined. In its primary capacity the lantern gives remarkably interesting results, the images, for instance, of butterflies or coins being most realistic in appearance, owing, no doubt, to the fact that the shadows of the objects viewed are reproduced just as in nature. Dark heat rays are trapped by a water tank, so that delicate biological specimens, and even living organisms, may be depicted on the screen. A notable feature of the instrument is its convenience in manipulation, the change from opaque to transparent bodies taking but a few seconds. The object chamber is large, and objects are laid on a horizontal table without clamping. Manuscripts and pictures so large as 8½ inches square can be shown, hence the instrument should be useful, not only to men of science, but for class lectures and educational purposes.

WE have received the *Proceedings* of the University of Durham Philosophical Society, vol. ii. part ii. Amongst other papers is an interesting communication by Prof. P. P. Bedson on the gases enclosed in coal. The gases enclosed in the various samples of coal or coal dust were obtained by heating weighed quantities of these in tubes connected to a Sprengel pump and heated usually to 100° C. by means of boiling water. In addition to marsh gas, carbon dioxide, oxygen and nitrogen, evidence has been obtained of the occurrence of the higher hydrocarbons ethane and propane. These latter are not evolved so readily at 100° C. *in vacuo* as marsh gas, and a partial separation of the hydrocarbons can be effected on the basis of this property. Another point of interest in the paper is the experimentally established fact that coal, after removal from the mine, not only gives off some of its "enclosed gases," but takes up the gases of the atmosphere and the oxygen more readily than the nitrogen.

THE annual report for 1901 of the Smithsonian Institution at Washington has reached us. Although many details of interest are described in Prof. Langley's report, most readers will turn with the greatest pleasure to the valuable appendix of nearly 600 pages. This appendix is a summary of the most interesting scientific work of the preceding year, presented in a form which will appeal, not to men of science alone, but to the intelligent general reader. It contains fifty articles by men of science of many nationalities, most of them profusely and excellently illustrated. The first article gives a short sketch of the history and work of the Smithsonian Institution, and this is followed by one by Mr. Abbot on some recent astronomical events. Prof. Rücker's presidential address to the British Association at Glasgow is reprinted, as well as a number of Royal Institution lectures. Among these are that of Prof. Poynting on recent studies in gravitation, Prof. Dewar's on solid hydrogen, Mr. Marconi's on wireless telegraphy and Dr. Glazebrook's on the aims of the National Physical Laboratory. Numerous other interesting contributions include that by Lord Kelvin on ether and gravitational matter through infinite space, one by Prof. J. J. Thomson on bodies smaller than atoms, and several by Prof. S. P. Langley—that which appeared first in NATURE, on "The Fire Walk Ceremony in Tahiti," is one of them; while another shows the comparative efficiency as flying machines of various large birds and artificial aërodromes. There are also papers on the utilisation of the sun's energy, the Bogoslof volcanoes of Alaska, forest destruction, irrigation, pictures by prehistoric cave-dwellers in France, and one on the National Zoological Park at Washington by Mr. Seton Thompson. Several beautiful coloured plates add to the attractiveness of the volume.

THE additions to the Zoological Society's Gardens during the past week include two Coquerel's Mouse Lemurs (*Chirogaleus coquereli*) from Madagascar, a Mohr Gazelle (*Gazella mohr*) from North Africa, two Gould's Monitors (*Varanus gouldi*), six Bearded Lizards (*Amphibolurus barbatus*) from Australia, a Tamandua Anteater (*Tamandua tetradactyla*) from South America, deposited; a Common Stoat (*Mustela erminea*), European, purchased.

CORRECTION.—In line nine from the end of Mr. G. W. Butler's letter in NATURE of February 12 (p. 344), omit the word *of*.

OUR ASTRONOMICAL COLUMN.

OBSERVATIONS OF COMET 1903 *a*.—M. P. Chofardet, of the Besançon Observatory, records in the *Comptes rendus* for January 26 that on January 21 the apparent diameter of this comet was 1′·5 and its magnitude was about 10–11; a small eccentric condensation towards the south was also observed. On January 24 the condensation was central, and a small stellar nucleus was seen.

DETERMINATIONS OF STELLAR RADIAL VELOCITIES.—As a supplement to a previous note on the determinations of the radial velocities of the planets made at Meudon, M. Deslandres contributes to No. 4 (1903) of the *Comptes rendus* the results of the determinations of the radial velocities of θ Aquilæ, ϕ Persei and ψ Persei, and he also describes the spectrograph with which they were determined, together with the sources of error to which the determinations are subject.

In the case of θ Aquilæ (a white star of Pickering's class viia.), where the hydrogen lines are broad and the metallic lines fine, the magnesium line λ 4481 was used. The results show a considerable variation in the velocity, and a mean period of about seventeen days with a shorter period of three days superimposed; the star is a spectroscopic binary.

The star ϕ Persei has bright hydrogen lines which show central reversals, and the fine dark reversals have been used in determining the velocity, which is variable.

In ψ Persei, the hydrogen lines are bright and superimposed on very broad dark lines, and each shows several dark reversals some distance apart, exactly similar in appearance to those seen in Nova Persei and other temporary stars.

For the comparison spectrum in each case, a spark from poles containing iron and titanium was used.

THE COLOUR OF THE ECLIPSED MOON.—In a description of the phenomena observed during the lunar eclipse of October 16, 1902 (*Astronomische Nachrichten*, No. 3845), Prof. E. E. Barnard comments on the various colours assumed by the eclipsed moon at different eclipses. He says that the appearance of the lunar surface during the last eclipse was by far the darkest he has yet observed, being of a dull coppery red colour, whilst that of June 11, 1881, was a beautiful bright cherry red, and suggests that this variation is probably due to the differences existing in the terrestrial atmospheric conditions during the various eclipses.

Prof. Barnard further remarks that the dark coloration is not evenly distributed during an eclipse, for in the present case he observed a dark smear running from east to west across the eclipsed moon, and he suggests that this phenomenon was probably due to some local disturbance in our atmosphere at the time of the eclipse.

SOLAR PROMINENCES AND TERRESTRIAL MAGNETISM.

SINCE the year 1871 the Italian astronomer, Prof. Tacchini, has been daily making spectroscopic observations of the sun, noting the number, size and position of the prominences visible on the solar limb. A preliminary study of this very valuable homogeneous series of data rendered it possible to demonstrate that the variation of the frequency of occurrence of these phenomena followed a very general law, the number waxing and waning at intervals of about eleven years, and synchronising with the variation of the number of spots on the sun's disc. This result was pointed out some time ago in the pages of this Journal (vol. lxvi. p. 248), and it was there further stated that there were in addition subsidiary maxima and minima superimposed on the main eleven-year curve.

This preliminary study dealt with the prominences visible on the sun's limb *in toto*, and did not consider their frequency in any particular part of it.

A subsequent analysis indicated, however, that by taking the solar limb to pieces, so to speak, and dealing with the individual parts of it, very interesting results might accrue. This work has recently been completed, and it was found that the frequency of prominences varied according to the particular solar latitude examined, and that the phenomena of terrestrial magnetism were very closely connected with these variations.

In a recent communication to the Royal Society[1] the comparison of these two classes of phenomena, as mentioned above, has been made in some detail, and the present article gives a brief account of the conclusions derived from the inquiry.

For the reduction of the prominence observations the limb of the sun was divided into parts ten degrees in length, corresponding with ten-degree zones of solar latitude north and south, and each zone was examined and discussed by itself. Further, the observations for every three months were, in the first instance, grouped together, and the percentage frequency for each of these periods was determined individually.

In this way a set of eighteen curves, nine for each hemisphere, was made, showing the variation from year to year of the percentage frequency of prominence activity in each ten-degree zone.

In the curves accompanying the present article (Fig. 1) the above-mentioned set, except those for 80°--90° north and south, was grouped in pairs, thus representing the percentage frequency of prominences in each hemisphere for zones of 20° of latitude, 0°--20°, 20°--40°, &c., since it was found that this reduction could be made without losing any of the characteristic variations.

An examination of these curves shows that they differ very considerably one from the other as we proceed from the equatorial to the polar zones. Generally speaking, the curves representing the variations for each of the zones, 0°--20° north and south, conform with the sun-spot curve; that is, the maxima and minima occur at about the epochs of sun-spot maxima and minima. Those for the two zones 20°--40°, in both hemispheres, conform also in the main to the general sun-spot curve, but in addition they display subsidiary maxima or changes of curvature superimposed on the main curve.

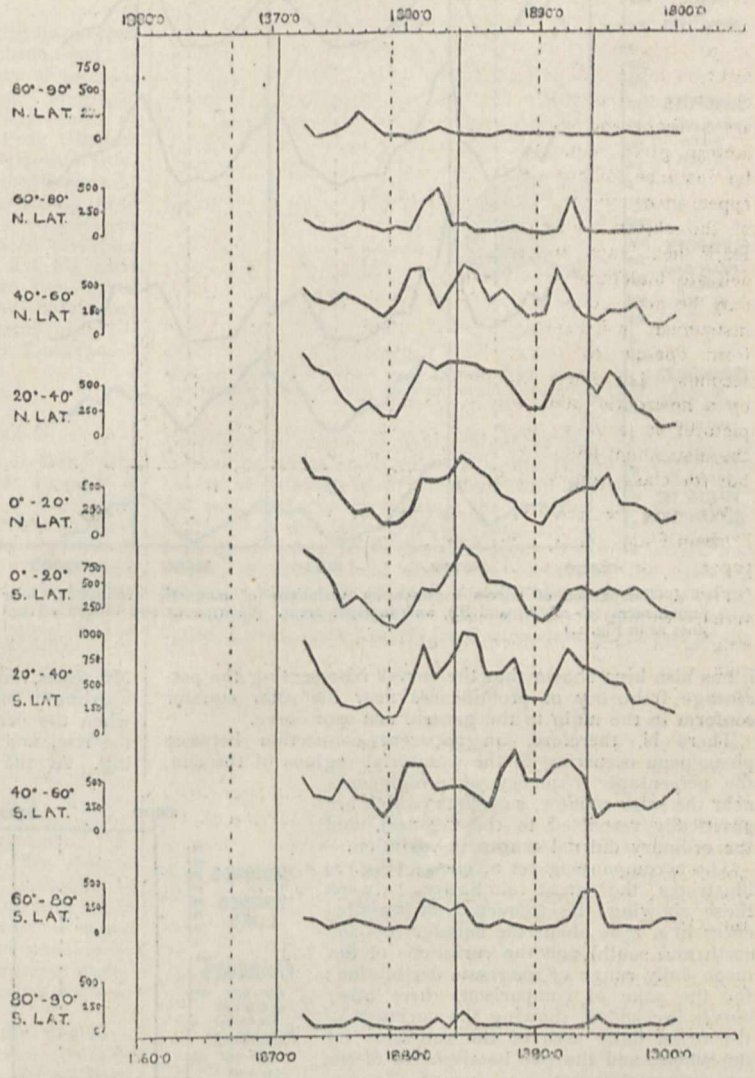

FIG. 1.—Curves showing the percentage frequency of solar prominences for each 20° zone N. and S. (The continuous and broken vertical lines indicate the epochs of sun-spot maxima and minima respectively.)

The curves for the two zones, 40°--60° north and south, have, on the other hand, hardly any likeness to the sun-spot curve, but are made up of a series of prominent maxima representing special outbursts of prominence activity.

Passing to the curves corresponding to the next zones, *i.e.* 60°--80° north and south, these indicate two prominent outbursts lasting for a short period, showing that this region of the sun is, as a rule, practically free from prominence activity; in the remaining zones, 80°--90° north and south, the variation is small, and is a faint echo of the condition of affairs in the neighbouring zone 60°--80°.

The data regarding the magnetic phenomena which were employed were those brought together by Mr. William Ellis, who very kindly brought the whole of them up to date for the purposes of the present inquiry.

Two classes of magnetic phenomena were dealt with, namely, the variations from year to year of the diurnal range of the declination and horizontal force, and magnetic disturbances. As regards the former, Mr. Ellis has shown that the curves indicating these variations are very similar to that of the general sun-spot curve; in fact, the curves were found to be almost identical in all their smaller irregularities. The second class of phenomena, namely, the magnetic disturbances, which are more irregular in occurrence, has been classified by Mr. Ellis into five groups, and tabulated by him

[1] "The Relation between Solar Prominences and Terrestrial Magnetism." By Sir Norman Lockyer, K.C.B., F.R.S., and William J. S. Lockyer, M.A., Ph.D., F.R.A.S. (Received January 14, read January 29, 1903.)

under five separate subheads. In this investigation only that class described as "great" has been used, since this group represented the largest disturbances.

Mr. Ellis, as already has been pointed out, has indicated the close resemblance between the sun-spot curve and that representing the variation of the magnetic elements; and it has also been shown that the curves representing the percentage frequency of prominences near the solar equator conform in the main to the general sun-spot curve.

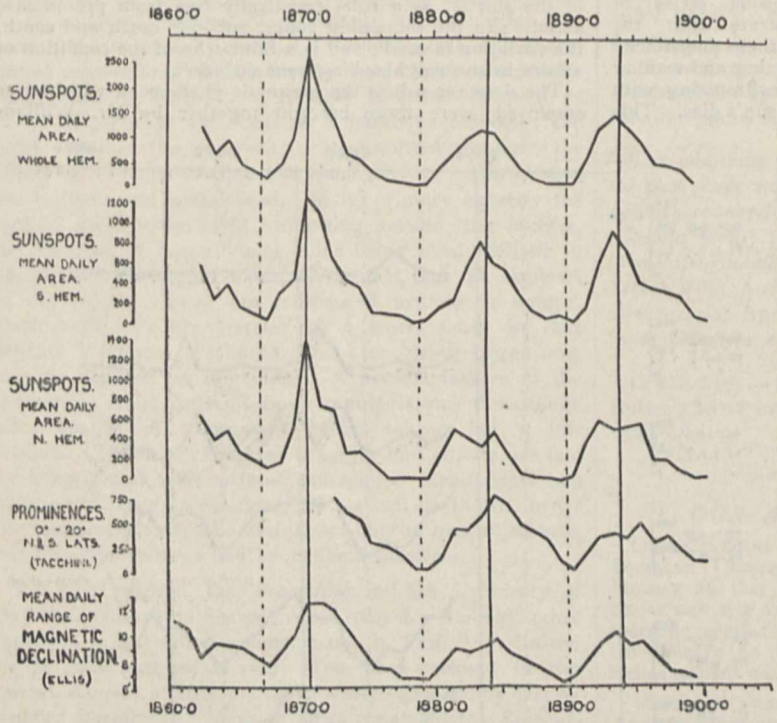

FIG. 2.—Comparison of curves representing variations of magnetic declination, solar prominences (0°–20° N. and S.), and sun-spot areas. (Continuous and broken vertical lines as in Fig. 1.)

There is, therefore, an apparent connection between phenomena occurring in the equatorial regions of the sun, the percentage frequency of prominences near the solar equator, sun-spots (which are practically restricted to these zones), and the ordinary diurnal magnetic variation.

The accompanying set of curves (Fig. 2) illustrates the great similarity between those showing the frequency of prominences in a zone about the equator (0°–20° north and south) and the variations of the mean daily range of magnetic declination; for the sake of comparison, three other curves are added, showing the variation of the mean daily area of the sun-spots for the whole, and the two hemispheres of the sun separately.[1]

[1] In referring to the curve representing the variation of the mean daily areas of sun-spots, it may be noted that this is obtained by combining the mean daily areas of both hemispheres of the sun. A closer analysis shows, however, that this variation is not the same for both hemispheres. From the year 1862, when such a division of the sun's disc can be easily investigated, the northern hemisphere, about the time of the two last maxima, displayed double maxima occurring in the years 1881 and 1884, and in the years 1892 and 1895. About the time of the maximum of 1870 this duplicity is not so marked, although when compared with the curve for the southern hemisphere for this period, there is a slight indication of a subsidiary crest in 1872. In the case of the curve representing the mean spotted area for the southern hemisphere alone, at all the three epochs of maximum, the curves are single-crested and indicate sharply-defined maxima in the years 1870, 1883 and 1893.

From the above it will be seen, therefore, that the actual epochs of sun-spot maxima, as determined from the northern and southern hemispheres respectively, are not the same, and in dealing with the curve representing this variation for the whole hemisphere, this fact should be borne in mind. It may further be noted that the epochs of minima may be practically considered the same for both hemispheres.

Leaving the variation of the diurnal range of the magnetic elements and turning our attention to the magnetic disturbances, it will be seen that if a comparison of the curve representing the number of days of the "great" disturbances be made with those representing prominence frequency (Fig. 1), the former is as unlike the curves representing the prominence frequency about the solar equator as it is like those near the poles; in fact, the polar prominence outbursts and great magnetic disturbances occur almost simultaneously.

The peculiar form and general similarity of the curves can be best seen from the accompanying illustration (Fig. 3). In the figure comparison is made between the epochs of the crossing of the known and unknown lines observed in sun-spot spectra, the percentage frequency of prominences about the solar poles and Ellis's "great" magnetic disturbances.

Two curves representative of prominence frequency are given, one to indicate the abrupt nature of the curves representing the frequency in a zone near the pole 10 degrees in width (in this case 60°–70° north), and the second to illustrate polar action as a whole; this latter was obtained by making a summation of prominence frequency for the two zones 60°–90° north and south.

The simultaneous occurrence of the maxima suggests that, when the prominence action takes place at the polar regions of the sun, one effect on the earth is that we experience our greatest magnetic disturbances.

Mr. Ellis has previously stated that unusual magnetic disturbance is frequent *about* epochs of sun-spot maximum. The present inquiry indicates that not only do these "great" disturbances occur at the same time as the *polar* prominences, but the spectroscopic observations of sun-spots show that they take place not only "about" the times of spot maximum, as stated by Mr. Ellis, but when the sun-spot curve is *approaching* a maximum and at the dates of the widened line crossings, when the curve representing the "unknown" lines is on the rise, and crosses the "known" line which is descending. At the other epoch of "crossing," *i.e.* when the curve showing the "known" lines is on the rise and the "unknown" is falling, there is practically no "great" magnetic disturbance recorded.

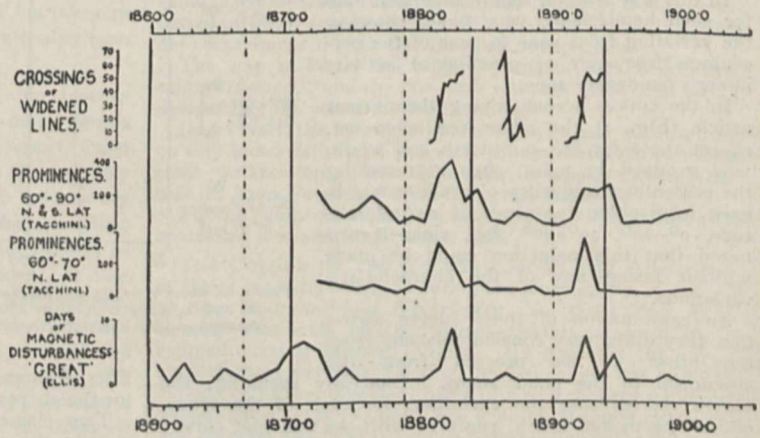

FIG. 3.—Comparison showing days of "great" magnetic disturbance, polar prominences, and crossings of widened lines. (The continuous and broken vertical lines as in Fig. 1.)

This apparently close connection between solar prominences and magnetic storms perhaps explains why it is that the latter sometimes take place when there are no spots, or no very large spots on the solar surface. Thus, for instance, there may be prominences and magnetic storms when there are no spots; prominences may also sometimes be associated with large spots, and as the latter can be seen while the former cannot, the resulting magnetic storm is generally attributed to the spots.

Further, the magnitude of magnetic storms appears to vary according to the particular position as to latitude of the prominence on the sun's disc. The nearer the poles (either north or south) the prominence occurs, and these are the regions where no spots exist, the greater the magnetic storm.

In conclusion, it may be stated that the inquiry has shown that the variations of the general magnetic phenomena, as given by Ellis, synchronise with the occurrence of prominences about the solar equator, while his "great" magnetic disturbances occur, in point of time, with the appearance of prominences in the polar regions of the sun. Prof. Bigelow has recently (U.S. *Monthly Weather Review*, July, 1902, p. 352) investigated the variations in the horizontal magnetic force, and finds that the curve representing these changes exhibits subsidiary maxima which synchronise with those recorded in the curve representing the mean variation of prominences for all latitudes. Thus, to use his own words, "the remarkable synchronism between the curves cannot escape recognition, except after the year 1894, when an extra minor crest is developed in the horizontal force."

WILLIAM J. S. LOCKYER.

THE FORTRESS OF THE MOLE.

FOR the last three-quarters of a century, at any rate, natural history writers have been content to copy a diagrammatic figure of the breeding-hillock of the mole, without the least attempt to ascertain for themselves to what extent it is based on actual fact. The diagram in question was based on a fairly authentic account of the mole's habits drawn up by de Vaux just a century ago, but was elaborated by G. St. Hilaire and further "improved" by Blasius. Recently, Mr. L. E. Adams, whose special study is the Mollusca, has examined a large series of mole-hillocks in Staffordshire and has found that in no case does the structure of the one in which the nest is formed correspond with the current diagram of the so-called "fortress." His account, illustrated with numerous diagrams (two of which we are enabled to reproduce) is published in vol. xlvii., No. 4, of the *Memoirs* of the Manchester Literary and Philosophical Society. It shows that in certain other respects our ideas of the life-history of the mole require modification.

With regard to the situation of the breeding-hillock, or fortress, as it still may be conveniently called, Mr. Adams finds that this is generally in the open field, although it may occasionally be placed in a hedge-bank, but only when there is a ditch alongside. Indeed, the proximity of water seems to be the main factor in determining the position of the structure. Now and then a fortress may be found under a tree, but it is considered by the author that such a position is probably accidental.

According to the old idea, it was supposed that the runs with which it is permeated were made on a certain definite plan, allowing of free escape from the invasions of foes both above and below ground. This idea receives no support from the new observations, which tend to show that the more or less complicated galleries are purely incidental, and, with the exception of one "bolt-hole," have no reference to premeditated escape. In place, indeed, of being examples of a wonderful instinct of self-preservation on the part of their constructor, it appears that the galleries of the fortress are the natural, incidental and inevitable outcome of the work of excavating the nest-cavity and piling up the superincumbent mound.

When the site for the fortress has been fixed, a circular cavity is excavated for the reception of the nest at a depth of from two to six inches below the surface of the ground, except in the case of boggy soil or in situations liable to be flooded, when the nest is often made above the original ground-level. The easiest way to dispose of the excavated soil is to push it up to the surface, and for this purpose a tunnel is constructed, and in such a case the whole mound is made by this tunnel.

"When this superincumbent earth," writes the author, "has reached an inconvenient height, another tunnel is made, sometimes from another part of the nest-cavity (Fig. 1, *a*, *b*), but more often sideways from the first upward tunnel. All this takes time, and the mole meanwhile makes fresh runs from the fortress, the seat of its labour, in various

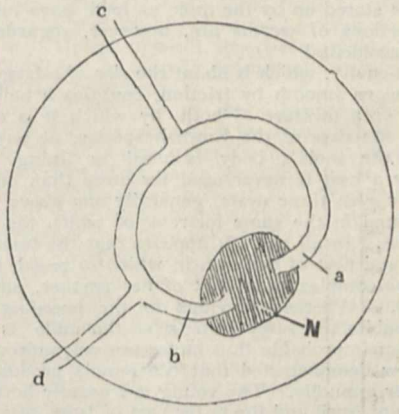

FIG. 1.—Plan of a simple mole fortress, from above. *a*, *b*, excavation tunnels; *c*, *d*, tunnels made for forming protecting heap; N, nest.

directions in search of food. Much of the earth displaced in making these fresh runs falls into the nest-cavity, and has to be disposed of in the same way as before, and also the soil displaced in making the bolt-run and the down-shaft, when this latter occurs. Now the tunnel (or tunnels) leading upwards from the nest-cavity becomes larger and larger, winding round under the surface of the growing fortress. When this removal of earth becomes too fatiguing, on account of the length of the tunnel, the mole will often begin to make new tunnels from runs close to the end of the

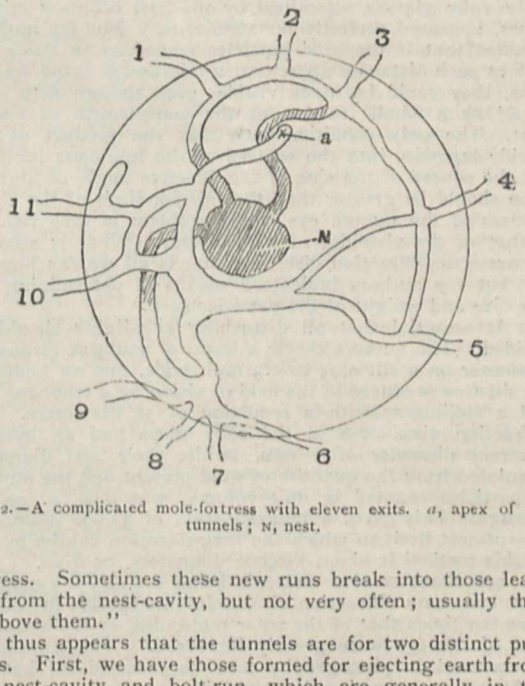

FIG. 2.—A complicated mole-fortress with eleven exits. *a*, apex of the tunnels; N, nest.

fortress. Sometimes these new runs break into those leading from the nest-cavity, but not very often; usually they lie above them."

It thus appears that the tunnels are for two distinct purposes. First, we have those formed for ejecting earth from the nest-cavity and bolt-run, which are generally in the shape of a corkscrew ascending from the nest, and often with blind divergent terminations. And, secondly, tunnels

unconnected with the nest-cavity, but traversing the fortress from external runs, through which earth has been carried to heap over the nest. Fig. 2 shows a fortress of the most complicated type.

Except when in marshy soil, nearly every fortress has the aforesaid bolt-run, which leads upwards from the bottom of the nest, and thus outwards, without connection with the other tunnels. More rarely a down-shaft, which may be nearly a yard in length, descends obliquely from the nest. The use of these down-shafts is not apparent. Presumably it is in them that the collections of paralysed worms, supposed to be stored up by the mole as food, have been found. Such collections of worms are, however, regarded by the author as accidental.

The nest-cavity, which is about the size of a large cottage-loaf, and worn smooth by friction, contains a ball of grass or leaves, or a mixture of both, by which it is completely filled. In the case of the English species, at any rate, no fur from the mole's body is used in lining the nest. Apparently a nest is never used for more than one season, but two or even three nests, generally one above the other, may be found in the same fortress, of which the newest is alone in use. In all cases it appears that the female makes a fortress and nest of her own in which to breed, this being usually less complex than that of her partner, and without a bolt-run. Whether previous to the breeding-time the female inhabits the same fortress as the male is doubtful, and it is not improbable that moles are polyandrous.

It is now demonstrated that the female produces only a single litter annually. The young are usually born between the middle of April and the latter part of June, after a gestation of four weeks; the number in a litter varies from two to six, three or four being usual. The number of teats in the female is eight, and not, as usually stated, six. R. L.

THE VISIBILITY OF ULTRA-MICROSCOPIC PARTICLES.[1]

IN the course of an optical investigation of various shades of ruby glass, Messrs. Siedentopf and Zsigmondy devised a method of observing small particles of gold which closely approach molecular dimensions, and thus extending our range of molecular vision very considerably.

The ruby glasses, examined by the best ordinary microscopes, appeared perfectly homogeneous. But the authors reasoned that if the gold particles embedded in the glass were at such distances apart that a microscope could resolve them, they could be made visible even though their size should be a small fraction of the wave-length of visible light. The only condition was that the product of the specific intensity into the surface of the luminous particles and the square of the sine of the effective angle of illumination should be greater than the inferior limit of the sensitiveness of the human eye. The problem is thus reduced to that of the visibility of a fixed star. What is seen is, of course, a diffraction disc, and that is all we can hope to see, but the authors indicate a means of determining the true size and weight of the particles seen.

It is essential that all disturbing side-lights should be avoided. The authors threw a beam of sunlight through a condenser on a slit 0.05 to 0.5 mm. wide, and an image of the slit was produced in the field of vision by a telescope lens and a collimator with a reduction of 36 diameters. The diffraction discs seen in the ruby glass had an average apparent diameter of 1 mm., while their real diameter, calculated from the quantity of gold present and the number of particles counted in unit volume, was 0.02 μ. on the average. This gives a magnification of 50,000 diameters. The utmost limit to which the magnification can be pushed by this method is about 150,000 diameters, or 6 $\mu\mu$. The average diameter of a molecule being 0.6 $\mu\mu$., it cannot be seen, even as a diffraction disc, unless its specific luminosity were ten times that of the solar molecules, or the sensitiveness of the eye were greatly increased. The cumulative effects used in photography may be resorted to, but the authors do not mention that possibility.

[1] Abstract of a paper by H. Siedentopf and R. Zsigmondy (*Annalen der Physik*, No. 1, 1903, pp. 1–39).

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—A meeting of the teachers of natural science was held in the examination schools last Saturday to hear the views of a deputation of the Association of Public School Science Masters on the subject of entrance scholarship examinations. It was agreed that two principal subjects should be offered in scholarship examinations, and a suggestion was made that the subjects should be selected from physics, chemistry, botany, zoology and geology. The meeting was divided in opinion as to whether botany and zoology should form one group or two. With regard to the recommendation of the deputation that candidates not offering chemistry and physics should be given an elementary paper in these subjects, the meeting was unanimous as to the desirability of this course, and further suggested the addition for those candidates of a practical examination in elementary chemistry and physics, which should not be confined to qualitative analysis.

CAMBRIDGE.—At a conference held on February 7 between representatives of the Association of Public School Science Masters and the college tutors in natural science, the following recommendations in regard to the college examinations for entrance scholarships and exhibitions were provisionally agreed to:—(1) That the science part of the examination should consist of: (1) Papers and practical work in not more than six subjects, namely, (1) physics, (2) chemistry, (3) geology, (4) the natural history of plants, (5) zoology, (6) the elements of botany and zoology, it being understood that no candidate may take the subject (6) if he take either of the subjects (4) or (5). Of these six subjects candidates must offer not more than two. (2) Candidates who take subjects (3), (4), (5) or (6) should be required to take an elementary paper in physics and chemistry. (3) Candidates who take subject (1) should be required to take an elementary paper in mathematics.

The vacancy at Caius College, caused by the death of Dr. N. M. Ferrers, F.R.S., has been filled by the election of the Rev. E. S. Roberts, senior tutor to the mastership.

The Gilbey lecturer in agriculture will give this term a course of lectures on small holdings and allotments in the Chemical Theatre, on Fridays, at 5.

A REPORT of the Committee of Privy Council in favour of the petitions of the Liverpool University College and Owens College, Manchester, for charters of incorporation as independent universities, was submitted to the King in Council on Monday and approved by him. The decision will be received with pleasure by all who are interested in the development of higher education in this country. It is essential that we should have more universities if we are to march with the times. Regional universities are not known in any civilised country, and only end in examinations and the destruction of real teaching and research. In the report published in Tuesday's *Times*, the committee expresses the opinion that as the step involves issues of great moment, and as the effect of the multiplication of universities ought not to be lost sight of, the authorities of the Yorkshire College at Leeds should have the opportunity of submitting a draft charter incorporating a University in Yorkshire before the draft charters sought are finally settled, and that the institutions concerned should be invited to consider in greater detail not only the points on which joint action is desirable, but also the methods by which it can best be secured. The committee also considers that special rights of inspection should be reserved to the King as Visitor, and that careful provision should be made in the charters to secure an effective voice to external and independent examiners in all examinations for degrees.

DR. D. J. CUNNINGHAM, F.R.S., professor of anatomy in Dublin University, has been unanimously elected to succeed Sir William Turner in the chair of anatomy at Edinburgh.

REUTER reports that it has been decided to create a chair of commercial science, with a special faculty, in the University of Zurich, which is the first on the continent to establish such a chair.

THE Duke of Devonshire will lay the foundation stone of the new technical institute and public library for Eastbourne on Saturday, April 25. The Duke has presented a site valued at 10,000*l*.

DR. ARTHUR DENDY has resigned the chair of biology in the Canterbury College (Christchurch, New Zealand), in order to go to the Cape of Good Hope as professor of zoology in the South African College, Cape Town, Cape Colony.

As an instance of the thorough manner in which educational problems are taken up in America, an announcement made by the Lahore correspondent of the *Pioneer Mail* is interesting. It appears that the University of Chicago has commissioned Mr. Alleyne Ireland to make a tour of the European dependencies in the East with a view to deliver a series of lectures on "Management of Tropical Colonies." He has already visited Hong Kong, Borneo, Singapore, and is now in India, though only as a tourist. He is devoting his attention for the present to European dependencies in Asia other than India.

AT the last monthly meeting of the Pharmaceutical Society of Ireland, the following resolution was adopted :—That, in connection with the appointment of teachers of chemistry under the Department of Agriculture and Technical Instruction, the council take steps to ascertain the requirements of the Department, with the view of having their certificates accepted as qualifying their licentiates for the appointments. This resolution may lead to a modification of the course of instruction in the Irish Pharmaceutical Society's School of Chemistry which will make it possible for the licentiates of the school to qualify as teachers of chemistry in the Irish intermediate schools.

REFERENCE to the Education Bill for London was made in the King's speech delivered by His Majesty at the opening of the new Session of Parliament on Tuesday. The words used in the speech to the Commons were :—"Proposals will be submitted to you for completing the scheme of educational reform passed last Session by extending and adapting it to the metropolitan area." It is believed that the central authority for education in this area will be the County Council, but administrative details will be left in the hands of the borough councils to a greater extent than is the case with the local authorities under the extra-metropolitan Act of last year.

THE current number of the *Library* summarises, in a convenient tabular form, Mr. Carnegie's gifts to libraries and other educational institutions down to November 30 of last year. From these tables it is seen that England and Wales have benefited to the extent of 376,100*l*., this amount including a donation of 50,000*l*. to the University of Birmingham and one of 13,000*l*. to the Iron and Steel Institute. Ireland has received 100,600*l*. and Scotland 2,479,250*l*. The princely gift to Scotland includes the endowment fund of 2,000,000*l*. for Scottish universities, a sum of 100,000*l*. given to the Technical School at Galashiels, 38,000*l*. to the Dunfermline Technical School, and 50,000*l*. to Aberdeen University. Canada has received 954,000 dollars, which represents the total sum given for the foundation of thirty-one public libraries. Libraries and other educational institutions in the United States have reaped the advantage of Mr. Carnegie's munificence to the enormous extent of 212,882,173 dollars. The Fayette Upper University, Iowa, has received 225,000 dollars; the Louisville Polytechnic Institute 125,000 dollars; the Carnegie Laboratory of New York City 600,000 dollars; the Pennsylvania State College 100,000 dollars; the Carnegie Institute at Pittsburg 7,250,000 dollars; the Polytechnic School of the same place, as an endowment, two million dollars; and the National University of Washington ten million dollars. Cuba, too, has shared in the same lavish generosity, for Havana has received 250,000 dollars and Matanzas 2000 dollars.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 22.—"Solar Eclipse of 1900 May 28. General Discussion of Spectroscopic Results." By J. **Evershed**, F.R.A.S.

The spectra discussed in this paper were obtained near the southern limit of total eclipse, and include, therefore, the chromospheric spectrum of the south polar region of the sun, as well as the same spectrum in mid-latitudes.

The coincidence in position of the vast majority of the bright lines with the Fraunhofer dark lines is shown to be exact within the limits of the measures. But the relative intensities of the bright lines of any one element, although in general agreement with those of the corresponding dark lines, are not in all cases the same, and those lines which are exceptionally strong in the chromospheric spectrum are mostly lines which are enhanced in the spark spectrum of the element.

All the more prominent enhanced lines of iron and titanium as determined by Sir Norman Lockyer are found to coincide with strong lines in the chromosphere, and these lines are found to be equally prominent in the south polar region and in mid-latitudes.

The abnormal intensity of the enhanced spark lines in the flash spectrum is explained by assuming a continuous circulation of the solar gases in a radial direction, the highly heated ascending gases, emitting the enhanced lines, giving the predominant features to the chromospheric spectrum, whilst the cooler, more diffused gases, slowly subsiding, determine the character of the absorption spectrum.

The entire chromosphere is supposed to consist of innumerable small eruptions or jets, of a similar nature to the so-called metallic prominences, which latter are only the more pronounced manifestations of the same eruptive agencies.

Evidence for this is found in the characteristic features of the chromosphere, and in the structure of many of the Fraunhofer lines, which show emission lines underlying the narrow absorption lines. These ill-defined bright lines in the normal solar spectrum are displaced towards the violet, indicating a strong uprush of the hotter gases, whilst the narrow dark lines would appear to indicate a slow and uniform descent of the absorbing gases.

The final conclusion is that the spectrum of the chromosphere represents the emission of both ascending and descending gases, and the Fraunhofer spectrum represents the absorption of the descending gases only.

"Preliminary Note on the Relationships between Sun-spots and Terrestrial Magnetism." By Dr. C. **Chree**, F.R.S.

This deals with results of magnetic declination, inclination, horizontal and vertical force obtained at Kew Observatory (National Physical Laboratory) on magnetically quiet days from 1890 to 1900. The ranges of the diurnal inequalities are compared with the sun-spot frequencies as calculated by Wolfer. Between the diurnal range R of an element and the sun-spot frequency S, a linear relation $R = a + bS$ . . . (1) is assumed, a and b being taken as constants for any given month of the year, but as fluctuating from one month to another. The values of a and b have been calculated for each month of the year from the eleven years' data by least squares. The preliminary note gives the mean values for "winter," "equinox" and "summer"—including four months in each season—and the mean for the twelve months. The constants a, representing the values of the range for zero sun-spot frequency, are smallest in winter and largest in summer. The constants b are in the case of the declination, inclination and horizontal force—where the sun-spot connection is more clearly marked than in the vertical force—largest at the equinox. The variation of b with the season appears closely the same for the three magnetic elements specified. On the average of the three, the proportional values obtained for b are, winter 82, equinox 115, summer 103. Whilst b, considered absolutely, appears largest at the equinoxes, the sun-spot influence (or rather correlation) is relatively much most important in winter. During the eleven years considered, Wolfer's mean sun-spot frequency was 41·7; so that, according to (1), $1 + 41{\cdot}7b \div a$ represents the ratio of the range answering to mean sun-spot frequency to the range answering to absence of sun-spots. The average values of $41{\cdot}7b \div a$ for the declination, inclination and horizontal force in winter, equinox and summer respectively were 0·57, 0·38 and 0·27. The means of the twelve-monthly absolute values found for b were, declination 0′·041, inclination 0′·013, horizontal force 0·19γ and vertical force 0·03γ, where γ represents 1×10^{-5} C.G.S. Reference is made to work by Balfour Stewart, Ellis, Wolfer, Rajna and Angot, and the legitimacy of the use of Wolfer's table of sun-spot frequencies is considered.

January 29.—"On Skew Refraction through a Lens, and on the Hollow Pencil given by an Annulus of a very obliquely placed Lens." By Prof. J. D. **Everett**, F.R.S.

The investigation here described was undertaken with the view of finding an explanation of the curious curves obtained by receiving on a screen, at certain distances, the hollow pencil which emerges from an annulus of a lens placed at a large obliquity (such as 30° or 45°) to the incident beam.

The first requisite is a process for calculating the direction cosines of a ray after refraction at a given surface, when those of the incident ray and of the normal are given, along with the relative index of refraction; and the leading feature of the process here described is, *the preliminary calculation of the direction cosines of the tangent to the refracting surface in the plane of refraction.* The refracted ray (or unit length of it) is projected on this tangent and on the normal; and these two projections are themselves projected on the axes of coordinates, and added. This process differs *in toto* from that devised by Seidel and employed by Steinheil.

A simple case is chosen for testing the working of the process, the case of a narrow and thin annulus of a plano-convex lens, with a parallel pencil incident at 45° on its plane face, the index being 1·5, and the sine of the inclination of the normals to the axis 0·1. The direction-cosines are found for the emergent rays at twelve equidistant points; and from these, by harmonic reduction, expressions are deduced for the direction-cosines of any emergent ray. From the equations of the rays in terms of the direction-cosines and starting-points, numerous cross-sections are calculated and plotted.

Each ray intersects two others, and the aggregate of these points of intersection constitutes the two focal lines. The secondary line is found to be nearly straight, and inclined at about 17° to the original direction of the beam. The primary line is approximately a parabola, the chord joining its ends being about $1\frac{1}{2}$ the distance of the chord from the vertex. The vertex is next the lens, and is the intersection of the two rays which lie in the principal plane. The rays which intersect at its ends have starting-points 79° distant from one of these rays, and 101° from the other.

Every cross-section shows a double point wherever it meets a focal line; and at the ends of the two focal lines these double points become cusps. The ends of the primary line have been located, and the rays which pass through them found as above, by means of the conditions for a stationary point, which must always hold at a cusp.

Chemical Society, February 5.—Dr. E. Divers, F.R.S., vice-president, in the chair.—The following papers were read:—The solubilities and transition points of lithium nitrate and its hydrates, by Dr. F. G. **Donnan** and Mr. B. C. **Burt**. Lithium nitrate was found to yield two hydrates, $LiNO_3,3H_2O$ and $LiNO_3,\frac{1}{2}H_2O$. Determinations of the solubility of these hydrates and of the anhydrous salt were made, and the various quadruple points thus located confirmed by thermometric and dilatometric measurements.—The synthesis of $\alpha\alpha$-diglutaric acid, by Drs. O. **Silberrad** and T. H. **Easterfield**.—Distillation of chlorine water, by Dr. A. **Richardson**. When chlorine water is distilled below 100° C. the distillate contains free chlorine; the residue left in the retort liberates iodine from potassium iodide, bleaches indigo solution immediately and gives the usual reactions obtained with hypochlorous acid. Distillation of chlorine water in a current of chlorine gas shows that the hydrochloric acid formed in the residue is equivalent to the hypochlorous acid found in the distillate, indicating that a portion of the chlorine reacts with the water thus, $Cl_2+H_2O=HCl+HClO$. When chlorine water is heated in a flask provided with a reflux condenser no change in its composition occurs.—A new vapour density apparatus, by Mr. J. S. **Lumsden**. This apparatus is based on the principle that the molecular weights of all substances in the state of gas, when occupying the same volume at the same temperature, exert the same pressure. From the pressure produced by vaporising a weighed quantity of a substance the molecular weight of which is required, the weight in milligrams which would produce the milligram molecular pressure is calculated and taken as the molecular weight.—A new form of pyrometer, by the same. A further application of the principle employed in the foregoing apparatus. A constant volume instrument, made of glass, porcelain or metal, is used, in which a weighed quantity of a substance is vaporised and the pressure measured by a mercury gauge. The pressures produced by equal weights of substances are proportional to the absolute temperatures; therefore, if at two temperatures the pressures produced by equal weights are measured and one temperature is known, the second is determinate.—Tertiary butyl phenol, by Mr. E. W. **Lewis**. The non-formation of phenyl-*ter*-butyl ether when phenol in alcoholic solution is digested with *ter*-butyl chloride and alkali affords an instance of the difficulty attending the preparation of phenyl ethers containing a tertiary radical in place of the hydrogen atom of the phenolic hydroxyl.

Mathematical Society, February 12.—Prof. H. Lamb, president, in the chair.—The following papers were communicated:—Lieut.-Colonel **Cunningham**, On 4ic residuarity and reciprocity. The criterion for distinguishing the plus and minus signs in the congruence denoted, after Dirichlet, by $(q/p)_4 = \pm 1$, is the object of investigation. Reductions of the criterion to convenient forms are given and the properties of the symbol $(q/p)_4$ are developed. Tables are appended giving the quadratic partitions (when possible) of all primes less than 500.—Mr. E. T. **Dixon**, Note on a point in a recent paper by Prof. D. Hilbert. It is pointed out that in the non-Pythagorean geometries devised by Hilbert, Helmholtz's axiom of monodromy is not verified, inasmuch as it is possible, by rotation through four right angles, to bring the points of a line into positions which they do not occupy before the rotation. It is pointed out further that, in the same geometries, it is possible to pass from one point to another of a straight line without passing through all intermediate points and without leaving the line. The application of the name "geometry" to systems which admit such possibilities is criticised.—Mr. H. **Hilton**, Some properties of binodal quartics. Properties of bicircular quartics are deduced from those of spheroconics by stereographic projection, and properties of binodal quartics are then deduced by plane projection.—Prof. A. W. **Conway**, The field of force due to a moving electron. The electron is treated as a point singularity of the electromagnetic equations, and formulæ to express the field of force about the electron, when moving with any velocity, are obtained. The amount of radiation from the electron is calculated.—Prof. W. **Burnside**, An arithmetical theorem connected with the roots of unity, and its application to group characteristics.

Royal Microscopical Society, Annual Meeting, January 21.—The president, Dr. Hy. Woodward, F.R.S., in the chair.—A series of twenty-four photomicrographs in colour was exhibited by Mr. Albert **Norman**, who said the examples shown were an application of the Sanger Shepherd process to medical photomicrography. The examples shown comprised histological and pathological sections, malaria and tse-tse fly parasites, and various bacilli, including tetanus and typhoid showing the flagella.—The **President** delivered his annual address, its title being "Some Ideas on Life," based on the development of life as shown by fossil organisms found in geological strata.

Mineralogical Society, February 3.—Prof. H. A. Miers, vice-president, in the chair.—Mr. L. **Fletcher** gave an account of the fall of a meteoric stone on August 22, 1902, at Caratash, Smyrna, and also contributed a note on the history of the mass of meteoric iron found in the neighbourhood of Caperr, Patagonia.—Mr. H. L. **Bowman** gave the results of determinations of the refractive indices of pyromorphite and vanadinite by means of artificially ground prisms having an angle of about 30°. For red light the refractive indices of pyromorphite were $\omega=2.139$, $\epsilon=2.124$, and of vanadinite, $=2.354$, $\epsilon=2.299$.—Mr. T. V. **Barker** described quartz crystals of peculiar habit which were collected by Lieut. E. G. Spencer-Churchill near De Aar, South Africa. Two crystals were remarkable as exhibiting faces seldom observed on quartz, one face in the zone *mz* and another in the zone *rz*.

Geological Society, January 21.—Prof. Charles Lapworth, F.R.S., president, in the chair.—The figure of the earth, by Prof. W. J. **Sollas**, F.R.S. The almost precise correspondence of great terrestrial features with a circular form seems to be frequently overlooked. The Aleutian curve has its centre in latitude 6° N., longitude 177° W., that of the East Indies about 15° N. and 118° E., and round the latter centre are several concentric curves. The northern part of South America, the Alpine-Himalayan chain, the western shore of North America and a portion of Australia may be similarly reduced to geometric form. A great circle swept through the centres of the East Indian and Aleutian arcs runs symmetrically through the bordering seas of Asia as far as Alaska, borders the inland lakes of America, passes the Californian centre, extends through the middle of the Caribbean Sea, runs parallel with the coast of the Antarctic Continent, and returns to the East Indian centre without touching Australia. This course is in remarkable correspondence with the general trend of the great zone of Pacific weakness. If the pole of this circle in the Libyan Desert is placed towards an observer in a globe, the African Continent appears as a great dome surrounded by seas and separated from the Pacific by an irregular belt of land. A second great circle defined by Lake Baikal, and with its centre at "the morphological centre of Asia" of Suess, and passing through the East Indian centre, may be regarded as the direction-circle for the Eurasian folding. These two centres intersect at an angle of 39°, and, on bisecting this angle, a mean directive circle is found, with its pole near the sources of the White Nile, 6° north of the Equator. The axis of terrestrial symmetry through this pole passes through the middle of Africa and of the Pacific Ocean. The smallest circle which will circumscribe Africa has its centre near this pole, and within it the symmetry of the fractured African dome is observable. Outside this comes a belt of seas, and outside that again the Pacific belt of continents, the Antarctic, South America, North America, Asia and Australia. Mr. Jeans has concluded on mathematical grounds that the "pear-like shape of the earth" might have been possessed by it at the time of its consolidation; and he has suggested that Australia may represent the "stalked end" of the "pear." The author's observations would lead him to place it in Africa, and to regard the Pacific as covering the "broad end."—The sedimentary deposits of Southern Rhodesia, by A. J. C. **Molyneux**. The greater portion of the area of Southern Rhodesia lies on granite and gneiss, and on the schists and slates that contain the auriferous veins worked in ancient times, and now being again opened up on an extensive scale. The remaining area is on sandstone and other sedimentary beds, with coal-deposits and regions of volcanic rocks. To explain the deposition and order of these sediments several sections are given, one being along a line extending from the Zambesi River on the north, through Bulawayo and the central plateau, to the Limpopo River on the south, a distance of more than 400 miles. Another section, with remarks thereon, is copied, by permission, from a report by Mr. C. J. Alford on the coal-bearing rocks of the Mafungibusi District. Three appendices are added; one, on a new species of Acrolepis from the Sengwe Coalfield; a second, on some Lamellibranch Mollusca; and a third, on some fossil plants from Rhodesia.

Zoological Society, February 3.—Mr. Howard Saunders, vice-president, in the chair.—Dr. Walter **Kidd** read a paper describing the arrangement of hair on four mammals, the otter, domestic dog, ox and horse, considered as typical from the point of view of hair-slope. The rising complexity of these phenomena in the four forms was shown to be closely related to their differing habits and environments, and a division was made of adaptive and non-adaptive modifications of hair. It was maintained that the facts dealt with were closely connected with the problems of heredity.—A communication from Captain F. **Wall**, of the Indian Medical Service, contained an account of all the snakes hitherto recorded from China, Japan and the Loo Choo Islands, together with notes on those obtained by himself during the time he was attached to the China Expeditionary Forces in 1900-1902.—Mr. H. J. **Elwes**, F.R.S., read a paper on the variation of the elk, in which it was pointed out that from the author's personal experiences in Norway during six years' hunting he could entirely confirm the observations of Dr. Lönnberg. Specimens showing variation in the antlers of the elk from Norway were exhibited.—Mr. R. **Lydekker** gave a description of the wild sheep of the Kopet Dagh, the range of mountains forming the northern boundary of Persia; this race had been named *Ovis arkal*, in 1857, by Blasius. Mr. Lydekker considered that this animal formed a recognisable subspecies of the Urial, and proposed to call it *Ovis vignei arkal*.—Staff-Surgeon P. W. **Bassett-Smith**, R.N., communicated a paper on three new parasitic Copepoda obtained by Mr. Cyril Crossland in East Africa.—A short paper was read by Colonel C. E. **Stewart**, C.S.I., in which he contended that the tiger was a recent intruder into the Peninsula of India. His reason for believing this was the absence of any Sanscrit word for tiger, and also the absence of any allusion to tigers among many of the older writers.—A communication was read from Prof. Sydney J. **Hickson**, F.R.S., containing a description of a new Hydrozoan obtained by Mr. Cyril Crossland in Zanzibar, for which the name *Ceratella minima* was proposed.—Dr. G. Herbert **Fowler** presented an eighth contribution to our knowledge of the Plankton of the Faeroe Channel, which dealt mainly with the Ostracoda, Copepoda, Amphipoda and Schizopoda captured during a cruise of H.M.S. *Research*, and their horizontal and vertical distribution. Short diagnoses by Dr. Wolfenden of three new species of Copepoda were given.

PARIS.

Academy of Sciences, February 9.—M. Albert Gaudry in the chair.—On the gradual extinction of the motion at the back of an isolated wave, in an elastic medium having a resistance proportional either to the velocity or the displacement, by M. J. **Boussinesq**.—On the equations of motion and the supplementary relation in the midst of a vitreous medium, by M. P. **Duhem**.—Remarks by M. Alfred **Picard** on the first volume of his report on the Exhibition of 1900.—The **President** announced to the Academy the death of M. Lechartier, correspondant for the section of rural economy.—On entire functions of infinite order and differential equations, by M. Edm. **Maillet**.—On functional operations, by M. **Hadamard**.—On a theorem analogous to that of Bobillier, in the case of the rolling of a surface on an applicable surface, by M. G. **Kœnigs**.—Temporary and permanent changes in nickel steels, by M. Ch. E. **Guillaume**. The permanent changes undergone by a bar of nickel steel have been observed over a period of six years, and amounted to about 12 μ. The amount of this change is too great for the alloy to be safely used for the construction of length standards of the first order, but serviceable secondary standards may be made, provided that comparisons with a primary standard are made at intervals.—On the variation of the mean velocity of the wind in the vertical, by M. Axel **Egnell**. The quantity of air displaced in the wind is constant at all heights from 300 metres to 12,000 metres. From this follows the very simple law that the mean velocity of the wind is in inverse proportion to the density of the air.—On a magnetic apparatus serving as a detector for electric waves, by M. G. **Tissot**.—On the disappearance of the radio-activity induced by radium on solid bodies, by MM. P. **Curie** and J. **Danne**. After a certain period the intensity of the radiation follows an exponential law with the time, of the form $I = I_0 e^{-\frac{t}{\theta_1}}$. In general this law is independent of the nature of the radiating body, but for a few substances, of which celluloid is the best type, the activity decreases much more slowly, taking several days to fall to one-half.—On the displacement of the sulphuric acid of alkaline bisulphates by water, by M. Albert **Colson**. From a thermochemical study of the behaviour of solutions of sodium bisulphate the conclusion is drawn that this salt can react with water to give sulphuric acid and the neutral sulphate. An attempt will be made to utilise this reaction on the large scale.—On a new synthesis of orthodiazine, by M. R. **Marquis**. The diazine is obtained by the action of hydrazine hydrate upon maleic aldehyde. On the reduction of the diazine with sodium and alcohol, a small quantity of tetramethylene-diamine is produced, together with ammonia.—On the formation of azo-bodies. The reduction of ortho-nitrobenzyl alcohol, by M. P. **Freundler**.—The oxidation of the acetates of manganese and cobalt by chlorine, by M. H. **Copaux**. The acetates of cobalt and manganese

behave differently towards chlorine; in the first case a complicated chloroacetate of the oxide Co_3O_4 is obtained, and in the second a manganese acetate derived from the sesquioxide.—Study of the action of selenyl chloride upon mannite, by MM. C. **Chabrié** and A. **Bouchonnet**.—The synthesis of anisic acid and paraethoxybenzoic acid, by M. F. **Boudroux**. Monobromo derivatives of phenols react readily with magnesium in the presence of anhydrous ether, and the magnesium compounds produced absorb carbon dioxide. The product of this reaction, treated with hydrochloric acid, gives the corresponding carboxylic acid. Acids have been obtained in this way from anisol and phenetol.—Studies in the pyrane series, by M. R. **Fosse**.—The migration of the methyl group under the action of hydriodic acid, by M. E. E. **Blaise**.—On a new orthocyclohexanediol and its derivatives, by M. Léon **Brunel**.—On two new glucotannoids, by M. Eugène **Gilson**.—On the essence of *Calamintha Nepeta* or *Marjolaine* in the south of France, by MM. P. **Genvresse** and E. **Chablay**. The essence contains pinene, pulegone and a new ketone, calaminthone, the properties of which, together with those of its oxime and semicarbazone, are described. Nascent hydrogen transforms this ketone into menthol.—Morphogenesis in *Salmacina Dysteri*, by M. A. **Malaquin**.—On the presence of glucose in the cephalorachidian fluid, by MM. L. **Grimbert** and V. **Coulaud**.—On the nutrition of *Sterigmatocystis nigra*, by M. Henri **Coupin**. Iron, silicon and zinc are not used for nutrition by *Sterigmatocystis nigra*, zinc even retarding the development. The mycelium is capable of furnishing the acidity necessary for the entire development.—On a disease of the branches of the fig, by M. A. **Prunet**.—On phthiriosis, a disease of the vine caused by *Dactylopius Vitis* and *Bornetina Corium*, by MM. L. **Mangin** and P. **Viala**. The disease is very prevalent in the vine in Palestine. The use of carbon bisulphide injected into the soil is recommended for combating the disease.—On a caoutchouc-bearing plant of the Lower Congo, by M. E. de **Wildeman**. The plant is a new species of Clitandra, resembling *C. orientalis*; it is named *C. Arnoldiana*.—On vegetative activity at the epoch of the Coal-measures, by M. B. **Renault**. From a study of the fossils in coal, it is concluded that the cellular tissues possessed a greater activity of formation than at present, this activity being favoured by an appropriate vascular development.—On a special type of dunes on the borders of the Sahara, by M. B.-P.-G. **Hochreutiner**.—On the reduction of oligiste and magnetite by hydrocarbons, by M. L. de **Launay**.—An experimental contribution to the knowledge of life and muscular reactions, by MM. Ed. **Toulouse** and Cl. **Vurpas**.—On the lifting effect developed by the rotation of helices with vertical axes, by M. Henri **Villard**.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 19.

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

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

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

FRIDAY, FEBRUARY 20.

GEOLOGICAL SOCIETY, at 3.—Annual General Meeting.

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

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

MONDAY, FEBRUARY 23.

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

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Further Explorations in the Canadian Rockies: Prof. Norman Collie, F.R.S.

INSTITUTE OF ACTUARIES, at 5.—Further Remarks on the Valuation of Endowment Assurances in Groups: George J. Lidstone.

TUESDAY, FEBRUARY 24.

ROYAL INSTITUTION, at 5.—Recent Advances in Photographic Science: Sir William Abney, K.C.B.

ANTHROPOLOGICAL INSTITUTE, at 8.15.—Exhibition of Bronze Bells and other Objects from Nigeria: C. Partridge, jun.—Stone Implements from Perak: R. Swan.

SOCIETY FOR THE PROMOTION OF HELLENIC STUDIES, at 5.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Mechanical Handling of Material: G. F. Zimmer.

WEDNESDAY, FEBRUARY 25.

GEOLOGICAL SOCIETY, at 8.—On the Occurrence of Dictyozamites in England, with Remarks on European and Eastern Floras: A. C. Seward, F.R.S.—The Amounts of Nitrogen and Organic Carbon in some Clays and Marls: Dr. N. H. J. Miller.

SOCIETY OF ARTS, at 8.—Tonkin, Yunnan and Burma: F. W. Carey.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Discussion on the Panama Canal and the Introduction of Yellow Fever into Asia, to be opened by Dr. Patrick Manson, F.R.S.

UNIVERSITY COLLEGE CHEMICAL AND PHYSICAL SOCIETY, at 8.30.—The Attainment and Measurement of Low Temperatures: Dr. M. W. Travers.

THURSDAY, FEBRUARY 26.

ROYAL SOCIETY, at 4.30.—Bakerian Lecture: Solid Solutions and Chemical Transformation in the Bronzes: C. T. Heycock, F.R.S., and F. H. Neville, F.R.S.

ROYAL INSTITUTION, at 5.—Insect Contrivances: Prof. L. C. Miall, F.R.S.

SOCIETY OF ARTS, at 4.30.—Gleanings from the Indian Census: J. A. Baines.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Nernst Lamp: J. Stöttner.—And, *if time permit*, Distribution Losses in Electric Supply Systems: A. D. Constable and E. Fawssett.—A Study of the Phenomenon of Resonance in Electric Circuit by the Aid of Oscillograms: M. B. Field.

FRIDAY, FEBRUARY 27.

ROYAL INSTITUTION, at 9.—Perfumes: Natural and Artificial: Dr. A. Liebmann.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Relative Advantages of Single Screws, Twin Screws, and Triple Screws, for Marine Propulsion: E. Falk.

SATURDAY, FEBRUARY 28.

ROYAL INSTITUTION, at 3.—Light: Its Origin and Nature: Lord Rayleigh.

CONTENTS.