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THE ELEMENTS OF PHYSICS.

The Elements of Physics. By Edward L. Nichols and William S. Franklin. Vol. i. Mechanics and Heat. Pp. x + 228. Vol. ii. Electricity and Magnetism. Pp. ix + 272. Vol. iii. Light and Sound. Pp. vii. + 201. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1896.)

THE title and contents of such a work as that before us open up many questions regarding physical theory and its presentment, on which every teacher must hold more or less strong views resulting from his training and experience. Hence, in reviewing it, the temptation to discuss particular points rather at length is almost too powerful to be resisted, and perhaps need not always be overcome. If then, in what follows, there is any noticeable tendency of this kind, it is not to be supposed that the pronouncement of the authors is necessarily objected to; but that some passage or other has suggested what may appear to be rather a digression.

The authors have endeavoured to give a short and clear account of the various quantities in the subjects of Mechanics, Heat, Electricity, Optics, and Acoustics, which are capable of exact measurement. Of course, within the limits of space assigned, a full theoretical discussion is impossible; but each concept is carefully explained, and an indication is given of how its numerical magnitude can be determined. The work is in our opinion a thoroughly sound and satisfactory introduction to the science of physical measurements.

Volume i. begins with a chapter on Length, Time, and Mass. It includes an account of such length-measuring instruments as the scale and vernier, cathetometer, dividing engine, and spherometer, and of instruments for weighing and the measurement of time. These discussions are merely in skeleton, and must be supplemented as regards both the theory and the use of the instruments by reference to more exhaustive special treatises.

With regard to the measurement of time, variation in the amplitude of vibration of a clock-pendulum ought, as the authors say, to be avoided as far as possible by making the gear and escapement of fine workmanship, and no sensible alteration of the rate of a clock ought to be allowed to arise from such a cause. Since, however, the word "pendulum," as used by the authors, appears to include the balance of a pocket chronometer or watch, it would have been well to point out here that, in such a case, large variations of amplitude with changes of position of the chronometer cannot be avoided, and to mention the interesting fact that practical equality of period is, in such circumstances, secured by carefully adjusting the balance-spring to the exact length for which the long and short vibrations are most nearly isochronous. We may refer, in connection with this very important subject, to a valuable, though apparently little known, memoir by M. Phillips in *Liouville's Journal*, Sér. ii., Tome v. (1860), in which the Breguet form of balance-spring, with its peculiarly curved over-coil, now generally adopted in compensated chronometers, is arrived at as a result of mathematical calculation.

The chapter on Physical Quantity contains a very short account of the Dimensions of Derived Units. The exact meaning and force of a dimensional equation are of great importance, and a page or two of additional space might with advantage have been devoted to this subject, at the expense, if need were, of the explanation of vector-products which comes immediately after, and which, so far as we have observed, is not called into active service subsequently in the book.

The authors rightly devote a little space to making clear exactly what is meant by the equality of action and reaction asserted in the third law of motion. It is curious that the most essential point is not more emphasised in elementary text-books of dynamics, namely, that the action and reaction, which are equal and opposite, and which act across the same cross-section of a wire or rod, or across the surface of contact of two links of a chain, and which the ordinary learner often thinks ought to cancel one another, are opposite forces *acting on different portions of matter*, and therefore do not annul one another, unless the rate of change of momentum of a system including both portions of matter is under consideration.

It is remarkable that the paradoxer who insists on making the mistake here indicated, and supports his views with so much nonsensical rigmarole, mixed up with wild talk about conspiracies of mathematicians to defend the views of Newton, never commits a similar error in financial matters! He does not consider the handing over of a sum of money by one person—himself, for example—as cancelled by its receipt by another person. Yet the two aspects of this transaction (like the forces which are the two aspects of a stress) are equal and opposite; but they affect different persons, and he sees clearly enough that one cannot be regarded as annulling the other, unless the question is as to the total sum of money possessed by the two persons concerned.

We may remark that it does not seem clearly brought out in connection with the experiments of Galilei, mentioned on p. 36, that what was proved by his famous experiments on bodies let fall from the top of the leaning tower of Pisa to the pavement beneath, and also by Newton's pendulum experiments, was the proportionality of the gravities of different bodies to their inertias. Hence the experiments show that when the masses of bodies are measured by their inertias, the results are equivalent to those obtained by the process of weighing.

In this chapter the authors call a velocity of one centimetre per second a "kin." There is undoubtedly an advantage in having names for the units of quantities which are apt to be confounded; but velocity and acceleration are both so fundamental conceptions as to make it imperative on the student to completely master their meaning and the manner in which they involve the fundamental units, if he wishes to make any progress at all; and we question if there is any real want of names for their units.

Equation (48) on p. 50, expresses a result in simple harmonic motion which is one of the few formulæ in

physics it is desirable to carry in the memory for instant use. It would be more portable if made explicitly kinematical by being reduced to the form

$$\frac{\text{acceleration}}{\text{displacement}} = \frac{4\pi^2}{T^2},$$

where, on the left, numerical values without regard to sign are understood. The introduction of the mass m of the vibrating particle, together with a quantity a, which is the product of m by the positive numerical value of the acceleration, seems an unnecessary complication.

The authors give in Chapter vi. an excellent elementary account of stress and strain. Everything is clearly and concisely stated, and a student seeking an accurate quantitative outline of the subject as a starting-point for a more complete study of experimental elasticity could hardly find anything more satisfactory.

We note in this chapter the use of the form "elotropy" for "eolotropy" (or, better, "æolotropy") to denote difference of elastic quality in different directions in a body. It seems hardly allowable to adopt this spelling in view of the derivation of the first part of the word from αἰόλος, meaning *quick-moving*, *changeful*, *variegated*.

It is of considerable experimental importance to point out that what the authors call the constant of torsion of a wire (that is, the torsional rigidity) is calculated on the assumption of perfect circularity of cross-section, and further involves the fourth power of the radius of the wire; so that it is hardly possible to draw from oscillation experiments exact conclusions as to the value of the rigidity-modulus of the material.

The definition of perfection of elasticity, on p. 102, seems hardly guarded enough. A body may, after the removal of stress, return to precisely its former configuration, so far as that can be tested at least, and yet be subject to imperfections of elasticity. Let the body be subjected to increasing stress, and let the successive configurations be noted; then let the stress be gradually altered back again to the former value, and the configurations in returning be again noted. If the configuration corresponding to a given value of the stress be the same during the removal of the stress as during its imposition, the body is perfectly elastic, but not otherwise. If the configurations and stresses be represented graphically, the curves for the transition from initial to final stress may not coincide with that for return from final to initial stress, and energy will be dissipated (in consequence of imperfection of elasticity), the amount of which can be estimated from the area enclosed between the two curves.

The next chapter (vii.) deals with Hydro-Mechanics, a subject the extent of which must have been very embarrassing to the authors, considering their plan, and the amount of space at their disposal. On the whole, they have given a fair account of leading principles, and especially of those of capillarity and viscosity; and we have in these all the merits of treatment that mark the rest of the work.

In the remarks in this chapter on the experimental verification of Boyle's law (Mariotte's or Boyle's law the authors call it !), there is no reference to what constitutes the real divergence of gases, such as nitrogen, oxygen and hydrogen, from fulfilment of this law. In fact, it is stated that for a gas the "loss of volume is greater than would be expected from Mariotte's law, the divergence from inverse proportionality increasing as we near the point of condensation." But, as no doubt the authors are fully aware, deviations from fulfilment of Boyle's law are not confined to gases which are in "an intermediate condition preparatory to liquefaction," but are found also in true gases—gases, that is to say, which are far above their critical temperatures. The researches of Regnault, and the later and much more extended investigations of Amagat, which have given us most complete and interesting information as to how far "true gases" conform to Boyle's law, are of great importance from the point of view of kinetic theory, and should surely have been noticed here.

The account given in Art. 192, p. 136, of efflux of liquid from an orifice in a vessel, seems to require amendment, which should also be extended to Art. 193. As a matter of fact, the pressures at the outside of the jet and at the free surface are practically the same, so that $p - p_1$, instead of being equal to xdg, is really zero. Also, though this is a small matter, it would seem better to use ρ than d to denote density; as expressions like dv^2, dg, are instinctively associated with other meanings than those intended.

Passing now to the part of the book which treats of Heat, we are glad to see so excellent an account of the subject of temperature. It is short, and seems to be correct; which is more than can be said of nine out of ten of the discussions in text-books on this very important subject. Of the fact that thermometers made with different kinds of glass, and graduated with absolute accuracy, will agree at the temperatures of reference, 0° C. and 100° C., and will agree nowhere else, the majority of text-book writers seem to be in blissful ignorance. Nothing is more confusing than the customary proceeding (much followed by a certain class of writers on thermodynamics !) of defining temperature on a mercury-in-glass thermometer, sometimes with ignoration of the expansion of the vessel, sometimes not; but always with the further erroneous statement that the increase of pressure of a gas kept at constant volume is the same for each degree of rise of temperature on this scale, a "fact" which is supposed to express the law of Gay-Lussac. It does not occur to such writers that, if Gay-Lussac's law were to thus hold for one thermometer, it could not hold for other thermometers made with different kinds of glass, and therefore having different scales. And, unhappily for those who define their scale of temperature with regard to the absolute expansion of mercury, with or without nonsense about mercury being "chosen on account of its uniform expansion," the divergence of the air-thermometer from such a standard is much greater than from a thermometer constructed with ordinary glass.

The vicious circle thus introduced into the definition of the standard scale of temperature, and the failure to regard the air-thermometer scale and the absolute thermodynamic scale of temperature as each derived from its own independent definition, is responsible for much of the prevalent haziness in the application of the fundamental principles of heat and thermodynamics.

These mistakes are avoided in the book before us; but we cannot help thinking that the part of the book which deals with thermodynamics would have been improved by a somewhat different order of treatment. The first real step in thermodynamics should always be a discussion of Carnot's heat-engine and Thomson's definition of absolute temperature. Then, all about the behaviour of gases, and the deviation of temperature as defined on the air-thermometer from absolute thermodynamic temperature, could have been told, we think, much more effectively. As it is, Joule and Thomson's experiments, which we are informed were made for the purpose of deciding whether there is any sensible attraction between the particles of a gas, are mentioned only once in the book, and that long before the scale of absolute temperature is referred to. The most important part of the significance of this investigation is really lost unless its bearing on the realisation of absolute temperature is fully pointed out. We may have unduly emphasised this omission; but we are sorry a book, so generally good as this is, should have in any degree missed an opportunity of insisting on absolute temperature and all that thereto relates, as the first and fundamental thing, we had almost said the only thing, in thermodynamics.

The second and third volumes of Messrs. Nichols and Franklin's book, which deals with Magnetism and Electricity, we have but little space left to deal with. But we may say at the outset that, good as the first volume seems to us to be, these seem quite up to the same level.

In vol. ii. a short and satisfactory account of Galvanometry is given under the heading of Electrolysis and Batteries. The laws of electrolysis are stated, and some space is devoted to a discussion of the Energy Theory of the Voltaic Cell, though not more than or even quite as much as the importance of the subject deserves. In the sketch of the thermodynamics of the voltaic cell the phrase, "sweeping processes performed by the current," strikes one as quaint, to say the least. The "sweeping process" is not performed by the current at all, but by Messrs. Nichols and Franklin when they draw an indicator diagram to represent a certain part of the work done by the current.

The book is brought up to date by an account of the kathode discharge within a Crookes' tube, and of Röntgen's discovery. This chapter contains, besides, a very brief account of the discoveries of Hertz.

Practical Applications are dealt with in a chapter mainly devoted to Electric Signalling. The usual telegraphic devices are described; but none of the vexed questions on this subject are gone into. The authors, however, do say that the so-called KR law holds for telephonic signalling as well as for submarine telegraphy, which is, to say the least, a rather inadequate statement.

A chapter on Mechanical Conceptions of Electricity and Magnetism completes the second volume. The idea adopted is that the ether in a magnetic field has a cellular structure, and that these cells have a rotational motion about axes parallel to the direction of the field at each point, while the lines of electric force are marked by displacement of these ether-cells—the positive in one direction, the negative in the opposite. There are, of course, serious difficulties in this mode of regarding what takes place; so much so, that there seems now rather a consensus of opinion in favour of the view that the direction of magnetic force is that of flow of the ether regarded as a perfect fluid. Such questions, however, the authors, probably from want of space, do not discuss.

Volume iii. begins with a statement of the distinction between light and sound as cases of wave-motion, and a comparison of the methods of determining their velocities of propagation. Then follows an account of wave-motion with the usual theorems on composition of vibrations, constructions for wave-fronts of reflected and refracted waves, Huyghens' zones, &c. The succeeding chapters deal with the theory of mirrors and lenses, treated, as they always ought to be in a physical book, by means of considerations of wave-propagation and the principle of equal optical distances. The old rule, convenient for use in the approximate fashioning of glass lenses, might have been noticed at p. 47, that the radius of the opening of a convex lens is nearly (for index of refraction 1·5) a mean proportional between the focal length of the lens and its thickness.

The chapter on Dispersion (prismatic) strikes us as capable of considerable expansion. The conditions for obtaining a pure spectrum do not seem to be stated, except in so far as they are given more or less implicitly in connection with the spectroscope. In preparation for this an elementary account of primary and secondary focal lines might be added to the chapter on lenses, and the reason for placing the prisms of a spectroscope in the position for minimum deviation explicitly brought out.

The account of double refraction we find unexpectedly short. Refraction in uniaxal crystals is alone treated, Huyghens' construction is given for the single case of Iceland-spar, and there is no notice of the other typical case, that of quartz.

But the most serious omission in this volume, perhaps in the book, is that of any adequate discussion of magneto-optic rotation. Article 754 is devoted to "Rotation of the plane of polarization; the saccharimeter," and Art. 755 (rather more than half a page) deals with magneto-optic rotation. The latter subject is not discussed in vol. ii., and we had expected to find in vol. iii. an account of phenomena, of the very important absolute determinations of Verdet's and other constants that have been made, and of the applications of the knowledge so obtained in magnetic research. As it is, six lines are given to rotation of the plane of polarised light in bisulphide of carbon, and the remainder to a photo-chronograph, which, though ingenious and valuable, hardly in the circumstances should have had so relatively large a part of the available space devoted to it.

In our account of this work we have referred to a number of points in which, as it appears to us, it could be improved and amplified without seriously adding to its bulk. The number of such points may seem rather large, but in this it is like every other treatise on its first appearance; and we hope that the authors will believe that the statements above are not made in any carping spirit, but rather as marking appreciation of what is, within its scope and purpose, really an excellent work.

A. GRAY.

THE IRISH DOLMENS.

The Dolmens of Ireland; their Distribution, Structural Characteristics, and Affinities. By William Copeland Borlase, M.A. 3 vols. Pp. xxxvi + 1234. (London: Chapman and Hall, Ltd., 1897.)

THIS work is divided into four parts: a descriptive topographical catalogue of the Irish dolmens; a discussion of the classification and distribution of dolmens in general; a collection of the popular lore relating to the Irish examples; and an ethnological investigation of the subject.

Until the long-desired official survey of British archæology is carried out, we can hardly look for the compilation of a perfect list of dolmens or of any other remains of the kind. At present a student has to be content with the Ordnance maps—from the archæological point of view most unsatisfactory documents—and with the often inadequate and unscientific writings of previous workers. Mr. Borlase has made the best possible use of this imperfect apparatus; but the Ordnance maps have misled him into including an uninteresting microlithic cairn at Baltinglass among the Wicklow dolmens, and into omitting an example at Donard in the same district: while it is something of a disgrace to Irish archæologists that for an account of the very remarkable structures at Breastagh and Rathfran, in Mayo, he has had to depend on Cæsar Otway's worthless gossip. Notwithstanding these and similar more or less unavoidable inaccuracies, the first part of this book is a useful contribution to archæological literature; indeed, it is almost a pity that Mr. Borlase did not content himself with publishing Parts i. and iii. together, omitting the speculative portions of the book, which overload it and are sufficiently independent of its subject to form a separate work. Four excellent maps show the distribution of the recorded dolmens in each of the provinces of Ireland; but their value would have been enhanced by the use of different marks to distinguish dolmens of different types from each other and from chambered tumuli.

The second part consists of a conspectus of the dolmens of Europe and Asia, resembling the well-known bird's-eye view in Fergusson's "Rude Stone Monuments," but much more full and up to date. It reveals, however, how much has still to be done in elementary field-work on the prehistoric remains of the continent.

Part iii. is of considerable value. It consists of a careful classification of the names attached to various Irish monuments and the popular lore concerning them. Here Mr. Borlase has made full use of the Ordnance Survey Letters, now so long left unpublished by the deplorable parsimony of the wealthiest of Governments. Not the least valuable part of the work consists in the long extracts from these MSS., here for the first time edited. It is not, however, to be expected that all Mr. Borlase's statements will command acceptance. His view, somewhat obscurely set forth[1] on p. 758, that a reference to *cats* in the name of a monument has no connection with the animal, but means that the object has a hole in it (*cuthe*, a pit), is negatived by one of his own examples—Kit's Coty House, which has no such hole, except one left by the natural irregularity of the central stone: nor is there any hole in the ring-fort known as *Cathair na gcat* at Ballywiheen, in Kerry. It is not necessary, as the author does (p. 769), to make a pagan word of *leaba* "a bed" (in the sense of "grave"); on Aran we have *Leaba Brecain*, *Leaba na seacht naomh*, and the strangely named *Leaba an Spioraid Naoimh*. On p. 842 the author repeats one of the most extraordinary blunders made in recent anthropological research—the assignment of a high index of nigrescence to the west of Connacht and Kerry.

Ireland is no exception to the rule that the antiquities of a country cannot be properly investigated without a preliminary study of its language. An experience narrated on p. 846, shows that Mr. Borlase has not gone through this desirable preparation. For two reasons this is regrettable: popular lore would be much more accessible to him; and some of his amazing blunders in writing Irish names and words would have been impossible. Such a sentence as the following—supposed to be addressed to a child—could not have been passed without a feeling of discomfort—

Eist a laogh (!) agus cuiramag (!!) diotal (!) air an Garran (!) ban (!) dhuil (!!)[1]

The eccentricities of this sentence exemplify what is a very serious fault throughout this book—its typographical inaccuracy, which is little short of disgraceful to printer, publisher and author. Mr. Borlase speaks in his preface of the "desperate monotony" of proof-reading: but this monotony is the common lot of all authors, and affords no excuse for "Sir S. Fergusson," "O'Curr*ie*," "Hissar*l*ik," "paals*l*ab" (four times, pp. 675–80), "poletax" (p. 1090), "culminator" (for calumniator, p. 1046), &c.

In the fourth part of the book the author discusses at considerable length the physical features of the inhabitants of different districts in Ireland, with reference to the characteristics of other races. He begins with the skulls, comparing them with all European varieties, from the Neanderthal downwards. On the whole this part of the work is unsatisfactory; it is inaccurate in some places, out of date in others; and most of the pictures of skulls are very bad. For instance, it is a pity that the author speaks (pp. 979 *sqq*) of Irish "long-barrow" skulls; for no such thing has hitherto been described. Both the Trillick and Tily Hole specimens have been posthumously deformed, and they are thus more than doubtful analogues of the English long-barrow type. The Aylesbury Road mound, on which Mr. Borlase lays much stress, is an equally unfortunate example; for, in the first place, Prof. Macalister, of Cambridge, who exhumed many and examined all of the remains there found, is positive that "no one familiar with the long-barrow race could ever confound a single skull from this heap with the long-barrow type of skull"; and, in the second, it is questionable whether the Aylesbury Road massacre, which has been so luridly depicted for us, is a historical event at all, for there is no reason for regarding the mound as anything less prosaic than a mediæval plague-

[1] A fault not confined to this one passage: the book is sometimes difficult to follow from the imperfection of the English style, and the frequency and length of the digressions. On pp. 1056–7 is one portentous sentence, unbroken by any stop heavier than a comma or dash, thirty-four lines long!

[1] It ought of course to be something like this—*Eist a laoigh, agus cuirfead diallaid air* (better *ar*) *an ngarrán bhán duit*, "Hush, calfie, and I'll put a saddle on the white nag" (not white *mare*, as Mr. Borlase renders it) "for you."

pit. It is curious that Mr. Borlase calls the Armoy skull (p. 993) dolichocephalic with an index of 0·77 ; the limit of dolichocephaly usually adopted is 0·75.

After touching on nigrescence and other physical features, Mr. Borlase concludes his work with a dissertation on the Invasion Saga-group of the Irish manuscript romances. It will be observed that he has practically left the dolmens : but his thesis is that the dolmens and all the other tangible remains of prehistoric Ireland have nothing to do with the extant legends. With singular ingenuity Mr. Borlase develops a two-fold theory about these writings : first, that they are a barbaric version of the historical *Volkswänderung ;* and, secondly, that they are native to the south coast of the Baltic, being only Irish in the sense of having become naturalised there. Conaing's tower on Tory Island is razed, to be rebuilt on Rügen ; and all the other sites and scenes are transported in a manner equally calculated to disturb the repose of the honoured ghosts of Keating and the Four Masters. Clearly this novel theory leaves all Irish remains unaccounted for by divorcing from them the legends which, in some measure, fit them with tolerable accuracy ; and transfers the legends to a soil where there are neither tangible remains, nor local folklore, with which they can be compared. It would be easy to pick holes in some of Mr. Borlase's etymologies, such as the suggested connection between Partholan and the Lombards, which reminded us of nothing so much as the schoolboy's correlation of eel-pie with a pigeon : but space forbids our saying more than that we do not believe the last word has yet been said on the mystery of the Irish romances.

We have read these three handsome volumes with interest and pleasure, not unmixed with regret that a little more judicious pruning was not employed in both letterpress and illustrations. Many of the pictures of dolmens might as well have been omitted, since in the absence of plans they are useless.[1] The money thus saved would profitably have been expended in improving the quality of the remaining cuts, and in remunerating a competent proof-reader.

One more complaint in conclusion. Why does Mr. Borlase—a scientific archæologist—speak of the Clonmel tragedy of two years ago as a witch-burning case ?

R. A. STEWART MACALISTER.

HUMAN EMBRYOLOGY.

Human Embryology. By Ch. S. Minot, Professor of Histology and Human Embryology, Harvard Medical School, Boston. Pp. xxiii + 815. Large 8vo. (New York, 1892. English edition : Macmillan and Co., Ltd., 1897.)

IT is now five years since the publication of this work in America, but it is not to be supposed that because the science with which it deals has all the while been making rapid progress, it is on that account to be regarded as already out of date. For the nature of the book is of such a character as to constitute it a permanent work of reference in the subject ; in which respect, although not in its scope and intention, it resembles closely the comparative embryology of Francis Balfour.

This is not the place to enter into a discussion of any of the immense mass of details which Prof. Minot has accumulated in his work, which he himself confesses to have occupied ten years of his life, nor would the space at my disposal enable me to do so, except in a most inadequate manner. Suffice it to say that there is no part of the subject which is not treated by the author in the most complete manner possible within the limits of a text-book. Beginning with an account of the structure of the uterus in its varying functional conditions, the history of the sexual elements, and a discussion of theories of sex and heredity, the author attacks the main subject of the work by an account of the segmentation of the ovum and the formation of the germ layers. The formation and destination of the primitive embryonic organs, the origin of the blood and blood-vessels, of the urogenital system, and of the archenteron are next treated of, and then follows a most important section of the work, in which the human embryo is dealt with as a whole, and followed through all its known stages. Accompanying this account is a complete and original description of the appendages of the ovum and their relation to the uterine wall. Finally the development of each tissue and organ is separately dealt with ; and not only the changes of form, but the histogenesis of the organs also—a subject often left untouched in text-books of embryology—are considered in abundant detail. Each chapter—almost each page—is a mine of information, so that the book will be an essential companion of every one who may be working at vertebrate embryology. For although the author has not departed more than was possible from the scope of his work as indicated by its title, there is so much that is common in the development of all vertebrates that much of our knowledge of human embryology is primarily founded on facts observed in other mammals, and even in lower vertebrates, and reference must necessarily be constantly made to these.

The subject is so big, that it is obviously impossible for any one during a much longer period than ten years, and even if he should be in possession of the needful material, to attempt to give any account of it which shall be based upon his own investigations. Short of this, however, he may in many cases verify the statements of others ; and when this does not prove possible, he may at least subject them to so critical an examination as to lend an additional value to them by reason of the stamp of his criticisms. These two processes Prof. Minot has very fully carried out in each subject which he has dealt with ; and when to this statement it is added that some parts of the subject are based wholly upon the author's investigations, it will be seen that, exactly as with Balfour's book above referred to, there is a colour of originality pervading the whole work, which greatly tends to enhance its value.

Prof. Minot obtained his training in embryology and in the allied biological sciences mainly in German schools, and he is naturally thoroughly imbued with German methods of expression. This does not, however, in my opinion, justify him in bodily transferring German terms into the text of an English book without any attempt to furnish either an English equivalent, or an

[1] A perspective sketch, or photograph, of any structure is of little or no (generally no) value without a plan. We trust that all promoters of photographic surveys realise this.

equivalent easily coined according to the convenient and acknowledged methods of scientific word-making from the Greek or Latin. One gets accustomed to such a word as Anlage, which is in constant use throughout the book, and after a time begins to forget that it ever was anything but pure English; but I confess to being still somewhat staggered whenever I come across such phrases as that leucocytes "are transformed into *Bildungsgewebszellen*," that certain fibres are "situated in the Randschlier of the dorsal zone of His," and, only two lines further, that "the Rautenlippe during the fifth week buries the solitary tract." Prof. Minot belongs to a University which justly boasts having produced writers of as good and as pure English as can be met with anywhere, and he has himself a clear and trenchant style. It seems a pity, therefore, that he should not have stuck to his own language, or, as an alternative, he might have written his book wholly in German. It is no doubt sometimes difficult to get a good short equivalent of some German expressions, which include the meaning of a whole sentence in a single word; but the same difficulty has been met and combated successfully by other writers; and even if one has to resort to a phrase of two or three words to express in English the idea which one compound German word will imply, it is better, it seems to me, to adopt this plan than to intercalate into an English sentence foreign words, which can only be properly understood by those who are very familiar with the tongue they are written in. Your French scientific writers are never guilty of this fault—they have too much respect for their own language; but the practice is not an uncommon one with English and American scientific men, and ought, in my opinion, to be resorted to either not at all or only on the rarest possible occasions.

This is, however, a very minor fault, and one which in no way affects the scientific value of the book. And it is no exaggeration to say, in spite of the modest manner in which the author introduces his treatise to the public in the preface, that the work before us constitutes a monument of erudition in the difficult and complex subject of which it treats. E. A. SCHÄFER.

OUR BOOK SHELF.

Catalogus Mammalium tam viventium quam fossilium. A Doctore E. L. Trouessart, Parisiis. Nova Editio (Prima completa). Fasciculus I. Primates, Prosimiæ, Chiroptera, Insectivora. Fasciculus II. Carnivora, Pinnipedia, Rodentia I. 8vo. (Berolini: R. Friedländer und Sohn, 1897.)

A NEW catalogue of Mammals is much wanted, and will be of great use to the many workers in that group of animals. This important branch of the Vertebrata appears to have been rather neglected by the authorities at the British Museum, who have recently issued many excellent volumes on the Birds, Reptiles, Batrachians and Fishes in the National Collection, but have done little work on the recent Mammals, although they have catalogued the fossil members of the group. We are glad, therefore, that Dr. Trouessart has taken up the subject, although he merely gives us a systematic list of names and localities, without any descriptions. Two parts of his "Catalogus Mammalium" are already issued. The first contains the Primates, Prosimiæ, Chiroptera and Insectivora; and the second, the Carnivora, Pinnipedia and the first portion of the Rodentia (Protrogomorpha and Sciuromorpha). We presume that a third part will finish the work. Up to the end of the second part, Dr. Trouessart, who includes both recent and external forms, has catalogued 1294 species. Of each of these the principal references and synonyms are given, and a short list of localities. We venture to think that it would have been better if the names of the recent and fossil species had been a little more clearly distinguished in the type. The fossil mammals are only recognisable in the present work by the "dagger" placed before the name, which may be easily overlooked. In most respects, however, the work appears to have been performed in a satisfactory manner, though it would not be difficult to point out a certain number of slips and errors. We have, nevertheless, no doubt that the volume when complete will be of much use for reference, and will supply a quantity of much needed information.

Essais sur la philosophie des Sciences Analyse-mécanique. Par C. de Freycinet, de l'Institut. (Paris: Gauthier-Villars, 1896.)

TREATISES of this nature are popular in France, to cite only the "Réflexions sur la Métaphysique du Calcul Infinitésimal" of Carnot, and the "Méthodes dans les Sciences de Raisonnement" of Duhamel; the only English equivalent would be Jevons's "Principles of Science."

M. de Freycinet has employed the leisure of the arduous duties of a Minister of War, in writing these essays, in which a philosophical view is taken of various sciences, treated in ordinary language, and addressed to cultivated minds. In the deep concentration now required in the specialisation of science, books such as this will prove very valuable to give the worker, too much absorbed in his own subject, a general perspective glance of what others are doing, devoid of all repulsive technicalities. We find on p. 158: "Il ne suffit pas d'avoir la notion claire de la masse. Il fait aller plus loin. Pour les besoins de la Dynamique il est nécessaire de *Savoir* chiffrer les masses;" . . . and again on p. 162, "Une quantité d'eau peu inférieure a 10 décimètres cubes, soit 9 litres 8088 . . .; le nombre habituellement désigné par la lettre g; voila l'unité de masse."

This will please Prof. Perry; and it is the definition of Euler, Lagrange, Laplace, Poisson, &c.; but, as a recent discussion has shown, the definition is considered heretical in certain educational quarters.

The Metric System is not absolutely sacred, even to a former Minister of France. M. de Freycinet brings forward, on p. 186, his proposal to shorten the metre, or rather to make g at Paris the unit of length, the sexagesimal second being the unit of time; while others would make the seconds pendulum at Paris the unit of length. G.

Wild Flowers of Scotland. By J. H. Crawford, F.L.S. Pp. 228. (London: John Macqueen, 1897.)

A NUMBER of people object to an abrupt introduction to nature; they prefer to flit around her like a butterfly around a flower, merely to take a casual glance at different aspects. To confront people of this temperament with a bare fact would be to destroy the interest—aimless though it be—they have in science. Wherefore such books as the one before us are written—books in which pretty things and picturesque scenes are viewed "in contemplative fashion" and poetic state of mind. The present work is not without a value; for it certainly teaches something about a few of the wild flowers of Scotland, but we fancy it will be read more for its easy style of composition than for the facts it contains.

The Science of Speech. By Prof. Alexander Melville Bell. Pp. 56. (Washington, D.C.: The Volta Bureau, 1897.)

THE purpose of the author of this work is to define the actions of the mouth and the vocal organs in the production of speech, and express them by a species of

phonetic nomenclature. Thirty-six vowel sounds are developed by labial modifications of sounds produced with definite positions of the tongue and certain size of the cavity of the mouth. The cause of the differences between vowels and consonants is explained, and the mechanism of distinct utterance is expounded. Teachers of languages and elocution may find the book of service for instructing their pupils how to arrange the tongue and lips in order to speak with correct accent.

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.*]

Bipedal Locomotion among Existing Reptiles.

I COMMUNICATED to NATURE of February 27, 1896, and elsewhere, details with accompanying figures concerning the bipedal locomotion of the North Australian Frilled Lizard *Chlamydosaurus Kingi*, and which, with reference to such method of progression, apparently occupied a unique position among existing reptilia. As the result of a more recent investigation, I have discovered that a corresponding bipedal gait is assumed under favourable conditions—*i.e.* when running across a wide expanse of smooth and level ground—by the handsome Australian water lizard, *Physignathus Lesseuri*, such method of progress being most conspicuously manifested by the young and slender individuals. I have also ascertained that a similar mode of locomotion is adopted under like conditions by *Amphibolurus muricatus*, and I am inclined to anticipate that it will be found to obtain among many other of the Australian, and possibly African, Agamoid lizards that share with the foregoing species a relatively excessive development of the hinder limbs.

A like bipedal formula of locomotion has been hinted at, though not yet demonstrated, in the case of the Mexican Iguanoid, *Corythophanes Hernandesyi*, and will possibly be found to be shared by many allied members of the same family that present in common with it a corresponding superficial structural parallelism with the typical Australian Agamidæ. The discovery here recorded is submitted with the main object of indicating that the bipedal locomotion of Chlamydosaurus can no longer be regarded as a mere specific idiosyncrasy. The fact of its being shared by other widely differing members of the same Agamoid group, together with the circumstance of, as in the case of Physignathus, its being most prominently manifested in young individuals, would appear to indicate that the habit has been inherited from a race that possessed yet more essentially bipedal progressing proclivities. Reserving fuller details for a future communication. W. SAVILLE-KENT.

Wallington, Surrey, July 18.

Sensitiveness of the Retina to X-Rays.

Is it not possible that the persistence of an image on the retina is due to phosphorescence? This would at once explain the sensitiveness of the retina to X-rays.

The curious phenomenon of the image moving in the opposite direction, observed by Mr. Harrison (p. 248), is no doubt due to the rays passing through the lens without being refracted; the effect of the image becoming larger, is also the result of the same cause. All objects to become visible must, therefore, be smaller than the retina. ERNEST BRAUN.

42 Henslowe Road, East Dulwich.

Sample-Post for Natural History Specimens.

IN the issue of NATURE for June 17 (p. 159) it is stated that, at the recent Postal Congress held at Washington, it was decided that natural history specimens, not sent for commercial purposes, were to be permitted to pass by Sample Post between the countries of the Postal Union.

Permit me to mention that I have been informed by the Secretary to the Post Office, that the Convention giving effect to that decision does not come into operation until January 1, 1899. WALTER F. H. BLANDFORD.

July 15.

AUSTRALIAN NATURAL HISTORY.[1]

WHETHER designed or accidental, it is a fortunate circumstance that this sumptuous volume—a real *édition de luxe*—makes its appearance at a time when the most remote portions of the British Empire are being brought into closer connection with the mother country. At such a time everything that tends to promote a more intimate knowledge of the natural products of our colonial dependencies deserves a hearty welcome at the hands of all interested in the expansion and unification of the greatest empire the world has ever seen. On these grounds, to say nothing of others, Mr. Saville-Kent and his enterprising publishers are to be congratulated on the appearance of the work before us. As an attractive volume for the drawing-room table, it would be hard to equal anywhere; the beauty of its illustrations, whether in the form of coloured plates or of collotypes, being above praise, and calculated to arrest the attention of many of those who have hitherto cared little or nothing for the products of tropical and subtropical nature. Indeed, the two chromos of coral-reefs at low water, one of which forms the frontispiece, while the other illustrates the chapter on Houtman's Abrolhos, may well make every reader long for the opportunity of beholding scenes of such transcendent loveliness.

For the production of such a work the author is fortunately gifted with endowments denied to many of his fellow naturalists, for, as we learn from the legends to the chromos, he is not only an accomplished artist with the brush and pencil, but diligent practice has made him no less successful with the camera. And as a consequence of this, one of the striking features of the work is a series of life-like portraits of many Australian animals in attitudes as unlike those given in ordinary natural history books as it is possible to conceive; the one being nature, while the others are but too often death caricatured. What, for instance, can be better than the picture of Spinous Lizards with the curious expansions on the neck on p. 84, reproduced on the next page, by the courtesy of the publishers? (Fig. 1). It is, however, not only with animate nature that Mr. Kent has been successful, his views of scenery, especially where the wonderful termite mounds are concerned, being admirable works of art, interesting alike to the lover of strange landscapes and to the naturalist.

As may be gathered from his preface, the design of the author was not to produce a systematic work on the fauna and flora of Australia—of which we have plenty—but "to present to the English reading public a few glimpses" of its natural products, with special attention to the habits of some of the more interesting animals. In this laudable object he has, on the whole, succeeded admirably; and although his primary object has not been to attract the professed naturalist, many of his observations—notably those on the use of the leg-spur of the Duckbill—are of the highest importance to all students of natural history.

Not that Mr. Kent treats many parts of his subjects in a superficial, or even what may be termed a purely popular manner. We have, for example, in the introductory chapter a long dissertation on the relation of Australasia to other countries of the southern hemisphere, which may possibly be above the heads of some of his readers. In this we note that he adopts the view that Australasia, Africa, and South America have been in mutual connection at no very remote epoch; but in giving his adhesion to the theory that such connection took place solely by means of an Antarctic continent completely cut off from more northern lands, he has evidently not studied some of the more recent literature on this fascinating but difficult subject. And we should

[1] "The Naturalist in Australia." By W. Saville-Kent. 4to. Pp. xv + 302. (London: Chapman and Hall, Ltd., 1897.)

much like to know how he reconciles this assumed southern origin of the marsupial fauna with the occurrence of opossums in the European Oligocene. He is also not quite up to date with regard to the extent or affinities of some of the groups of the southern fauna. For instance, on p. 4, we find no mention of the fact that *Galaxias* is represented at the Cape; while, from a statement two pages later, the author appears to be unaware that the giant extinct birds of Patagonia have no sort of relationship with the Ostrich group. Then, again, we must take exception to the statement on p. 15, that the Australian fauna comprises only "a few rodents"; while we should like to be informed whether, in face of the views of Mr. Douglas Ogilby, he has any special reason for the statement that "there is strong reason to believe" the Dingo "was introduced by human agency." Although it is perhaps invidious to call attention to slight slips in a work of this nature, it is difficult to avoid asking why Señor Ameghino is credited on p. 20 with writing in the "Brazilian" *Bulletin of the Academy of Cordova;* to which it may be added that the voluminous writer referred to has had a good deal to say on the same subject since 1894.

After treating in the introductory chapter of the leading types of Australian mammals, some of which are admirably illustrated, and a few of the birds, in the second chapter the author describes in detail the manners and appearance of some of the more notable species among the latter. And here his photographs of the "More-pork" (*Podargus*) and "Laughing-jackass" (*Dacelo*) are almost speaking likenesses. Something, however, might well have been added with regard to that very characteristic Australian bird, the Piping-crow (*Gymnorhina*), which appears to be only incidentally mentioned on p. 52. Following birds, the third chapter is naturally devoted to lizards, where the author's illustrations of the extraordinary attitudes assumed by the frilled lizard (*Chlamydosaurus*), previously published in the Zoological Society's *Proceedings* and in NATURE, are reproduced. Although it is less apparent than before, it is to be regretted that the author cannot thoroughly purge himself of the idea that the erect attitude of this creature has something to do with Dinosaurian ancestry; and it would have been much better if all reference to the structure of *Compsognathus*, about which the general public knows nothing and cares less, had been omitted. After lizards we look in vain for snakes, and we should have expected fishes in juxtaposition. These latter are, however, treated of in the sixth chapter, where Mr. Kent, with twelve years' experience as inspector of fisheries in "Westralia," speaks with authority. We are here introduced to a number of piscine types unfamiliar to the European, some remarkable for their size and peculiar structure, while others, like the Coral-fishes, to which a coloured plate is devoted, claim attention from their brilliant hues and grotesque forms. It is, however, by no means the largest or the best-flavoured fish that are of the most commercial value. "From a utilitarian point of view," writes the author, "the Barracouta (*Thyrsites*) is undoubtedly one of the, if not the, most important of the Tasmanian food-fishes. While the real or Hobart Trumpeter may be said to typify the species fitted, like the Turbot, to grace the table of the wealthy, the Barracouta may be as essentially styled the poor man's fish. It takes in Tasmania the place that is occupied by the modest Herring or the Haddock in the English market."

Turning back to chapter iv., we find this devoted to White Ants, or Termites, and the marvellous size and form to which they raise their mounds in certain parts of the country. Indeed, so numerous and so large are these mounds, that they frequently form an important feature in the landscape, as is well shown in several of the illustrations, one of which we are able to give (Fig. 2).

Perhaps the most fascinating chapter in the book is the one (v.) describing Houtman's Abrolhos, those low-lying coral islands situated off Western Australia, so interesting to the historian as being the scene of the wreck of the Batavian expedition of 1629, which led to the discovery of Australia, and to the naturalist as forming the border line between a tropical and temperate fauna. Nowhere else, we are told, are such extensive sheets of one and the same species of coral to be met with as here. Of the reef corals, the author writes that "while growing very near to the surface level of the water at low ebb tide, they very rarely appear above it, and then to the extent of a few inches only." And it is well for them that this is so, since the author relates how on one cold winter morning he found the tips of the madrepores that had been thus exposed, completely killed, indicating, in spite of their luxuriant growth, that we are near the limits suitable for coral existence. Much interest attaches to the author's description and illustration of "the birth of a coral island," but for this and the description of the coral reefs themselves, we must refer our readers to the original. Pearls and pearl-fishing, although intimately connected with coral reefs, are treated of in chapter vii. in a manner adequate to the importance of such a valuable trade; and the reader will there learn how the fishery has been gradually driven by exhaustion from the shallows to deeper and deeper water, while the complexity of the plant required for its

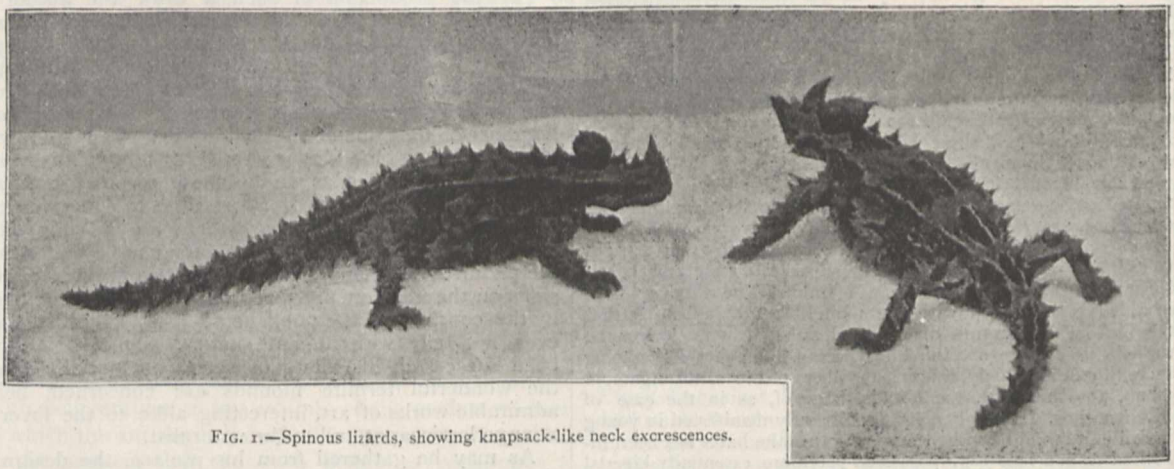

FIG. 1.—Spinous lizards, showing knapsack-like neck excrescences.

successful prosecution has concomitantly increased. To replenish the waste, artificial cultivation of the pearl-oyster has been tried in various localities; and of all these, the author considers that the islands of Torres Straits are the most likely to yield successful results.

The last three chapters, respectively entitled "Marine Miscellanea," "Insect Oddities," and "Vegetable Vagaries," we are reluctantly compelled to pass by without mention, although all merit the reader's best attention. Were our notice extended to three times its length, even then but comparatively few of the more interesting points in this volume could be touched upon; but as it is,

FIG. 2.—Termite mounds, Albany, North Queensland.

enough has been said to indicate how well the author has made use of his exceptional opportunites of observation, and in what an attractive guise he has presented his results to the public. R. L.

THE CALCUTTA EARTHQUAKE.

ON Saturday, June 12, at almost precisely five o'clock in the afternoon, Calcutta was visited by a somewhat severe shock of earthquake, most sensational reports of which, judging from the accounts that have appeared in the Indian papers, were probably telegraphed to England, and must have caused considerable anxiety among those who have relatives or friends out here. As a matter of fact few lives were lost, the warning given by the preliminary tremors allowing every one ample time to escape from their tottering dwellings, while in the crowded native quarters of the city the damage done is remarkably slight, the European quarter having suffered most. This apparent partiality of the shock is not, I think, to be attributed to any difference in its severity over the two areas, but rather to differences of construction and environment of the buildings. In the native town the houses are, as a rule, low, and built close together, thus supporting each other, while the European houses are generally detached, each standing in its own compound, and very commonly three stories in height. It is a notable fact that the only buildings greatly damaged are old, mostly dating back to the beginning of the century, or even older, and that they have already been subjected to severe shocks of earthquake, and were badly cracked. No new buildings have suffered in anything like the same degree, and it is difficult to find a crack anywhere that one can safely assume to have been caused in the first instance by the present earthquake. The common practice of the owners, after such a visitation, is to have the cracks covered up by a thick coating of plaster, so that to all appearance a house is as sound as before. In many cases this practice is being followed out now, so that there is every prospect of the next earthquake being attended with still more disastrous results.

In addition to the faulty construction of the buildings just mentioned, the damage caused must be attributed to the duration of the earthquake, rather than to any inherent severity of the shock itself. Various estimates are given as to the duration of the shock, ranging from four to ten minutes, and it must have lasted at least six minutes. The most trustworthy observations give 16h. 58m. (local time) as the time of commencement, while two of the observatory clocks at Adipur stopped, within a few seconds of each other, at 17h. 4m. 22s. and 17h. 4m. 26s. respectively. The buildings had thus ample time to take up the impulses given to them by the vibration of the soil, and after the earthquake had continued for a couple of minutes or so, each building was rocking to and fro with its own particular period of vibration, irrespective of the period of vibration of the earth, which I do not think varied much during the time it lasted. I happened to be on the third story of a new building, which was not damaged, at the time of the earthquake, and it seemed to me (and my observation has been confirmed by others to whom I have spoken on the subject) that distinct nodes were perceptible, during which, presumably, the vibrations of the house and those of the earth interfered with each other, and it is to the twisting effect produced by the presence of these nodes that I would attribute most of the damage done. It is curious that not a single factory chimney was overturned, or even cracked, though the chimneys rocked violently from side to side; their rate of vibration probably synchronised more or less with that of the earth. On the other hand, three, at least, of the church spires have broken off near the top; but in

their case the vibrations were probably more complicated than in the chimneys, through their being attached to the body of the church in each case, and also owing to their conical shape.

Falls of isolated objects, unconnected with any building, from which the direction of the shock might be ascertained, are exceedingly rare. Only two of the monuments in the old cemetery were affected, but both of these give the same direction, viz. approximately N. 30° E., S. 30° W., the fall being in each case towards the S.W. One of these monuments is an obelisk over the tomb of Sir William Jones, the founder of the Asiatic Society of Bengal. The building of this Society has suffered severely, being cracked in every direction.

It is too soon as yet to speak with certainty of the extent of the earthquake, or of the causes which led to it. So far as present reports go, the province of Assam has suffered most damage, and it is possible that the cause of the earthquake will be found in some movement

FIG. 1.—Calcutta Earthquake, June 12. Messrs. Traill and Co.'s Office, British Indian Street. A Verandah, with portico beneath it supported on pillars in front of the building, has been entirely destroyed.

either along the line of dislocation which separates the Himalayas from the Assam valley, or that which runs along the south flank of the Assam range, at the northern edge of the plains of Sylhet and Cachur.

It is unfortunate that Calcutta does not possess a single seismograph of modern construction. Without one of these it is hopeless to expect to obtain perfectly accurate details, as to time, duration, force, &c., so necessary for a full discussion of the subject.

I enclose two photographs [one is reproduced in Fig. 1] taken immediately after the earthquake, which show the kind of damage that has been caused by it. The vibration of the walls loosened the ends of the beams carrying the massive roofs, which then crushed down, carrying the lower floors with them, the outer walls being usually left standing, but badly fissured. T. D. LA TOUCHE.

PAUL SCHÜTZENBERGER.

PAUL SCHÜTZENBERGER was born at Strassburg, and died at Paris on June 28, 1897, at the age of sixty-seven. He first studied medicine at the University of Strassburg, graduating in 1855 with a thesis entitled "Du Système Osseux." Subsequently, however, he devoted himself to chemistry, occupying successively the posts of Préparateur in the chemical laboratory of the Conservatoire des Arts et Métiers at Strassburg, Professor at the Mülhausen High School, Assistant-Director of the chemical laboratory of the Sorbonne, and Head of the chemical department of the Collège de France, where, since 1876, he has occupied the chair of Chemistry. In 1884 he was elected a member of the Academy of Medicine, and in 1888 he was elected to fill the place rendered vacant by the death of Débray in the Paris Academy of Sciences.

Much of his work exhibits the influence of his earlier medical training: for example, his "Chimie Appliquée à la physiologie animale et au diagnostic médical," published in 1864, his work on fermentation (1875), and his well-known researches on the chemical nature of the albuminoids and of the vegetable alkaloids. He also devoted much attention to the chemistry of colouring matters and of their applications, in which branch of science he was one of the first authorities. His book entitled "Des Matières Colorantes," first published in 1866, is, perhaps, his best-known work. He did not confine himself, however, exclusively to organic chemistry, his name being honourably known in inorganic chemistry in connection with the discovery of hyposulphurous acid.

T. E.

NOTES.

THE Queen held a Court at Windsor Castle on Thursday last, at which an address was presented by deputations from several bodies, among them being the Royal Society. The deputation from the Royal Society, consisting of Lord Lister (President), Sir John Evans (Treasurer), Prof. Michael Foster (Secretary), Prof. Arthur W. Rücker (Secretary), Prof. R. B. Clifton (Vice-President), Sir William Huggins, K.C.B. (Vice-President), Mr. W. T. Thiselton-Dyer, C.M.G. (Vice-President), Sir Joseph Dalton Hooker, G.C.S.I., C.B. (Past President), Lord Kelvin, G.C.V.O. (Past President), Sir George Gabriel Stokes, Bart. (Past President), with Mr. Robert W. F. Harrison (Assistant Secretary), was introduced to her Majesty's presence, when the President presented the address, to which the Queen made a gracious reply. The President, Treasurer, and Vice-President Prof. R. B. Clifton, had the honour of kissing her Majesty's hand.

THE Russian Admiral Makaroff, who is well known for his hydrological researches in the Northern Pacific on board the corvette *Vityaz*, has just left St. Petersburg for an Arctic trip. He will take this year the command of a flotilla of seven steamers, which are sent out by the Russian Government for the transport of coal and mixed cargo to the mouths of the Ob and the Yenisei, and for bringing back to Europe various cargo from Siberia. Three of these steamers have strongly-built stems, and will be used to break through the ice, in order to see if the short period of navigation across the Kara Sea cannot be prolonged in this way for a few days. Admiral Makaroff takes with him all the hydrological and meteorological instruments which he had on board the *Vityaz*, and he proposes to sail up the Yenisei in his flagship, and to return by the overland route.

THE fourth summer meeting of the American Mathematical Society will be held, under the Presidency of Prof. Simon Newcomb, at Toronto, on Monday and Tuesday, August 16 and 17. By invitation of the University of Toronto, the meeting will take place in the main building of the University. It has been decided to set apart one of the sessions for the general discussion of the following subjects: (1) The accurate definition of the subject-matter of modern mathematics. (2) The vocabulary of mathematics; the possibility of correcting and enriching it by co-operative action. Members of the British Association are invited to be present at the sessions.

THE nation owes much to the catholic taste and great liberality of Sir Augustus Wollaston Franks, late Keeper of British and Mediæval Antiquities in the British Museum. Archæologists are given further cause for cherishing his memory by the announcement that he has bequeathed to the Museum all the collections lent by him to the Museum or to any other museum, with various other valuable collections and books, conditionally on the Government allowing a remission of probate duty with respect to them. This condition is thus expressed in the will: "And as to these bequests to the British Museum I desire my executors to apply to the Government for a remission of probate duty with respect to them. And if this be not granted I declare my said bequests to the Trustees of the British Museum to be null and void, and I desire and direct that the objects which would otherwise have passed to the British Museum be sold by public auction and the proceeds added to my general residuary estate." Sir Augustus Franks also bequeathed to the Society of Antiquaries of London, of which he was President, a number of rare and valuable books on antiquities, art, history, and genealogy, together with various heraldic manuscripts, drawings, and engravings of ancient seals.

THE Commission, under the direction of Prof. Koch, which investigated the origin of the plague in India, has issued its report, and a few of the conclusions have been transmitted from Berlin through Reuter's agency. It appears that the plague bacillus, outside the human body or certain animals, has very brief vitality; and it does not develop in the absence of oxygen. Rats were proved to be in the highest degree susceptible, and to spread the plague germs and communicate them to human beings. For experiments with the object of producing immunity, apes were used, and it was ascertained that grey apes were as highly susceptible as rats, while brown apes were less so. Immunity was established after a lapse of between five and seven days. Apes thus treated possessed a high degree of immunity, and could endure a large quantity of plague culture, about two milligrammes. For the purposes of serum experiments Yersin serum was employed. Its protective power in the case of brown apes did not exceed eight days. Strong injections of serum proved to be of unquestionable curative efficacy. Haffkine's system of inoculation, which was applied to 1400 patients, is reported to have shown undoubted protective results, although a number of the patients were taken ill in consequence of the inoculation.

HERR ANDRÉE, with his two companions, Drs. Strindberg and Fraenkel, started from Danes Island, on July 11, on their balloon voyage to the North Pole. The weather was favourable, and there was a good breeze, which took the balloon in a north-north-east direction at the rate of about twenty miles an hour. From Danes Island to the North Pole is a distance of about six hundred miles, and the same distance has to be traversed on the other side of the Pole before known *terra firma* can be reached. The risks to which the explorers have exposed themselves are thus very great, for it is difficult to believe that the balloon will keep afloat long enough to permit the expedition to be safely terminated, though the capacity of the balloon was enlarged by 300 cubic metres from 4500 cubic metres before starting, and the silk was greatly strengthened by additional coats of varnish. Since the balloon started, southerly to south-westerly winds have prevailed over Spitsbergen, Norway, and the ice-regions. It is therefore assumed that the balloon went in the direction of Eastern Siberia.

THE Weights and Measures (Metric System) Bill came before the House of Lords on Tuesday. Lord Balfour, in moving the second reading of this Bill, pointed out that the circumstances in which it was proposed to Parliament by the Board of Trade were these. During the Session of 1895 a Select Committee of the other House was appointed to inquire whether any, and, if so, what, changes in the present system of weights and measures should be adopted. The Committee practically confined their attention to the consideration of the metric system, and they agreed to these three recommendations: (1) that the metric system of weights and measures be at once legalised for all purposes; (2) that after a lapse of two years the system be rendered compulsory by Act of Parliament; and (3) that the system be taught in all public elementary schools as a necessary and integral part of arithmetic. The last recommendation could, if thought expedient, be carried into effect without legislation. The Government were not prepared to adopt the second recommendation—that after two years the system be made compulsory. The Bill carried out the first of the recommendations of the Select Committee, and the evidence taken by the Select Committee clearly proved that there was a genuine demand among some of the large trades in some of the important commercial centres of the country for the legalisation of the system, and from the reports of some of our Consuls abroad it seemed to be of considerable importance that the system should be adopted, and to be shown that if adopted it would prove of material benefit to British trade. The Government did not intend to make the system compulsory, and the present Bill was confined

to simply legalising the system for those who required it without going further just now. After a few remarks by Lord Colchester, the second reading of the Bill was agreed to.

THE French Société d'Encouragement pour l'Industrie Nationale has awarded the following prizes :—The Giffard prize of one thousand francs to M. Ducos du Hauron, for his works on photography in colours; the grand gold medal, with Lavoisier's effigy, to M. F. Osmond, for his metallurgical researches; a prize of two thousand francs to M. Rousse for his production of chenille web; and five hundred francs to M. Livache, for his work entitled "Vernis et Huiles siccatives."

WE regret to announce the deaths of the following men of science :—Prof. D. Wilhelm Preyer, the well-known German physiologist; Dr. P. C. Plugge, professor of pharmacology and toxicology in the University of Gröningen, and author of a number of papers on physiological chemistry; Prof. Arminio Nobile, professor of geodesy in the University of Rome, and author of many valuable papers on astronomy; and Prof. Oertel, of Munich, distinguished for his researches on the etiology of diphtheria.

WE notice with regret the announcement of the death of Sir John Bucknill, F.R.S. For nine years he edited the *Journal of Mental Science*, and he was one of the original editors of *Brain*. He was the author of numerous psychological works, and wrote largely on insanity and allied subjects. In the Royal College of Physicians he filled the posts of Censor, Councillor, and Lumleian Lecturer. He was elected a Fellow of the Royal Society in 1866, and was knighted in July 1894, in recognition of his pioneer services in connection with the Volunteer movement.

THE death of Dr. Steenstrup, formerly professor of zoology at the University of Copenhagen, and director of the museum of that city, has already been announced. Dr. Steenstrup (says the *Zoologist*) was born in 1813, and had thus reached the eighty-fifth year of his life. He published much on natural history, but he will be principally remembered by his work on the subject of "Alternation of Generations." He also studied the prehistoric remains found in his own country, both as regards fauna and flora, and in 1866, in conjunction with Sir John Lubbock, contributed a memoir to the Ethnological Society of London "On the Flint Implements recently discovered at Persigny-le-Grand." He was a correspondant of the Section d'Anatomie et Zoologie of the Paris Academy of Sciences.

THE annual meeting of the German Botanical Society for 1897 will be held at Brunswick, commencing on September 21. The sixty-ninth meeting of the German Association of Naturalists and Physicians will be held at the same time. A special feature of the meeting will be an exhibition of scientific apparatus and appliances.

M. GAYON has been elected a member of the Section d'Économie rurale of the Paris Academy of Sciences, in succession to the late Prof. Hellriegel.

PRESIDENT JORDAN, of the Leland Stanford Junior University, has gone to Alaska, with the sanction of the United States Government, for the purpose of branding female seals in order to impair the value of their skins, and thus destroy the industry of pelagic sealing.

WE learn from *Malpighia* that Prof. Penzig, of Genoa, has returned from his botanical expedition to Java and Ceylon with very rich matertals, which have been deposited in the Botanical Museum of the University of Genoa; and that Sig. F. Karo has undertaken a fresh exploration of Southern Siberia, as far as the river Amûr. His botanical collections will be examined and distributed by Dr. J. Freyn, of Prague.

THE detailed magnetic survey of the State of Maryland, begun last year, has been resumed, and is again under the charge of Dr. L. A. Bauer. Special stress will be laid this year upon the investigation of the marked local or regional disturbances in Central and North-eastern Maryland, revealed by last year's work. According to *Terrestrial Magnetism*, there are prospects that a neighbouring State will undertake a similar survey in the near future.

TO find the relation between the small variations which distinguish individuals of the same group, and the large differences which separate species and genera, Mr. E. T. Brewster has examined the body measurements of eight races of men, and has determined the coefficient of variability of each dimension for each race (*Proc. Amer. Acad. Arts and Sciences*, vol. xxxii. pp. 269–80, May). His conclusion is "that there is so intimate a causal connection between the characters of individuals and those of the allied groups into which they are combined, that, in proportion as any character is variable in the individuals of one group, it is different in the allied groups."

AN exhibition of navigational instruments has been arranged by the Shipmasters' Society, and will be open from 10 a.m. to 6 p.m. at the Fishmongers' Hall, London Bridge, on August 4, 5 and 6. The promoters have endeavoured to trace the progress made in navigational instruments during the last sixty years. Admission will be free upon presentation of a visiting card. Catalogues will be ready just before the opening.

THE *Ceylon Observer* of June 18 urges the advisability of the appointment in Ceylon of a Government agricultural chemist, and the institution of agricultural experiments under his guidance. It is pointed out that Barbadoes and British Guiana, each with populations and revenue and export trade much smaller than those of Ceylon, have their Government chemists, and naturally those interested in agriculture in Ceylon feel aggrieved at not being placed on a footing similar to that of the people of the two dependencies mentioned.

THE Russian bacteriological stations, or "Pasteur Institutes," are displaying a considerable activity. We find, from the annual report of the Kazan station, that over 82,400 vaccinations against the "Siberian cattle plague" have been made during the past year, and that not only educated agriculturists but also the peasants begin to vaccinate their cattle. The Kazan bacteriologists make use exclusively of the bacterial vaccine of Profs. Lange and Cienkowski, which is prepared in the field laboratories, on the spot, the day before vaccination takes place. Demands for it come from the surrounding provinces, even from East Siberia. Researches into rabies and tuberculosis among cattle were carried on at the same time.

THE researches lately published about the supposed new element, "lucium," have induced Prof. Chroustchoff to revise the work he had made in 1887 upon what he then supposed to be a new element, "russium," also obtained from the monazite sands of North Carolina. He gives a short report about his last investigations in the *Journal* of the Russian Chemical Society (xxix. 3). Having obtained during the last eight years about 25 kgr. of rare earths, he extracted from them 35 grammes of a substance which has all the properties of "russium." Its equivalent is equal to 70·5, and its spectrum is characterised by a group of green and violet lines. A detailed description of all the experiments will soon follow. Prof. Chroustchoff also mentions that cerium, after it has been freed of all traces of thorium and other impurities, can be separated into several fractions differing from each other by their physical properties, and having, respectively, the atomic weights of 138, 140, 142, 146, and 156·5. It also seems that besides the two components of didymium, described by Auer, there exists a third component. The note contains a list of all the rare earths hitherto obtained, or supposed to exist.

THE article on "Styles of the Calendar," in a previous number of NATURE (No. 1443), has brought us several letters with special reference to the time of adoption of the "new style" by England and Scotland. One correspondent writes: "Scotland, like England, adhered to the Julian Calendar till 1752. What has caused the error . . . is the impression that the Act of the Scottish Parliament in 1599, 'for the year of God to begin the 1st of January yearly,' introduced the Gregorian Calendar into Scotland. But all that that statute did (as indeed its title indicates) was to enact that the year should begin in accordance with classical usage, on the 1st of January, and not, as was the mediæval custom, on the 25th of March." Another correspondent, besides endorsing the above, adds: "That what is meant by 'new style' is, of course, the adoption of the Gregorian reckoning; . . . this was done by England and Scotland together in September 1752, by dropping eleven in the numbering of the days. Accordingly, old style was in use in Scotland till 1752, and indeed is by no means wholly disused yet. . . ." The author of the above-mentioned article, Mr. W. T. Lynn, writes: "The alteration made by the Scotch in 1600 was restricted to the adoption of January 1 instead of March 25 as the first day of the legal year. This was effected in England in 1751 by the same Act of Parliament which provided that the Gregorian reckoning should henceforth be used in Great Britain. Perhaps I may point out the erroneous statement in the subject in the current (ninth) edition of the 'Encyclopædia Britannica,' where we read (vol. iv. p. 677): 'In Scotland the new style was adopted from the beginning of 1600, according to an Act of the Privy Council in December 1599.' The writer may have had in his mind what he was speaking of in the preceding sentence on the alteration in the commencement of the year (where, by the way, there is a slip or misprint of April 25 for March 25), but the expression 'new style' could not apply to that."

MR. A. T. DRUMMOND, writing from Kingston, Canada, says:—"In the course of an inquiry into the subject of old age pensions in Canada, I have had occasion to investigate, among other matters, the proportion which those who had in that country attained sixty years of age and upwards bore to the whole community. The result showed a constant increase in this proportion from 1851 onwards, as indicated by the following figures:—1851, 3·70 per cent.; 1861, 4·49 per cent.; 1871, 5·10 per cent.; 1881, 6·32 per cent.; 1891, 7·01 per cent. In the earlier years given, the proportion relative to their respective populations was always somewhat greater in the Province of Quebec than in the Province of Ontario; but in 1891 this was changed by those in Ontario reaching 7·16 per cent. Nova Scotia's proportion has always stood relatively high, and in 1891 was 8·91 per cent. Whilst emigration and immigration have each in turn tended to increase or diminish these proportions, and to qualify any conclusion which may be drawn, the general impression from these figures is that the population coming within the old age limit is increasing. This may be fairly considered as due to better food, improved sanitation in houses, the use of new methods and appliances in daily life which result in less wear on the system, and the more careful attention to rules of health which better education and greater prosperity have brought about."

EXPERIMENTAL farms similar to those supported by various continental Governments and in the United States have, unfortunately for British agriculture, not yet been established in this country. Researches in pots and plots are, however, carried out by a few societies and technical colleges having the interests of agriculture at heart, and the results are made accessible to farmers. The Glasgow and West of Scotland Technical College is one of the institutions which encourages work of this kind. A report now before us shows the results of manuring experiments conducted last year on farms in the south-west and centre of Scotland, under the direction of Prof. R. Patrick Wright. The report will, doubtless, prove as helpful to agriculturists as the official bulletins are to the farmers in America.

AN electrical method of determining the moisture content of arable soils is described by Messrs. M. Whitney, F. D. Gardner, and L. J. Briggs, in *Bulletin* No. 6 of the U.S. Department of Agriculture (Division of Soils). For a long time the importance of having a trustworthy and convenient method for determining the amount of moisture in soils has been recognised. It is pointed out that the rain does plants but little positive good until it enters the soil, where it can be absorbed by their roots. A record of the actual amount of water in the soil from day to day would, therefore, give the absolute value of the moisture conditions under which plants are growing, and even without reference to rainfall data it would show, if the character of the soil was understood, whether the conditions were favourable or otherwise for the crop. The difficulty has hitherto been to make this determination easily; for though various methods have been tried, very little success appears to have been achieved. The method described in the present bulletin seems, however, to be practicable and readily carried out. It consists in burying specially-constructed electrodes in the soil, so that by measuring the resistance to the passage of a current through the soil the amount of moisture in the soil can be determined. The possibility of using the electrical resistance of soils for the determination of moisture was suggested to the authors some years ago by the necessity of thoroughly grounding lightning rods, telephones, and telegraph lines. If these are not carried to a considerable depth, so that the terminals are constantly in a moist soil, the lines do not work in dry seasons. A fair number of observations have been made with the instruments described, and they appear to be satisfactory. The work was begun before the modern conceptions of the nature and principles of salt solutions and electrical conductivity had been developed, and it has been brought to a successful termination by regarding the soil as a difficultly soluble compound, and the soil moisture as a salt solution derived therefrom. The research is thus not only interesting from a practical point of view, but also from the standpoint of physical chemistry.

IN the *Bollettino della Società Sismologica Italiana*, Signor G. Agamennone gives an account of the determination of the velocity of propagation of the earthquake shock which visited Amed (Asia Minor) on April 16, 1896. This investigation receives additional interest from the fact of the earthquake being the first occurring in the district, for the determination of whose velocity trustworthy data exist, the time of the Imperial Observatory of Constantinople affording an accurate means of timing the passage of the shock. Observations in Asia Minor itself gave a velocity of 1200 metres per second; but by comparing the observations with those made at Padua, a velocity of 3200 metres per second was obtained for the phase of reinforcement, and 2400 for the maximum disturbance.—In another part of the same journal, Signor Agamennone describes his photographic tromometer for registering seismic and other disturbances by means of a freely suspended heavy pendulum. In the present modification of the original apparatus, the components of the disturbance in two rectangular directions are separately registered.

WE learn from the *Annalen der Hydrographie und maritimen Meteorologie* for June that a new system of storm signals is to be established along the Dutch coasts. Nearly forty years ago the question of storm warnings was discussed by Prof. Buys Ballot at a meeting of scientific men at Bonn, and he subsequently adopted the method of cone and drum signals similar

to those introduced by Admiral FitzRoy in this country. But in the year 1866, when these signals were temporarily discontinued here, and shortly afterwards re-established in a slightly modified form, Buys Ballot adopted an apparatus called Aeroclinoscope, a kind of semaphore with mast and arm, by means of which the direction and magnitude of the barometric differences from the normal conditions between certain places were made known. The system to be adopted during the current year is similar to that used on the German coasts, viz. a ball, two cones and two black flags by day, and red lamps by night. They are to be established at thirty-nine stations; and with a view to making the system as useful as possible, additional telegraphic information is received at the central office in Utrecht twice or thrice daily from various countries, to supplement the observations made in Holland. Much credit is due to the Dutch Meteorological Institute for undertaking this expensive work, for the general benefit of navigators.

THE Central Meteorological Office of France has just published in its *Annales* a useful catalogue of all meteorological observations made in France from the earliest times down to the year 1850. The catalogue has been prepared at a great cost of time and labour by M. Angot, by means of personal visits and by circulars issued through the Ministry of Public Instruction, and contains particulars of observations made at 241 stations. If similar catalogues were published for all countries, they would greatly facilitate meteorological researches, especially those relating to periodical phenomena, which are often frustrated for the want of knowing where to find observations of long duration.

MR. R. THAXTER contributes to the *Memoirs* of the American Academy of Arts and Sciences a very interesting monograph of the *Laboulbeniaceæ*, an order of Ascomycetous Fungi which shows a remarkable analogy in structure to the highest family of Alga, the Florideæ. The *Laboulbeniaceæ* are all minute parasites on living insects, chiefly aquatic; the larger number are American; and for our knowledge of the family we are largely indebted to Mr. Thaxter. Of the twenty-eight genera described in the monograph, only nine have at present been found in the Old World. The main body of the fungus is usually quite simple in structure, is composed of several cells, and is attached to the chitinous integument of the insect, not penetrating its tissue in the form of a mycelium. The sexual organs of reproduction are antheridia and procarps, the latter being multicellular structures containing a carpogenic cell, and bearing a trichogyne resembling that of the Florideæ. After fertilisation the asci are developed from the carpogenic cell, enclosed in a perithecium which resembles in many respects the cystocarp of the Florideæ. The spermatozoids or pollinoids are very minute, often rod-shaped bodies, and attach themselves in large numbers to the trichogyne, though actual fusion has not been observed. The trichogyne varies much in complexity of structure. It is never in direct communication with the carpogenic cell; the fertilising process must be conveyed through one or through several cells before it reaches the carpogenic cell. The author believes that the nucleus of the spermatozoids must pass from cell to cell through the length of the trichogyne, before impregnating the female nucleus in the carpogenic cell, a phenomenon which he states to be without its parallel in either the animal or the vegetable kingdom.

A NEW edition (the fourth) of Mr. Marriott's "Hints to Meteorological Observers" has just been issued by Mr. E. Stanford.

THE first report of Mr. J. C. Willis, the Director of the Royal Botanic Gardens, Ceylon, and successor to the late Dr. Trimen, has just come to hand.

THE Report for 1895 of the Botanical Exchange Club of the British Isles (just received and dated 1897), by Mr. W. H. Beeby, contains a number of notes on critical species, as well as a record of many fresh localities.

THE current number of the *British Medical Journal* contains a list of the papers to be read, and the discussions announced to take place, at the forthcoming meeting of the British Medical Association in Montreal.

THE tenth annual report of the Scientific Society of the University of North Wales, for the Session 1896-97, has reached us. It contains brief abstracts of the papers and addresses which were given during the Session.

THE McGill University, of Montreal, has just issued the announcement of its Faculty of Applied Science for the Session 1897-98. The pamphlet contains all the preliminary information likely to be of use to those who may be thinking of taking instruction in science at the University.

MESSRS. SONNENSCHEIN AND CO. announce as in preparation "The Laws of Thought," by Mrs. Boole, who, since the death of her husband, has been engaged in translating the results of his researches into language intelligible to all familiar with the elements of arithmetic and geometry.

MESSRS. BLISS, SANDS, AND CO. will shortly commence the publication of a new scientific series, entitled "The Progressive Science Series," edited by Mr. Frank Beddard, F.R.S. The volumes will aim at pointing out the lines of future discovery, but they will also contain sufficient historical and expository matter to enable students and investigators to learn what has been done. The late Prof. Cope wrote a volume on "Vertebrate Palæontology" for the series, which will also include a volume by Dr. Geikie on "Earth Structure"; one by Dr. St. George Mivart on "The Groundwork of Science," and one by Prof. Bonney on "Volcanoes." Other volumes are in contemplation on heredity in relation to crime; theories of matter; and the relation between science and religion. The series when completed will comprise works on every branch of science, some half-dozen or more being published in each year at first.

AMONG the articles and other publications which have come under our notice within the past few days are:—"Heredity and Neurosis," by Dr. Geo. H. Savage (in *Brain*, Parts lxxvii. and lxxviii.). This (the presidential address to the Neurological Society of London for 1897) is a paper in which the relationships of the neuroses are compared, and the lineal descent of these disorders of mental function are traced. The article is thus a valuable contribution to the facts of evolution.—"The Structure of Cross-striated Muscle, and a suggestion as to the Nature of its Contraction," by W. M'Dougall, in the *Journal* of Anatomy and Physiology (July). The paper is illustrated with half-tone reproductions of more than fifty photo-micrographs of sections of muscles and fibres. The suggestion as to the cause of contraction is formulated as follows: "Contraction is the result of an increase in the volume of the fluid contents of the sacromere, and relaxation is accompanied by a diminution in their volume."—A detailed report on the violent Laibach earthquake of April 14, 1895, illustrated by four plates and forty-two text-figures, is given by Dr. Franz E. Suess, in the *Jahrbuch d. k.k. geol. Reichsanstalt*, Vienna (vol. xlvi.). The report extends over nearly five hundred pages of the *Jahrbuch*, An earthquake said to resemble in many points the disturbance which Dr. Suess discusses, is reported to have occurred at Laibach shortly before seven o'clock on the morning of Thursday last, July 15. Considerable damage appears to have been done.—A finely-coloured geological and topographical map of the northern part of the Lake of the Woods and adjacent country has been published by the Geological Survey of Canada.

A COMPARISON between the magnetisation and associated change of length of iron and steel (*Längenänderung und Magnetisirung von Eisen und Stahl*) is the subject discussed by Dr. Klingenberg in his "Inaugural Dissertation" at Rostock University. The magnetisation and elongation of various wires were measured simultaneously under varied conditions of field-strength, longitudinal loading, and mechanical jarring, and the general conclusion was arrived at that there exists a pronounced similarity between the two associated phenomena. In its details the investigation is, to a large extent, a repetition of the well-known experiments of Joule, Bidwell, Ewing and others; but the peculiar merit of Dr. Klingenberg's work lies in the coordination of the two classes of phenomena simultaneously studied. It is a careful discussion of a sound piece of experimental work. In his concluding sections the author touches upon the question of magnetic strain, which Dr. Jones has more elaborately worked out in a paper recently published in the *Philosophical Transactions*. An ingenious attempt is also made to coordinate the curiously contrasted magnetic phenomena in iron, nickel, and cobalt in terms of the shape and orientation of the molecular magnets, whose rotations are believed to be the most essential feature in these phenomena. On the assumption that the iron molecules are ellipsoids magnetised, some along the long axis, others along the short axis, the author shows how the former will have preponderating influence in weak fields, while the latter will tell more and more in strong fields. In nickel, the assumption is that the ellipsoids are almost exclusively magnetised along the short axis. On these assumptions the dilatation phenomena in iron and nickel, the Villari Reversal, &c., find ready enough explanation. The peculiarities of cobalt are stated to be explicable on the same lines.

IF a fused solid substance be cooled below its melting point in a tube, and crystallisation then induced at one end, the rate at which this is propagated along the tube may be taken as a measure of the velocity of crystallisation. Gernez has found, with phosphorus and sulphur, that this velocity is proportional to the degree of super-cooling. Since, however, the surface at which the crystallisation actually takes place is always at the melting temperature of the substance, G. Tammann considers that the velocity ought to be independent of the degree of super-cooling, and in the current number of the *Zeitschrift für Physikalische Chemie* publishes the results of some experiments on the point. Using benzophenone, which was not quite pure, he finds that the rate of crystallisation increases with the super-cooling until the latter amounts to about 20° (or less with a purer sample). From this point the velocity remains constant until the super-cooling is so great that the heat evolved by the solidification is insufficient to heat the solid formed to the melting temperature. *The rate of crystallisation diminishes rapidly from this point onwards.* For example, at −40° a crystal of benzophenone introduced into the super-cooled substance changes so little that an observer might easily imagine that the liquid was at its melting temperature; on allowing the temperature to rise crystallisation begins, slowly at −35°, rapidly at −25°. Phosphorus, again, solidifies at least one hundred times more slowly at 0° than at 24°. These observations seem to provide a fresh point of resemblance between so-called physical and chemical changes, since, of the latter, it has long been known that even the most energetic proceed extremely slowly at sufficiently low temperatures.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♂) from India, presented by Master Jan. B. Dickson; a Mozambique Monkey (*Cercopithecus pygerythrus*) from East Africa, presented by Mr. A. E. Snooks; a Bonnet Monkey (*Macacus sinicus*, ♂) from India, presented by Mr. W. Meears; a Black Lemur (*Lemur macao*), a Black-headed Lemur (*Lemur brunneus*), a Grey Lemur (*Hapalemur griseus*) from Madagascar, presented by Mr. R. A. Todd; a Roseate Spoonbill (*Ajaja rosea*) from South America, presented by Mr. E. J. Ghay; a Common Peafowl (*Pavo cristatus*, ♂) from India, presented by Mr. A. Burnell Tubbs; a Red-sided Eclectus (*Eclectus pectoralis*) from New Guinea, presented by Mr. Edward Hawkins; a —— Cassowary (*Casuarius*, sp. ?) deposited; a Thar (*Capra jemlaica*), a Red Deer (*Cervus elaphus*, ♂) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

CAMBRIDGE OBSERVATORY REPORT.—Sir Robert Ball records the completion and publication of the zone 25° to 30°, which forms part of the "Catalog der Astronomischen Gesellschaft." In it are the places of 14,464 stars, the result of about 47,570 observations, the Observatory having been engaged in this work during the last quarter of a century. The complete catalogue containing the individual observations is very nearly ready for press, and will be printed as soon as the volume already in the printer's hands has been issued. Mr. Hinks has undertaken a detailed comparison of the places of 671 stars in the Cambridge and Berlin Catalogues lying in the zone +24° 50′ to +25° 10′. The result seems to have been very satisfactory, the differences of declination being very small and apparently accidental, while in the case of the right ascensions small but systematic differences depending on the magnitude of the stars have been found. The designs for the new photographic telescope have been completed, and the instrument is being pushed forward; it is mentioned that probably the new building to contain it will be erected during the course of the summer. With regard to the Newall telescope, Mr. H. F. Newall tells us in his report, which is attached, that he has met with great difficulties in bringing his spectroscope into successful working order. The discrepancies were, however, securely traced, and the necessary alterations made, with the result that the photographs now obtained are considered very satisfactory. Some of the results already obtained, with regard to the motion of some stars in the line of sight, are given by him in his report, from which we make the following extract :—

Star.	No. of plates.	No. of lines employed.	Velocity deduced.	Potsdam results.	
				Vogel.	Scheiner.
α Tauri	1	5	+49·2	+47·6	+49·4
α Orionis... ...	1	4	+10·6	+15·6	+18·8
α Can. Min. ...	2	5 (each)	−3·5 −4·9	−7·2	−10·5
β Geminorum	1	5	−0·7	+1·9	+0·4
γ Leonis	2	3 (each)	−42·3 −37·5	−36·5	−40·5
α Boötis	7	7 (each)	−5·9 −6·8	−7·0	−8·3

In the last star in this list Belopolsky obtained the value −5·7, while Keeler's was slightly larger, namely −6·8.

The term of five years for which Mr. Newall placed his services at the disposal of the University in connection with this instrument has now been completed, and our readers will be glad to hear that he has renewed his proposal for another similar period.

NEW VARIABLE IN COMA BERENICES.—In a communication to the current number of the *Astronomischen Nachrichten* (No. 3433), Mr. T. D. Anderson gives details of the variable star he has recently discovered. It seems that on May 29 of this year he observed a star in the constellation of Coma Berenices, in position R.A. = 12h. 23·0m., Decl. + 32° 17′ ±1′ (1855·0). This star was not found mentioned in the BD., but its magnitude was estimated as exactly the same as BD. + 31° ·2373, namely 8·8. About ten days afterwards Mr. Anderson again observed the star, but could detect no change whatever in its brightness. Observing with his 2¼-inch refractor some four weeks later—on July 9 and 10—he was still unable to see the star, although BD. + 32°·2248 and 2253, which were both much brighter than it on May 29, were clearly visible. The magnitude of this new variable must have been lower than 9·5.

THE PHOTOGRAPHS OF THE MOON TAKEN AT THE PARIS OBSERVATORY.

THE second part of the Photographic Atlas of the Moon, published by the Paris Observatory, has just appeared. The photographs were taken at the Paris Observatory, by MM. Lœwy and Puiseux, and the negatives were exhibited at the Académie des Sciences in 1895. The satisfactory reception of the first series has induced MM. Lœwy and Puiseux to continue the work, and recently they have contributed two papers to the Académie des Sciences, of which the more recent deals with some new studies concerning the history of the lunar surface. We cannot do better than give a translation of this second communication.

"We have recently had the honour of presenting to the Academy the second part of the Photographic Atlas of the Moon, published by the Paris Observatory. We endeavoured on this occasion to enumerate, and to describe briefly, the principal objects which are represented therein. The object of this second note is to point out where the new maps seem to us to usefully complete the old ones, and to throw new light on the history of the formation of the lunar crust.

"We endeavoured before to ascertain what density of atmosphere might be conceded to the moon. This density being very feeble, it follows that the surface of our satellite must now be at a low temperature—at least, near the poles. There is even cause to ask if it is not totally or partially covered with ice. The most complete representation of the southern region, which is shown on Pl. vi., inclines us to the opposite view—that is to say, that the presence of a great accumulation of ice must be considered improbable, as well for the polar caps as for the equatorial region. One is, therefore, led to imagine that the total moisture on the surface must have disappeared, undoubtedly by penetration into the interior of the globe, before the polar regions sank permanently beneath freezing-point. It is simple enough to imagine this great absorptive capacity of the lunar crust for liquids. The cooling of our satellite, more rapid than that of the earth, has shortened the period of condensation of the vapours. The water was filtered as fast as it was formed in innumerable volcanic orifices, which seemed prepared to receive it. Pl. vi. gives us an idea of the abundance of these openings in the neighbourhood of the pole, and one is led to think that the same constitution must have existed on the whole of the moon previously to the formation of seas.

"The first pages of the Atlas gave us a fairly large number of rectilinear furrows, running without deviation across mountainous spaces, and subjected, in every region, to one or two principal orientations, in such a way as to constitute a sort of network. We have seen that these furrows could be replaced exceptionally by ridges presenting a similar condition. This appearance becomes, on the contrary, very frequent in Pls. vi. and vii., comprised in the present part. We see there signs of a strong lateral pressure, which has obliged two fragments of crust, brought into contact, to straighten their borders, or to encroach on one another. It is easy to see that the elevations thus formed by a local increasing of thickness are an efficient barrier to the formation and regular expansion of the walled plains. These tracings can be followed nowhere better than in the southern region, which is the best preserved of all, and has not participated in the general depressions of the rest of the crust.

"These depressions, whence the seas originated, are seen by crevices which practically fix the contour limit, and which are visible to us under favourable conditions. Pl. viii. shows a curious example of parallelism between these crevices and the prominent ridges which are seen to run great distances on the surface of the seas. This fact, and several others, lead us to think these undulations, in some respects inverse, as having a common origin.

"In fact, we observe in Pls. ix. and x. mountainous regions modelled on the same plan as their neighbours, offering, in point of view of relief, a perfect continuity with them, but distinguishing themselves by a darker colour. The situation of these markings on the edges of the seas gives us reason to believe that they have been occupied temporarily by liquid surfaces, and that these have retreated, before solidification, into more restricted limits. There would thus have been, in the inundated region, change of colour without appreciable alteration of relief. Taking into account the great delicacy of photography for differences of luminous intensity, it seems possible with its aid to distinguish the successive periods in the retreat of the seas of our satellite, as the palæontologists have successfully done with our globe.

"All the varieties of walled plains which we have come across so far are represented in the second part. There are some, like Gassendi and Eratosthenes, showing an irregular interior, and where the movement of the surface, which has brought them to their present state, has left very visible signs everywhere. Others, like Archimedes and Plato, have been invaded by interior overflowings, which have elevated and levelled the bottom. Elsewhere, as in Stadius and Guerike, the side has been corroded and partially destroyed. Copernicus and Aristillus, the walls of which rise considerably above the seas, are exceptionally interesting by the intensity of the upheaval, of which they seem to have been the centre, by the violence and long duration of the eruptions which have taken place within their walls, and which have modified, in a very extended way, the colour of the surface around them.

"However great the varieties in character of the walled plains, they are not always sufficient to completely explain their age and origin. We are only able to prove in each case the last term of a series of metamorphoses.

"The more or less perfect state of preservation of the walled plains is, however, an important indication always worth noting. The eruptive walled plains, with elevated borders and central mountains, cannot very well be of a great age. This relative soundness is apparently in favour of a more recent date, and other indications can be added to this. We see, for example, prominent formations, isolated in the middle of the seas, presenting generally a great regularity, as if they had been created in a crust, which became more homogeneous by liquid effusion. The absence of parasitic walled plains on their borders seems to show that at the time of their elevation the appearance of volcanic orifices had already become an exceptional thing. The great depression of their interior plains beneath the neighbouring level indicates a later solidification than that of the seas. The white streams which escape from them and stretch out, remaining visible on the surface of the seas, indicate notably Tycho, Copernicus, Aristillus, as having been the seat of great eruptions before all the parts of our satellite were fixed at their present level.

"The great walls totally effaced, partly destroyed, or filled up, perchance belong to a more remote time, because they have been subjected to greater modifications. The two principal causes of ruin have been the formation of parasitic orifices, and the overflowing of lava in the interior cavity. This second cause is without doubt that which has produced the most intense effects. By it a number of the great walls have come to be mixed up with the seas, and to possess only an obscure individuality. This slow destruction, which can be recognised in all its degrees, forces us to consider the majority of walled plains as more ancient than the seas. But the part of the local eruptive actions has, without doubt, extended over a much longer period than the overflowing of the lava. The abundance of small orifices surrounded by white borders, on the elevated plateaus as well as on the actual bed of the sea, leads us to look upon these violent eruptions as one of the most persistent phenomena in lunar history.

"Perhaps the linear features of the surface of the moon, very much neglected by selenographers in favour of the walled plains, offer, as well as these, a solid basis for establishing a chronology.

"In the first place, we will begin with prominent elevations, notably visible near Clavius, which have determined the polygon outline of the walled plains, and offered an almost invincible resistance to all the subsequent movements of the surface. By the side of these may be placed the rectilinear furrows in the region of Albategnius, representing, like the elevations, more or less intimate joints between the broken fragments of a primitive crust, but more easily destroyed or masked by recent eruptions. The spacious valleys which are met with near Herschel and Bode, across the Alps, are furrows enlarged by the movement of one of the fragments.

"The deep rectilinear crevices of Ariadæus and Hyginus, progressively narrowed at their extremities, indicate dislocations which have occurred in a crust already thicker and more coherent. The intercrossing systems, like those of Triesnecher and Ramsden, reveal the antagonistic influence of gravity and eruptive elevations.

"The parallel fissures which run to the outskirts of the

mountainous regions correspond to the successive depressions of the regions occupied by the seas. The obstruction of these fissures by the overflowing of lava has given most of them the aspect of prominent veins which can be seen branching at the surface of the seas, or crossing the middle part of some great walled plain. But amongst the concentric crevices at the seas, those which have remained open must have been contemporary with the most recent movements of the soil.

"If, however, we try now to compare and to make these two orders of parallel facts, often associated in the same region of the moon, agree, we shall be brought back by a slightly different way to the same chronology which we have already shown to be the most probable.

"The rectilinear furrows, transformed into elevations by a strong lateral pressure, or, on the contrary, into large valleys by a gradual disjunction, belong all to the first period—that in which the crust possessed a certain degree of mobility in the horizontal direction.

"The second period pertains to the forces of elevation which acted on extended areas, irregular as regards their boundaries. At this period great mountains begin to be formed. There are few forms sufficiently characterised which can be traced back to this obscure epoch of transition.

"Nevertheless the elevated regions with a scarcity of walled plains, covered with scoriæ which has accumulated without any regularity, can give an idea of what the general aspect of our satellite must have been at that time. The group of the Apennines is undoubtedly the most important vestige which remains from that epoch. In a third period appear conical intumescences, the first outlines of the walled plains. These obtain their real actual physiognomy by the progressive depression and the partial submersion of their central region.

"The fourth period, the grandest and most durable in its effects, brings about the destruction of a great part of the anterior relief, and gives to the whole of the lunar globe an aspect differing very little from that which we see now. The depressions, caused by the general contraction of interior fluid, include at once the vast regions which we designate by the name of seas, and cause immense quantities of lava to flow back in uniform sheets to the surface. The mountainous plateaus appear as isolated groups, and in the intermediate spaces a mass of furrows and walled plains disappear by submersion. An idea of the importance of the change brought about, will be gathered by comparing the polar and equatorial regions, so unlike to-day, but which, without doubt, formerly bore the same aspect.

"The first new features which become visible in the uniform plains thus formed are crevices which follow their borders and increase with the progress of the depression, until a fresh overflowing of lava takes place, stops them up, or transforms them into prominent lines. The most recent cracks can remain open, or become visible by the difference of altitude which exists between the two edges. This fourth period brings the lunar crust to a more stable condition, of which it did not actually appear possible to foresee the end. The local eruptions always become visible across the crust already solidified, and complete the fifth period. In the mountainous parts they create parasitic orifices, which degrade and render unrecognisable the ancient formations. In the seas the volcanic forces, which are obliged to cross a thicker and more homogeneous crust, enforce the appearance of regular cones, generally transformed into little walled plains by the depression of their centre. Some large formations, such as Copernicus, have probably appeared in this way. Most of the walled plains thus created in relatively recent times can be distinguished by their isolated situation in the middle of a plain, by the regularity of their form, by the white borders which surround them, and which indicate violent eruptions experienced in the neighbourhood of their centre.

"These inductions can, naturally, only acquire a convincing nature if the objects in question, or at least their exact image, are before us. When Beer and Mädler published their great work on the moon in 1837, they limited themselves to simply stating facts. They themselves acknowledged they had tried to eliminate from their descriptions all that could lead to a tendency to theorise, and favour any particular view concerning the actual state of the moon and the history of its metamorphoses. It has seemed to us that the editor of a photographic document was not bound to such reserve. The authenticity of the facts on which he relies can be absolutely verified. Placed in the presence of a true and impartial reproduction, the reader is in a position to judge for himself, and to have an independent opinion. It is not wanting in any respect to him, but to facilitate this task, that we try to formulate the very varied problems which the examination of the moon suggests, to report the most curious facts, and the examples which are best for determining the choice between the different possible theories. We have endeavoured to do this in the notice which accompanies the second part of the Atlas, of which the preceding lines contain the principal ideas."

THE INTERNATIONAL CONGRESS OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

THE recent congress of Naval Architects and Marine Engineers, which was brought to a conclusion on Thursday of last week, July 15, has taken the place of the usual summer meeting of the Institution of Naval Architects. As our readers are aware, the two preceding summer meetings of this Institution have been held respectively in France and Germany, and on both occasions the meetings have been of more than usual brilliancy and importance. The generous hospitality extended to members of the Institution in Paris, Berlin, and Hamburg created a very natural desire on the part of those entrusted with the conduct of the affairs of the Institution to do something to show that the sympathetic and friendly feelings aroused extended beyond mere expressions of gratitude conveyed in speeches and formal documents. It was determined therefore to hold a congress in London this year, at which naval architects and marine engineers of all nations should be the honoured guests of the Institution. The Earl of Hopetoun, the President of the Institution, threw himself into the work of forming a reception committee with characteristic enthusiasm, and was most ably seconded by Mr. George Holmes, the Secretary of the Institution, on whom, naturally, the chief burden of the work has fallen. A subscription list was opened, and, being most liberally supported by the leading members of the Institution, there was no lack of the most needful feature for success in all operations of this nature. The result has been one of the most brilliant and successful gatherings yet held by a technical society. Foreign delegates, representing the leading men in the twin sciences of naval architecture and marine engineering, attended in response to the invitation of the reception committee, and the whole proceedings were so perfectly organised by Mr. Holmes and his staff that the congress passed off without a break in the continuity of success.

In a grand function of this nature it is the social and international aspect which attracts attention rather than the scientific bearing. When the Queen extends hospitality, when the heir to the throne presides, even the most austere seeker after scientific truth may, perhaps, relax, and lose sight for a time of the sterner aspect of the meeting. Two sittings were held at the Imperial Institute for the reading and discussion of papers, but undoubtedly the chief features of the congress were the reception of the members and foreign delegates by Her Majesty at Windsor, the inspection of Portsmouth Dockyard, and the subsequent cruise in the Solent on the mail steamer *Mexican*, the conversazione held at the Mansion House by the Lord Mayor and Lady Mayoress, the reception by the First Lord of the Admiralty at his official residence, the Honourable Mr. and Lady Idina Brassey's soirée at Lord Brassey's house in Park Lane, and the concert at the Queen's Hall, in which the magnificent Yorkshire choir played so prominent a part, and at which Madame Albani was the principal singer. In addition to this there was a more business-like visit to the Docks, an opening reception on the first evening of the congress at the Hotel Cecil, and the annual dinner of the Institution. It is, however, not within our province to chronicle these delights; but before glancing at the more business part of the congress, we may call attention to the excellent effect produced by international gatherings of those devoted to applied science drawing closer the ties of friendship. The leading shipbuilders and marine engineers are men of high position and influence in the country. Their visits to France and Germany have led to the most pleasant relationships, and these have been cemented by the visit of so many foreign delegates during the recent congress. These things make for peace; so that when a section of the daily press, at home or abroad, is occupied in its frequent endeavour to stir up ill-feeling between different peoples, it will find its un-

amiable efforts less likely to be crowned by success. In support of this view, we would call attention to the generous letter of thanks from the foreign delegates which appeared in last Saturday's *Times*.

The first sitting for the reading of papers was held in the Imperial Institute on Tuesday, the 6th inst. The Prince of Wales, as President of the congress, delivered an opening address, and was followed by the First Lord of the Admiralty, and by Lord Hopetoun, the President of the Institution of Naval Architects. The congress was then divided into two parts, that relating to Naval Architecture being held in the Main Hall, whilst the Marine Engineers took possession of the East Conference Hall. The first paper taken in the former section was a contribution by M. Émile Bertin. It was on "hardened plates and broken projectiles," and discussed the effect of "Harveyising" steel armour. This paper was to some extent based on one read previously by Mr. C. Ellis, of Sheffield. The author supposed that a cap placed on the point of a projectile would assist in penetrating the plate. This system was first tried in England and met with approval, and judging by M. Bertin's paper he supports the device. The practical success of the Harvey system of treatment—which is in the nature of case-hardening—is now so fully established that it is needless to follow up the subject in this brief sketch; but, to those who wish to pursue the matter in its more scientific and abstract features, the paper in question will afford both instructive and interesting reading. It must, however, be taken with the illustrations.

"Non-flammable wood" was the subject of the next paper, contributed by Mr. C. Ellis, of Sheffield. In the process described, timber is placed in a cylinder and a vacuum is formed. Steam is then admitted, and the moisture is drawn off with it. A vacuum is then again formed, and a fine spray of a liquid containing certain salts is injected into the cylinder, the fibre being thus thoroughly impregnated by the chemicals. Under these circumstances the wood will not support flame. So far there does not appear to be anything very novel in the principles of the process, though there may be in the details, and possibly the "certain salts" cover an important point upon which information was not given in the paper. The advantage of wood used in warships being "non-flammable" is beyond question.

In the Marine Engineering Section, at which Sir Edward Reed presided, Sir John Durston and Mr. J. T. Milton contributed the first paper, which comprised "a review of the history of the progress of marine engineering in the Royal Navy and Mercantile Marine from the foundation of the Institution of Naval Architects to the present day." This was one of those elaborate contributions to the literature of the subject which will be invaluable to the historian of the future and the writers of books in general, but which it would be foolish to attempt to abstract here. Its title is sufficient to denote its scope, and the high reputation of the authors is sufficient to stamp the paper as a standard work. A paper by M. Sigaudy was next read. It treated upon water-tube boilers in high-speed ocean steamers, and gave details of actual practice in small vessels, and proposals for larger ones, strongly supporting the suggestion that small tubes, or, as they are called in England, "express" boilers, should be used on ocean-going vessels.

On the second day of the congress, Wednesday, July 7, the Naval Architecture Section was opened by the reading of a paper by Sir Edward Reed, on the mathematical theory of naval architecture. This was another monumental paper worthy of the subject and the year. It led to a discussion largely of a nature complimentary to the author, who had managed to compress a large mass of information of a general nature within the limits of his memoir, and to do this without making the subject repulsive by its dryness to the average reader of such contributions. Captain Tuxen, Chief of the Construction Department of the Royal Danish Navy, next read a paper, in which he described some of those admirable railway ferry steamers which break their way so remarkably through the ice-bound waters of his native land. The last paper read in this Section was contributed by Mr. J. Johnson, of Göthenburg, and dealt with "graphic aid in approximating hull weights."

In the Marine Engineering Section, in which Sir Nathaniel Barnaby occupied the chair, the proceedings were opened by Mr. G. W. Manuel reading a paper on "crank and other shafts." Mr. Manuel, as is well known, is the Chief of the Engineering Department of the P. and O. line, and his success in regard to the absence of accidents to the shafting of vessels under his charge has been remarkable. In this respect, however, he has been fortunate in being able to give such substantial proportions to this feature in machine design that success is not altogether to be attributed to good fortune; indeed, it has been said that if Mr. Manuel were to make his shafts of cast iron they would be reasonably safe. By aid of diagrams many instructive illustrations were given of the manner in which shafts fail, often by fatigue. Mr. Manuel is not an advocate of hollow shafts, and though he gathers countenance for his views to some extent from the fact that hollow shafts are not general in the mercantile marine, we do not think the reasons he puts forward would meet with the support of many naval engineers. The paper was, however, full of information, and was followed by an interesting discussion.

Mr. Sydney S. Barnaby followed with an excellent paper, in which he gave a lucid explanation of the theory of cavitation with screw propellers, that new disease which is the outcome of modern high speeds, and to which marine engineers are now turning their attention. We commend Mr. Barnaby's paper to all naval architects who have not mastered this somewhat intricate subject. The last paper read was contributed by Dr. H. S. Hele-Shaw, Professor of Engineering at Victoria University, Liverpool. Its title was "Experiments on the nature of surface resistance in pipes and on ships." This was a most interesting contribution, and might with advantage have occupied more time than could be allotted to it. Doubtless, however, the experiments shown will be brought forward again in other guise. The author's method of studying resistance is to inject water between plates of glass, placing such obstructions to the flow as may be desired, and to throw the image on the screen by the lantern. In order to get a visible result of the streams and eddies, air is injected into the water, or sometimes a coloured liquid. The result is most satisfactory, and cannot but lead to considerable light being thrown on this interesting and very debatable subject. It would be impossible to follow the author in the details of his paper without the aid of graphic representations; but the effects produced on the screen were mostly illustrated by engravings taken from photographs, and presented with the paper. It is to be hoped Dr. Hele-Shaw will carry his work further, and, by their aid, give substantial guidance in this field of research.

The foreign delegates and some of the home members of the Institution continued the work of the congress by visiting Glasgow and Newcastle, where a few of the most prominent shipyards—Fairfield, Denny's, and Elswick—were visited.

LIGHTHOUSE PROGRESS, 1887-1897.

IN 1887 some account was given in NATURE of lighthouse work and progress in the United Kingdom during the preceding fifty years. I propose in this article to consider briefly the same subject in connection with the past ten years, so that the whole may form a summary record of what has been attained during the Victorian era in this important branch of optical and mechanical science.

And, first, it may be asserted that the period of the Queen's reign, distinguished as it is for so many developments of new industries, can boast of none more valuable or more interesting than this now in question. Fresnel's monumental invention in 1819 of the dioptric system of lights was at once welcomed and realised by the French Government, who have since always encouraged and supported the native constructors of lenticular apparatus. But it was only after thirty years from this date that the lighthouse industry was planted in England, if we except the experimental attempts of Messrs. Cookson, of Newcastle. The systematic and permanent establishment is due to the public spirit and the enterprise of Messrs. Chance Brothers, subsequently aided by the mathematical talents and personal direction of Mr. James T. Chance, whose services to the Royal Commission on Lights of 1860, as well as to the Trinity House, and whose writings on lighthouse optics are widely known. It is said that great pecuniary loss resulted from the first efforts of Messrs. Chance, but they have gone on steadily and alone to the present day, with little or none of official aid or encouragement, and they are certainly entitled to full credit for having done so much and so well for the coast illumination of their own country and the world.

I adopt the main divisions of the former articles, viz. Towers, Apparatus, Lamps.

There is not much to be noted in regard to the architecture or engineering features of the iron and stone lighthouses erected in Britain during the past ten years. The principal island towers are in the Shetlands, viz. Stroma, Fair Island, and Sule Skerry, which is one of the dangerous reefs known as *skerries* so thickly strewn on the northern and western coasts. These all are the successful works of Messrs. D. and C. Stevenson. The Trinity House has not erected any rock or pile tower since the Round Island in 1887.

Of lightships there have been established two only, which are at the mouth of the Thames to mark the Edinburgh Channel, and, like all the Trinity lightships, they have 21-inch silver-plated reflectors, with the powerful two-wick oil burners of Sir J. Douglass, the flash from one face of the light being equal to 20,000 candles.

To nearly all the light-vessels in our waters sound-signals, chiefly of the siren type, have been added, which are invaluable in the frequent sea fogs that beset our shores, since by a marvellous beneficence of nature—for the proof of it we are chiefly indebted to the researches of Tyndall—fog that quenches light deepens the intensity of sound. The siren is now an indispensable adjunct to our principal land-lights, and a visit to the Isle of May, the St. Catherine's, or Ailsa Craig, would well repay any one desirous of seeing the latest and best arrangements for the production and transmission of its weird and inimitable notes.

Many of our land lights and floating lights have been connected with the main telegraphic system "for life-saving purposes only." There were, at the end of 1896, 27 such stations in England and Wales, 14 in Scotland, and 11 in Ireland. The most suitable places were selected for the observation of passing vessels and for the immediate transmission of reports of casualities to the nearest points available for help. It is by no means an easy work to make a durable telegraphic connection with a lightship, and with all stations the cost is considerable; but the benefit is so marked that this communication, long and urgently demanded, will soon be extended to all other sites on the coast where the advantage is evident, and the difficulty not insurmountable.

Of the new sea lights in the decade under review may be mentioned the Girdleness, the Rattray Head, the Tarbetness, the Stroma, the Scaddon, the Skroo, and the Sule Skerry, all on the Scottish coast; and the Round Island, the St. Catherine's electric, the Spurn Point, and the Withernsea, on the English coast. The characteristics of several older lights of fixed sections have been changed, such as the Whitby, Coquet, Orfordness, Southwold, and Needles, which have been made occulting lights.

To complete the bare statistics of the subject, it may be mentioned that the whole number of lights of all sorts and sizes on the coasts of the United Kingdom on December 31, 1896, according to the Admiralty List, was 1095, an increase of about 200 over the number of ten years ago. Of the 1095 lights, not more than 11 or 12 per cent. may be classed as of sea-power, and 6 or 7 per cent. as lightships. The rest are port, harbour and pier lights, showing a very abundant supply of local signals apart from the great coast signals controlled by the three Lighthouse Boards.

It would seem, indeed, that the programme of coast lighting is almost completed—at least as regards England. A powerful oil light is to be erected by the Trinity House in St. Mary's Isle, on the north-east coast, and two others in Lundy Isle in the Bristol Channel, where also, at Lynmouth, an electric light is proposed. A further improvement in the fine reflector light of Beachy Head is also spoken of. The Northern Commissioners will erect a first-class light at Noup Head, in the Orkneys, and another on the Flannan Islands in the Hebrides. For Ireland no new light appears to be intended for the present; but the improvement of the Fastnet, the most outlying of our lights westward, must soon be taken in hand.

The *lantern* which crowns the tower and protects the apparatus of a land or rock lighthouse has been materially improved in its construction. The perfect lantern is of adequate area to contain the light and accessory parts, and afford convenient space for service. Its diameter for a sea light is rather 14 feet than 12 feet. It is of circular form throughout, having a cast-iron pedestal of sufficient height to carry an inside and an outside gallery for cleaning purposes. The framing is of gun-metal or wrought iron. The half-inch plate-glass of the purest quality, while resisting wind and weather to a great extent, intercepts the least possible light from the lenses. There is provided abundant ventilation to sustain the central lamp, and refresh the keepers. The best contribution of the Trinity House to the structure has been the large cylindric ventilator on the double copper dome, by which the last-named advantage is mainly secured.

Turning to the optical features of the decade, let us see what changes have affected the two main factors of illumination—the fixed light and the revolving light. The ever-increasing number of ships and ports, and the sustained demand for greater and greater speed of vessels, and for sea signals that shall serve more and more to meet all conditions of weather and to discriminate harbours and channels of approach, have stimulated the efforts of lighthouse engineers in the two directions of power and distinctiveness.

The *characteristics* introduced of late years have been confined for the most part to new combinations and periods of group flashes, or of single equal flashes. Mixed lights of fixed and revolving sections, and therefore with unequal degrees of visibility, are no longer in good repute, although, in the French service especially, they are still retained. Colour also is being gradually abandoned for sea lights. For harbour lights, however, it is still freely resorted to, most of all in Northern Europe, as in the Omo light, Baltic Sea, where in one small apparatus there are no fewer than six characteristics with seventeen variations.

Power has been sought—

(1) By the substitution, wherever practicable, of annular for cylindric lenses, or of revolving for fixed sections.

(2) By the longer focal distance and larger condensing surface of these lenses, and by superposing them in vertical series.

(3) By using an illuminant of maximum intensity, whether oil, gas, or electricity.

(4) By certain variations and extensions of the Fresnel refractors, giving a higher coefficient of beam.

(5) By invoking the principle of the full perception of the light from an annular lens moving in rapid rotation with very short intervals between the flashes. This is known as the *feu éclair*.

(6) By rotating an opaque screen around a lamp, or by raising and lowering quickly an opaque cylinder, or by cutting off and relighting of gas in rapid alternation.

Let us consider these in order.

(1) The reasons for the disuse of fixed sea lights, except in the case of marking or intensifying particular sectors, are chiefly their want of power to penetrate to their natural horizon, and the increasing number of bright fixed lights on ships and on shore, which may in certain conditions lead a navigator into danger from the difficulty of distinguishing them from a lighthouse. The flashing light, with its superior power and numerous possible distinctions, is the best safeguard against this.

(2) The hyper-radial lens of 1330 millimetres focal distance, first suggested (as Prof. Tyndall declared) by Mr. John Wigham, and concurrently at least by Mr. Thomas Stevenson, who less fitly termed it hyper-*radiant* (a good name for the ten-wick oil flame, or ten-ring gas flame), has quite justified the expectation of lighthouse engineers as a convenient and powerful instrument admirably adapted to the large burners now employed. This lens, like its predecessor of 920 millimetres radius, is commonly used without catadioptric prisms, as in the Spurn Point light. The disuse of prisms effects a great saving in cost at but an inconsiderable diminution of power where a high vertical angle of refraction is adopted. Yet it must be admitted that this is at the expense of symmetry and elegance. The French light on Cape d'Antifer is a fine example of the hyper-radial system, embracing a full complement of prisms.

There has also been constructed, at Mr. Wigham's suggestion, as an experiment, what he aptly calls a giant lens of 2000 millimetres radius, but it is not yet adopted in practice.

The superposition of lens lights, each with its own burner, is an obvious means of gaining power, and it is remarkable that, although first suggested in 1859, it was not practically utilised with dioptric apparatus until 1872. Whether biform, triform, or quadriform arrangements be resorted to, the advantage of concentrating or reducing the intensity of the beam according to atmospheric variations is inestimable, and the adaptation reflects undoubted credit on Mr. John Wigham, whose polyannular gas-burner on a like plan had been already approved. The triform

Tory Island light, fitted with these burners, and variable in power from 17,500 to 326,500 candles, may be cited in illustration.

(3) The maximum intensity of an illuminant must still be sought in the electric arc. Gas and oil remain substantially equal compared in lamps of the same size and sort, the superior applicability of each being determined by local conditions. In Ireland the Wigham expanding burners give a marked prominence to the gas, which is copiously used in them. In England and Scotland mineral oil is preferred, its quality being carefully maintained at the highest standard. The old disability of this illuminant, the risk of explosion, has been almost nullified by the production of a petroleum whose flashing point is 230°, and long experience has confirmed its great value. On the other hand, the gas called "incandescent" has been introduced, the best form of it being of the Auer-Welsbach type. The brilliancy of this gas is perhaps only second to that of the electric arc, but the perishable character of its accessories exacts great caution in using it, and it has not as yet been employed in any sea light in this country, although it is already so adopted in France. A mixture of oxygen and coal gas, and one of oxygen and oil vapour, which have been tried in street lamps and otherwise, have been recommended for lighthouses, but not hitherto accepted.

Electricity has been, as it were, on its trial since the South Foreland experiments of 1885, and the evidence affecting it is hardly yet complete enough to justify a final verdict. The result established at the South Foreland was that the electric light is the most powerful under all conditions of weather, and has the greatest penetrative intensity in fog. The Committee of the Royal Society, which examined in 1890 this report of the Trinity House, found that the experiments did really justify the results given.

The twelve years that have elapsed since the trials at the South Foreland have on the whole tended to qualify the conclusion as to the penetrative power in fog. Three lights—two of the group-flashing, and one of the single-flashing character—constructed by Messrs. Chance, may be cited on this point. The triple flash of the Tino light (near Spezia) has been unmistakably discerned in rain and fog at a distance of more than twenty miles. On the other hand, the Isle of May light has been invisible in a thick atmosphere not amounting to fog, at a distance of twelve miles, and in a dense fog at half a mile; and the St. Catherine's light was equally invisible to the *Eider* before she grounded on the Atherfield ledges. It has been, indeed, asserted that the St. Catherine's has often been unseen at a quarter of a mile distance.

The truth appears to be that the electric light is very sensitive to atmospheric conditions, which are so many and so various, and that in thick weather it parts with its power in a much greater ratio than does a gas light, or even an oil light. There is a degree of fog which quenches the sun, while the large luminous surfaces of the superposed gas lenses project on the fog a reddish colouration, and the fog itself thus becomes a signal to the mariner when, as it were, in the words of Persius, "Pinguem nebulam vomuere lucernae." It would be most dangerous, however, for the mariner in a fog to approach the coast presuming on this quality of a light in whose vicinity he supposed himself to be. The lead, the anchor, the horn should be his trust till the veil lifts, and the electric beam shines out in full splendour.

There has occurred no important change in the *burners* of sea lights. The Trinity House improved six-wick, or rather five-wick, remains, if not the largest, the best working oil burner, with a power of 800 candles. This is used generally for lights of the first and second order, while the four-wick, with a power of 360, is used for third order lights, and the eight-wick, of 1200 candles, for hyper-radial lights. The lamp is of the "pump" or the "pressure" type, and contains from 10 to 100 gallons of oil. It is probable that, owing to considerations of space and economy, the gravity system may again be resorted to with enlarged reservoirs seated on the lantern-roof. The electric arc is used with carbons of from 15 mm. to 65 mm. diameter, and currents of from 50 to 400 amperes. The incandescent filament is not found equally appropriate. The luminous intensities obtained from the arc range from five to fifty thousand candles. Both direct and alternating machines are employed. The installations at St. Catherine's and the Isle of May are of the most complete character, and do honour to the distinguished engineers of the Trinity House and the Northern Commissioners.

It may be mentioned that for positions difficult of access, lamps having special wicks and reservoirs for oil or gas, capable of burning from ten to thirty days, are now in use, though, of course, these are only available for small isolated lights.

(4) The improvements since 1887 in dioptric lights are few, and, with one exception, are of no striking importance. The great invention of Fresnel, perfected by the beautiful holophotal arrangements of Stevenson, has remained the cardinal principle of all modern lights of the lenticular type. But the inevitable tendency to modify and improve has resulted in several proposals of more or less merit. Mr. Alan Brebner had, in 1882, submitted an ingenious plan for producing vertical and azimuthal condensation by single agency in cases where straight prisms placed outside the main apparatus had been employed to intensify one or more sea sectors. This method, however, has been seldom, if at all, adopted. Again, Mr. Brebner, in 1884, had recommended a plan of dipping a portion of the beam to some intermediate distance between the lighthouse and the horizon to meet the case of a fog which the strongest beam can only very partially penetrate. This, or some analogous plan, has been tried, but has not prevailed. The advantage of withholding from the horizon a substantial part of the beam, and deflecting it anywhere, is extremely doubtful. The depth and direction of a fog are always uncertain elements. The lighthouse may be surrounded by it while the offing is clear, or *vice versâ*. And it would be in equal measure mischievous to encourage the mariner to stand in, looking for a signal which he might never see, or see too late; and to entrust the lightkeeper with the power to deflect the light according to his own judgment. In 1892, Mr. Charles A. Stevenson published in NATURE an account of his spherical and equiangular refractors which remedy a certain loss of emergent light in the Fresnel refractors. In 1894, Mr. Stevenson further developed his design, claiming for it, within practicable limits, an advantage of at least 10 per cent. in increase of light as compared with the Fresnel lens. The improved refractors have been adopted with success in several of the Scottish lighthouses. In 1895 and 1896, Mr. John A. Purves contributed an able mathematical analysis of equiangular prisms and a new form of spherical central lens, called the Inverse Refractor (the facets of the lens turned inwards), to be used in connection with Mr. C. Stevenson's equiangular prisms. Messrs. Chance have raised the Fresnel lens from 57° vertical to 80°, using glass of the same refractive index, and this angle has been adopted by the Trinity House with great advantage.

(5) The one exception referred to in regard to the minor improvements of optical apparatus since 1887 is the "lightning light," an adaptation of serious importance which has attracted the attention of lighthouse engineers in nearly all maritime countries. The shortening of the interval between the flashes of a revolving light, so that the mariner, especially when in a fast liner, may have more speedy cognisance of the signal that guides him, has become a plain necessity, and led to the gradual reduction of the period from 60, 45 and 30 seconds to 20, 15, 10, and even 5 seconds, reducing proportionately the duration of the flash. So far the principle of the *feu éclair* has been approached. But much more than this is demanded. No one has advocated more strenuously than Lord Kelvin, himself a sailor and a benefactor of sailors, the acceleration of revolving lights. No one has laid it down more clearly that one-ninth or one-tenth of a second is sufficient for the eye to receive the full lustre of a lens passing it. Any longer duration is a loss of time, and therefore of intensity. German and French physiologists have confirmed this, and it is the principle on which the *feu éclair* system is based. In its application, then, if for any "order" of light the maximum of power be desired, the largest available lens in vertical and horizontal angle, combined with a totally reflecting mirror and a central flame of adequate dimensions, must be adopted. If two or more lenses be used, singly or grouped, the intensity of each flash is proportionately less, the interval of time, say five seconds, between the single flashes or the groups of flashes, being the same as where there is only one lens. In this manner the greatest intensity and the shortest interval are secured, and the characteristic as presented to the mariner seems theoretically perfect. The first general introduction of the "lightning light" is due to M. Bourdelles, the chief of the French Lighthouse Administration, under whose auspices several lighthouses on the coasts of France have already been endowed with it. In England Messrs. Chance have constructed, in 1895, for Cape Leeuwin, Western Australia, a "bivalve" apparatus of the first order, with an experimental duration of beam of one-fifth of a second,

and they have placed, this year, in the Exhibition of the Imperial Institute a "univalve," or one-lens apparatus, of the third order. Both these lights are on the *feu éclair* system.

Successful as this system appears to be, it should for the present be regarded as on its trial, and as awaiting the collective judgment of mariners on certain points. And meanwhile it should be estimated as supplementing, not displacing, the well-tried forms of apparatus at the disposal of the lighthouse engineer.

A notable adjunct to the new rapidly rotating lights is the mercury-float carriage, by which the effect of weight and friction is largely diminished. Another excellent quality of this arrangement is its suitableness for stations where earthquakes prevail, as it provides an elastic connection between the optical apparatus and the pedestal, instead of the rigid bearings in the older forms of carriage. If the Curaumilla lighthouse in Chili had been fitted with the mercury-float, it is probable that it would not have been wholly ruined by the shock.

(6) The principle of *occultation*—that is, of interrupting the fixed beam of a cylindrical lens of an oil light by a dark shade moving round or over the flame, or in a gas light by cutting off the gas—is acknowledged to be of extreme usefulness, and has been applied to many of the fixed lights of our coasts. It is not that any power is really added to the light, but that the quick alternation of light and dark in various groups or periods imparts a quasi-intensity to the beam, and a valuable set of characteristics for the mariner. The law of contrast has a physiological effect here, as it has in another manner with the *feux éclairs*. It is an extreme example, but it rests on trustworthy evidence, that the occulting light of Ventotene Island, near Naples, which is of the sixth order only, has been seen from a distance of nineteen miles, its normal range being nine miles. Using the words of Cicero with another application, it may be truly said, "Eo magis elucet quo magis occultatur."

Investigations into the amount of light reflected and transmitted by certain kinds of glass—lighthouse glass among the rest—have been most ably conducted by Sir John Conroy, Bart., at Oxford, in 1888. He traversed by newer methods and with surer results the ground of many observers, from Augustin Fresnel to Lord Rayleigh; and he demonstrated that "the values of the transmission-coefficients for light of mean refrangibility show that for 1 centimetre the loss by obstruction amounts to 2·62 per cent. with crown glass, and 1·15 with flint glass." The refractive index of lighthouse glass lying between 1·52 and 1·54, the loss may thus be practically taken as 2½ per cent. for 10 millimetres of thickness.

The intensities of lighthouse apparatus have of late been diligently considered by lighthouse authorities with the view of determining, once for all, the relative values of the six orders of lights, and of the lamps appropriate to them, and also of publishing the results in the Admiralty Light-list. A large amount of uncertainty and misconception seems to have prevailed on this question. M. Allard, in 1876, in a celebrated memoir, gave an elaborate exposition of the whole subject, but his conclusions, always tending to excess, have not been accepted by more recent investigators.

Other estimates, official as well as private, and more or less discordant, have from time to time appeared, both in this country and France. The factors of evaluation, such as radius, lens-surface, vertical section, flame, reduction for losses, &c., have been combined in different ways by different persons, and some of their conclusions must be regarded as merely empirical. But in 1891 and 1892 a serious attempt was made by a committee of the chief engineers of the three Lighthouse Boards to compile an accurate schedule of intensities with photometry as a basis. Taken as a whole, the values arrived at are fairly acceptable, not certainly erring on the side of excess.

But as yet only the lights with oil or gas for illuminants have been determined.

Electricity appears even more difficult to deal with, and no intensities have been assigned officially to any of the electric lights in the British Islands.

Thus it is uncertain whether, for instance, we are to consider the Isle of May as of six millions of candles, or of twenty-six millions, both estimates resting on competent professional authority. The lights on the *feu éclair* system, oil and electric, are obviously less amenable still to formulæ which may give their coefficients of intensity, although French writers do not hesitate to define these, and deduce thirty or forty millions of candles as "ayant la consécration de la pratique."

It is much to be desired that as a sort of sequel to the publication of the intensities of lights—at all events, of the British lights—there should be provided a form for every vessel under the control of the Board of Trade, in which a return should be made of the appearance of every light approached or passed, with statement of the weather, distance, name and character of the light, &c. These returns, duly kept and handed to the Board of Trade on the first opportunity, would gradually constitute an invaluable record of the merits or demerits of our lights, instructive to the engineer, and, through him, beneficial to the mariner. I have repeatedly, but in vain, urged this expedient on the authorities.

The administration of lighthouses in this country has undergone no change in the past decade, nor, indeed, since 1861, when the Royal Commission on Lights recommended that a Central Board should be constituted instead of the quadriform government then, as now, in force, and gave excellent reasons for the recommendation. The further experience of thirty-six years has amply confirmed the earlier conclusions on this subject, and has brought into stronger relief the example of the French Administration. Some slight approach to the desired reconstruction may be indicated in the Report of the Committee of Inquiry on the Mercantile Marine Fund of 1896, paragraph 71, in the following words: "From the evidence brought before us we unanimously recommend the formation of a small committee containing representatives, possessing as far as possible nautical knowledge, of the Trinity House, the Scotch Board and the Irish Board, which should be summoned at least once a year to advise the Board of Trade upon the desirability of all new works, whether in respect of lighthouses, steamers, buoys or signals, together with all renewals, alterations and important repairs."

But however we may regard the system of government of our lighthouses in contrast with the French system, and desire its amelioration, it is impossible to deny that the United Kingdom has during the Victorian era produced men who individually have done fully as much in every part, theoretical and practical, of lighthouse science as have the distinguished men of the sister country. In one group we can point to the names of Faraday, Airy, Thomson and Chance. In another to those of Stevenson, Douglass, Hopkinson and Matthews. In yet another to those of Farrar, Nisbet, Sydney Webb, Trevor, Wharton and Nares.

These men have enriched and illustrated lighthouse mathematics, engineering, optics, mechanics and nautical and general administration, in a manner and with a success to be gratefully remembered in our day, and never to be forgotten in the new developments of the years to come. J. KENWARD.

[*Note.*—I would invite the attention of visitors to the Imperial Institute to the very ingenious and effective illustration of the progress of British coast lights during the past sixty years, by means of two large illuminated maps and a relief plan. This is exhibited by the Trinity House, whose collection of models, lenses, reflectors and burners is also very commendable.—J. K.]

THE LIMITS OF AUDITION.[1]

IN order to be audible, sounds must be restricted to a certain range of pitch. Thus a sound from a hydrogen flame vibrating in a large resonator was inaudible, as being too low in pitch. On the other side, a bird-call, giving about 20,000 vibrations per second, was inaudible, although a sensitive flame readily gave evidence of the vibrations and permitted the wave-length to be measured. Near the limit of hearing the ear is very rapidly fatigued; a sound in the first instance loud enough to be disagreeable, disappearing after a few seconds. A momentary intermission, due, for example, to a rapid passage of the hand past the ear, again allows the sound to be heard.

The magnitude of vibration necessary for audition at a favourable pitch is an important subject for investigation. The earliest estimate is that of Boltzmann. An easy road to a superior limit is to find the amount of energy required to blow a whistle and the distance to which the sound can be heard (*e.g.* one-half a mile). Experiments upon this plan gave for the amplitude 8×10^{-8} cm., a distance which would need to be multiplied 100 times in order to make it visible in any possible microscope. Better results may be obtained by using a

[1] Abstract of a lecture delivered at the Royal Institution on April 9, by the Right Hon. Lord Rayleigh, F.R.S

vibrating fork as a source of sound. The energy resident in the fork at any time may be deduced from the amplitude as observed under a microscope. From this the rate at which energy is emitted follows when we know the rate at which the vibrations of the fork die down (say to one-half). In this way the distance of audibility may be reduced to 30 metres, and the results are less liable to be disturbed by atmospheric irregularities. If s be the proportional condensation in the waves which are just capable of exciting audition, the results may be expressed :—

c'	frequency = 256	$s = 6{\cdot}0 \times 10^{-9}$
g'	,, = 384	$s = 4{\cdot}6 \times 10^{-9}$
c''	,, = 512	$s = 4{\cdot}6 \times 10^{-9}$

showing that the ear is capable of recognising vibrations which involve far less changes of pressure than the total pressure outstanding in our highest vacua.

In such experiments the whole energy emitted is very small, and contrasts strangely with the 60 horse-power thrown into the fog-signals of the Trinity House. If we calculate according to the law of inverse squares how far a sound absorbing 60 horse-power should be audible, the answer is 2700 kilometres! The conclusion plainly follows that there is some important source of loss beyond the mere diffusion over a larger surface. Many years ago Sir George Stokes calculated the effect of radiation upon the propagation of sound. His conclusion may be thus stated. The amplitude of sound propagated in plane waves would fall to half its value in six times the interval of time occupied by a mass of air heated above its surroundings in cooling through half the excess of temperature. There appear to be no data by which the latter interval can be fixed with any approach to precision; but if we take it at one minute, the conclusion is that sound would be propagated for six minutes, or travel over about seventy miles, without very serious loss from this cause.

The real reason for the falling off at great distances is doubtless to be found principally in atmospheric refraction due to variation of temperature, and of wind, with height. In a normal state of things the air is cooler overhead, sound is propagated more slowly, and a wave is tilted up so as to pass over the head of an observer at a distance. [Illustrated by a model.] The theory of these effects has been given by Stokes and Reynolds, and their application to the explanation of the vagaries of fog-signals by Henry. Progress would be promoted by a better knowledge of what is passing in the atmosphere over our heads.

The lecture concluded with an account of the observations of Preyer upon the delicacy of pitch perception, and of the results of Kohlrausch upon the estimation of pitch when the total number of vibrations is small. In illustration of the latter subject an experiment (after Lodge) was shown, in which the sound was due to the oscillating discharge of a Leyden battery through coils of insulated wire. Observation of the spark proved that the total number of (aerial) vibrations was four or five. The effect upon the pitch of moving one of the coils so as to vary the self-induction was very apparent.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

AMONG other bequests, the late Mrs. Muspratt, widow of Dr. Sheridan Muspratt, left by will the sum of 500*l.* to University College, Liverpool.

DR. E. S. MACBRIDE, Fellow of St. John's College, and Demonstrator in Animal Morphology in the University of Cambridge, has been appointed to the newly-founded chair of Zoology in the McGill University, Montreal, Canada.

THE University of Leipzig has conferred the honorary degree of doctor of medicine upon Dr. Simon Schwendener, professor of botany at Berlin; Dr. W. Hempel, professor of chemistry at Leipzig; and Dr. W. Hittorf, professor of physics in the Münster Academy. The same University has conferred the honorary degree of doctor of philosophy upon Dr. A. Fick, professor of physiology at Würzburg; Dr. W. His, professor of anatomy at Leipzig; and Dr. K. von Leibermeister, professor of anatomy at Tübingen.

WE learn from the *Lancet* that Prof. Engelman, in taking over the late Dr. du Bois Reymond's chair of Physiology at Berlin, is arranging certain changes in the Physiological Institute and its four departments. The first, for microscopical and biological work, will remain under the charge of Prof. Fritsch. Similarly, the second, for chemical physiology, will continue under its present director, Prof. Thierfelder. The third, for special physiology, will be greatly enlarged, and the professor himself will take part in its work in conjunction with the present director, Dr. Immanuel Munk. The fourth department, for physical physiology, will also be largely increased; it will be called the Department for the Physiology of the Sensory Organs, and will remain under the direction of Prof. König. In addition to extensive new buildings, the supply of apparatus will be largely augmented. The lectures will be given by the professor in a course running through two semesters, but during the last four weeks in the summer Prof. König will lecture on the sensory organs, and during the first four weeks of the winter Prof. Thierfelder will lecture on physiological chemistry.

SCIENTIFIC SERIALS.

American Journal of Science, July.—Pressure coefficient of mercury resistance, by A. de Forest Palmer, jun. By means of Barus's screw compressor, a thread of mercury was subjected to a series of pressures up to 2000 atmospheres. If R is the resistance under any pressure, R_0 that under atmospheric pressure, P the pressure, and β the increment for one atmosphere, then $R = R_0 (1 + \beta P)$. The result of the measurements is that $\beta = -0{\cdot}0000332 - 5 \times 10^{-9} t$. This differs only very slightly from the value obtained by Barus.—An interesting case of contact metamorphism, by H. W. Fairbanks. Black Mountain is the highest peak of the El Paso range, a spur of the Sierra Nevada mountains extending eastwards into the Mojave desert. The mountain owes its name to the dark lava which covers it. The underlying rocks constitute a part of an extensive series of sedimentary beds exposed for many miles along the northern slope of the El Paso range. The strata have been considerably disturbed and faulted, and in one of the cañons have been intruded by two dykes. One of these is 14 feet across, and is a holocrystalline olivine diabase. The adjoining rock has been strikingly metamorphosed. The thickness of the band of altered tufa is about 2 feet where it is best exposed. The light-coloured soft rock has been baked to a dark, hard and very firm one, the slabs of which give forth a ringing sound when struck. The layer is not massive, but breaks up into slate-like slabs. The partings are probably due to contraction on cooling.—The tin deposits of Temescal, South California, by H. W. Fairbanks. The tin deposits lie nearly in the centre of a rudely semicircular area of granite, which is fissured along almost innumerable lines in which a black vein matter is deposited. The veins vary from one-fourth to a few inches in thickness, and consist of tourmaline and quartz, with which the tin ores are loosely associated. They occur in two forms: the common variety is either massive and brownish, or in clear reddish-brown crystals lining cavities; the less common variety is that of "wood tin," which appears uncrystallised and in the form of thin layers.—Electrosynthesis, by W. G. Mixter. Mixtures of various gases were subjected to a feeble alternate discharge in a special form of eudiometer, in which the terminals consisted of glass surfaces holding water on the other side. Under these circumstances, dry carbonic oxide and oxygen slowly combine. Ethylene and oxygen are partly converted into carbon dioxide and water. Acetylene and oxygen are wholly converted into the same. The molecular changes are analogous to those occurring in synthesis effected by heat or light where combination takes place at a temperature far below that at which the gaseous molecules dissociate.

THE *Rendiconti del Reale Istituto Lombardo*, which is devoted to both literary and scientific subjects, contains in recent numbers the following papers of physical interest :—Prof. Aurelio Mauri (xxx., vii.) describes a new potentiometer, and gives an account of observations of the electromotive forces of Clark's cell, and of a new form of element involving the use of acetate of mercury and acetate of zinc. In the next number (xxx., viii.) he gives tables of the electromotive forces of elements involving various salts. In a later number (xxx., x.) Prof. Paolo Cantoni describes certain phenomena connected with the charging of a condenser, and which on starting or stopping the electromotor give rise to sudden repulsions of the plates from the intervening dielectric, followed by attraction. These phenomena, the author considers, are the outcome of temporary

polarisation of the dielectric by induction, followed by permanent polarisation by conduction.—Dr. Giuseppe Bardelli (xxx. xii.) gives a short mathematical note on certain simple relations between centres of gravity and moments of inertia.

Bulletin de la Société des Naturalistes de Moscou, 1896, No. 3.—The reptile fauna of Europe, by Dr. J. Bedriaga. Part 2. *Urodela* (continued). A further instalment of this important work, in German, is given.—On the means of obtaining cells without a nucleus, by J. J. Gerasimoff (in German). Having previously obtained such cells by keeping cells of *Spirogyra*, *Sirogonium* and *Zygnema* at a temperature below zero during the process of bi-partition, the author now obtained the same results by means of chloral hydrate, æther, and chloroform.—The histology of the skin of *Petromyzon*, by W. Kapelkin (in German, with two plates).—On changes taking place in the nerve-system and the inner organs after the resection of *Nervus vagus* and *Nervus splanchnicus*, by Dr. W. Niedzvietzky (in German, with four plates). Parts of the *vagus* nerve (about one inch long) were cut out in four rabbits, and of the *Nervus splanchnicus* in two dogs. The animals supported the operations very well, and seven, eight and nine months after the operation they were killed. The author now gives the anatomical changes which were observed, especially in the nerve-system of these rabbits.—Remarks relative to a paper printed by the author in the *Archiv für Psychiatrie*, by Mme. Olga Leonova (in German).

SOCIETIES AND ACADEMIES.

EDINBURGH.

Royal Society, July 5.—The Hon. Lord McLaren in the chair.—Mr. Thomas Heath read a note on the Calcutta earthquake (June 12, 1897), as recorded by the bifilar pendulum at the Edinburgh Royal Observatory. His results have been already communicated to NATURE (June 24, p. 174). He described the instrument as set up on Blackford Hill, and exhibited a model. Vibrations of a transient character due to shocks in or near the building were damped out by immersing the pendulum in the clearest paraffin oil. According to a rough calculation the seismic disturbance on the 12th took twenty-two minutes to travel 4970 miles in a great circle. There were absolutely no premonitory disturbances on the day of the earthquake, but there were indications of continued activity till the 16th. Reference was made to the services this instrument might render in "laying" a certain notorious ghost.—Prof. Tait briefly described the contents of a paper by Lord Kelvin and Dr. Magnus Maclean on leakage from electrified metal plates placed above and below uninsulated flames. The most important result—and an anomalous one apparently—was that the amount of discharge under a flame was much greater when the body ended in a plate than when it ended in a point.—In a paper on the antivenomous properties of the bile of serpents and other animals, and an explanation of the insusceptibility of animals to the poisonous action of venom introduced into the stomach, Prof. Fraser described the steps taken to isolate the constituent of the bile of serpents and other animals that render the venom harmless, and described various experiments on rabbits and white rats illustrating its use.—On the influence of excessive muscular work on the metabolism, by Drs. Dunlop, Noël Paton, Stockman and Mr. Ivison Macadam.—Dr. Gregg Wilson read a paper on the development of the Müllerian ducts of reptiles. In embryo reptiles the first foundation of the Müllerian ducts is a thickened plate of epithelium on the region of the excretory system that has been identified as pronephros. Growth backwards is quite independent both of the segmental duct and of the cœlomic epithelium posterior to the pronephric thickening. There is an anterior ventral extension of the foundation, comparable to the anterior part of the duct in elasmobranchs and to the temporary ventral extension of the Müllerian duct foundation in Rana.—Mr. J. A. Macdonald read a paper on the C discriminant as an envelope. The purpose of the paper was to find the conditions under which the discriminant of the equation

$$U = Ac^n + Bc^{n-1} + Dc^{n-2} + \ldots + Nc^2 + Pc + Q = 0$$

where A, B, &c. are synectic functions of x and y, and c is a parameter, yields a curve which at every point of its length is touched by one of the curves of the system $U = 0$.

Scottish Meteorological Society, July 19.—Extreme variation of the surface temperature of the ocean for every two degrees square, by Dr. John Murray, F.R.S.—Hourly variation of the rainfall at Ben Nevis and Fort-William Observatories, by R. T. Omond.—Some striking peculiarities of the weather of June last, by R. C. Mossman.—Exhibition of a convenient apparatus for the determination of the temperature of saturated steam in connection with barometric pressure, by J. Y. Buchanan, F.R.S.

MANCHESTER.

Literary and Philosophical Society, July 2.—Dr. Edward Schunck, F.R.S., in the chair.—The meeting was held for the presentation of the Wilde medals, and the delivery of the Wilde lecture. The Wilde medal for 1896 was awarded to Sir George Gabriel Stokes "for his pre-eminent services to mathematical and physical science, and in regard of the standing which he occupies in relation to the leading physicists of this and other countries." The Wilde medal for 1897 was awarded to Sir William Huggins "for his researches on the application of spectrum analysis to solar and stellar physics." The state of Sir William Huggins' health unfortunately prevented him from receiving the medal in person.—The premium, under the Wilde Trust, for 1897 was awarded to Mr. Peter Cameron for his papers, published by the Society, on Hymenoptera Orientalia.—Sir George Stokes then delivered the Wilde lecture on "The Nature of the Röntgen Rays."

PARIS.

Academy of Sciences, July 12.—M. de Chatin in the chair.—The Perpetual Secretary announced to the Academy the loss it had sustained by the death of M. Steenstrup, Correspondant in the Section of Anatomy and Zoology.—Approximate theory of the passage from a gradually varied to a rapidly varied state, or *vice versâ*, by M. J. Boussinesq.—On the employment of copper salts in the estimation of several elements in cast iron and steel, by MM. Ad. Carnot and Goutal. A modification of the cupric ammonium chloride method for the estimation of carbon in steel is described, which permits of a complete determination in less than two hours. Sulphur may be determined by a similar method with equally satisfactory results. In the residue, the chromium, tungsten, and titanium may be estimated.—M. Gayon was elected Correspondant in the Section of Rural Economy, in the place of M. Hellriegel.—Treatment of psoriasis by intra-muscular injections of orchitine, by M. F. Bouffé.—Researches on the ostioles, by M. J. J. Andeer.—On the actual state of the geodesic work in Russian Turkestan, by M. Venukoff.—Observations on the periodical comet of D'Arrest, made at the Observatory of Toulouse with the large Gautier telescope and the Brunner equatorial, by M. F. Rossard.—Observations on the same comet, made at the Observatory of Algiers, by MM. Rambaud and Sy.—On the linear differential equations belonging to the Riemann class, by M. F. Marotte.—Magnetarium designed to reproduce the phenomena of terrestrial magnetism and the secular changes of the horizontal and vertical components, by M. Wilde.—On the absorption of light by crystals, by M. V. Agafonoff.—On a standard thermal mercury voltmeter, and on some applications of the calorimetric method in electric measurements, by M. Charles Camichel. The indications of the instrument are given by the expansion of column of mercury, about one metre long, after the current has been passing for a known interval of time.—A new optical method of studying alternating currents, by MM. H. Abraham and H. Buisson. The rotation produced by the current in a concentrated solution of an alkaline iodomercurate is not directly measured as in the method of Pionchon, but is reduced to zero by applying a second bobbin carrying a continuous current capable of being directly measured. In the curve thus obtained the positive and negative parts are not found to be exactly symmetrical.—Physiological action of the galvanic current, by M. Dubois.—Electrical influence by Crookes' tubes, by M. Foveau de Courmelles.—On the complexity of the bundle of X-rays, by MM. A. Imbert and H. Bertin-Sans. After prolonged use, a Crookes' tube emits rays which appear to differ from the X-rays at first produced, inasmuch as they are able to traverse bodies relatively opaque to the X-rays without appreciable absorption.—On mercury pumps without taps, by M. Chabaud. The mercury pump described in a recent note by M. Henriet (see p. 263), is not new; neither does it present any advantage over the form with valve.—On some basic salts of copper, and on the brown hydrate of copper, by

M. Paul Sabatier.—On the reduction of molybdic anhydride by hydrogen, and on the preparation of pure molybdenum, by M. M. Guichard. The reduction may be completed at 500° C. if the reaction is sufficiently prolonged. The experiments afford no evidence of the existence of any oxides of molybdenum, but $Mo.O_3$ and $Mo.O_2$.—Action of benzoyl chloride upon the mono-substituted derivatives of the orthodiamines, by M. Fernand Muttelet. In the cold, and in presence of a solvent, a benzoyl derivative is obtained, but at 220°, in presence of an excess of benzoyl chloride, an internal anhydride is formed.—On the formation of mixed hydrates of acetylene and some other gases, by MM. de Forcrand and Sully Thomas. A description of a crystallised compound of acetylene, carbon tetrachloride and water.—Action of sulphuric acid upon lævorotatory terebenthene, by MM. G. Bouchardat and J. Lafont.—Development of aromatic principles by alcoholic fermentation in presence of certain leaves, by M. Georges Jacquemin.—On a new hydrolytic enzyme, caroubinase, by M. J. Effront.—The optical analysis of urine, by M. Frédéric Landolph.—Composition of haricots, lentils, and peas, by M. Balland.—Physiological action of the venom of the Japanese salamander (*Sieboldia maxima*). Attenuation by heat, and vaccination of the frog against the poison, by M. C. Phisalix.—Trophic troubles, resulting from the section of the cervical sympathetic, by MM. J. P. Morat and M. Doyon.—The centrifugal elements of the posterior medullary roots, by MM. J. P. Morat and C. Bonne.—Perforated muscle of the hand. Its appearance in the animal series, by M. A. Perrin.—On two new types of Crustaceæ (Isopods) belonging to the subterranean fauna of the Cévennes, by M. A. Dollfus.—Remarks on the sense organs of the *Sphæromides Raymondi*, *Stenasellus virei*, and of some Ascellidæ, by M. Arm. Viré.—On the defence of vines against the attacks of Cochylis, by M. P. Cazeneuve.—Remark on the subject of the methods of destruction of Cochylis in the vine, by M. Émile Blanchard.—On the tubercles of Orchidaceæ, by M. Leclerc du Sablon.—On the replacement of the principal root by a radical in Dicotyledons, by M. Boirivant.

ST. LOUIS.

Academy of Science, June 7.—Mr. Robert Combs, of Ames, Iowa, presented a paper entitled "Plants collected in the District of Cienfuegos, Province of Santa Clara, Cuba, in 1895-96." The paper embraces the results of a collection extending from the commencement of the rainy season of one year until the close of the dry season the following spring, the territory covered by the collection lying between the entrance of the bay of Cienfuegos, on the south coast of Cuba, up the bay and the river Damuji to Rodas, and extending back from the river to Yaguaramos, and almost to the Cienega de Zapato, a region including nearly all kinds of soil and condition found upon the island, except those of the mountain regions and the mud swamps. A brief statement was made concerning the origin of the Cuban flora, and its affinities with that of continental Central America, rather than the geographically nearer Floridan region. The paper comprised a full catalogue of the collections made, which had been determined at the herbarium of Harvard University, and of which several sets had been distributed to the larger herbaria.—Prof. F. E. Nipher made some remarks on the difficulties yet involved in the theories of the ether.

NEW SOUTH WALES.

Royal Society, June 2.—The President, Mr. Henry Deane, in the chair.—A contribution to the study of oxygen at low pressures, by Prof. R. Threlfall and Florence Martin. There is known to be a pressure (about 0·7 mm. of mercury) at which oxygen becomes unstable in its volumes and pressure relations. This instability may plausibly be attributed to a change in the chemical nature of the gas, and during the period of change it is possible that ozone may be temporarily produced. An experiment was made with the object of investigating whether oxygen can form ozone simply by virtue of a reduction of pressure. A suitable indicator having been discovered, an experiment was satisfactorily carried out showing either that no ozone at all is formed when the pressure falls to from 0·4 to 0·1 mm., or that, if such formation does occur, it is to an extent less than 0·005 per cent. of the volume of the gas employed.—Determination of the orbit elements of comet of 1896 (Perrine), by C. J. Merfield. The author explained that his deductions were based on observations made in various American and European observatories, and also on observations made by Mr. John Tebbutt, of Windsor, New South Wales. The elements as determined by him agreed substantially with those determined by Dr. Knopf, and would not, in his opinion, be sensibly varied by further investigations.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (mathematico-physical section), Part 1 for 1897, contains the following memoirs presented to the Society.

January 9.—P. Stäckel: Extracts from the correspondence of Gauss with W. Bolyai. R. Müller: Approximately rectilinear motion by means of the jointed quadrilateral. W. Schur: The polar flattening of the planet Mars.

February 6.—W. Voigt: The kinetic theory of ideal fluids.

February 20.—D. Hilbert: Diophantine equations. A. Wirnau: The substitution-groups of eight things.

March 6.—D. Hilbert: On the development of a given analytical function of one variable as an infinite series of rational integral functions. A. Hurwitz: On the generation of invariants by integration.

The accompanying *Geschäftliche Mittheilungen* include a memoir of Karl Weierstrass by David Hilbert, of Ernst Curtius by F. Leo, and of August Kekulé by Otto Wallach.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Voyages made by the Sieur D. B. to the Islands Dauphine or Madagascar, &c.: translated and edited by Captain P. Oliver (Nutt).—Elemente der Geologie: Dr. H. Credner, Achte Auflage (Leipzig, Engelmann).—Fifteenth Annual Report of the Fishery Board for Scotland, Part 3 (Edinburgh).—Wild Flowers of Scotland: J. H. Crawford (Macqueen).—The Elementary Part of a Treatise on the Dynamics of a System of Rigid Bodies: Dr. E. J. Routh, 6th edition (Macmillan).—Introductory Course in Differential Equations: Dr. D. A. Murray (Longmans).—Modern Mythology: Andrew Lang (Longmans).—Our Coal Resources at the Close of the Nineteenth Century: Dr. E. Hull (Spon).—Ludwig Otto Hesse's Gasammelte Werke (München, K. Akademie).—The Ascent of Man: H. Drummond, new edition (Hodder).—Among British Birds in their Nesting Haunts: O. A. J. Lee, part v. (Edinburgh, Douglas).

PAMPHLETS.—Effects of the Weather upon Vegetation: J. Clayton (Bradford, Byles).—Nel Paese della Amazzoni: Dr. V. Grossi (Roma).

SERIALS.—Proceedings of the Physical Society of London, Vol. xv. Part 7 (Taylor).—Quarterly Review, July (Murray).—Terrestrial Magnetism, June (Wesley).—Engineering Magazine, July (Tucker).—Proceedings of the Royal Society of Queensland, Vol. xii. (Brisbane)—Journal and Proceedings of the Royal Society of New South Wales for 1896 (Sydney).

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