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ELECTRICITY AND RAILWAYS.

Applications of Electricity to Railway Working. By W. E. Langdon. Pp. xvi + 331. (London: E. and F. N. Spon, Ltd., 1897.)

IN this book the author shows that he is well acquainted with the subject on which he writes, and that his knowledge is of a thoroughly practical character; we can, therefore, recommend it not merely to those who are professionally engaged with railway working, but also to that portion of the public who take an interest in the various methods that are adopted for securing their safety, and administering to their comfort, when they are travelling by rail.

The book opens with a chapter "on the construction of a line of telegraph," in which cogent reasons are advanced why, in the making of a new railway, the company ought to face the initial expense of constructing good, rather than cheap, telegraph lines; and the results of a "penny wise and pound foolish" policy are pointed out.

The language used in this chapter—indeed throughout the book—recalls the telegraph engineer of thirty years ago in that force and expressiveness, rather than elegance or exactness, are the result aimed at. The older engineer, for example, speaks of the "railway metals" when he means the iron rails, "metalling a road" when he means laying down stones, and the "metal" of an insulator when he is referring to the porcelain cup, and not, as a person might imagine, to the iron stalk of the insulator. Sentences like—"Iron arms formed of L-iron . . . are less costly than the tubular arm, but fall short of the degree of strength which the latter enjoy," the portion of the arm earth-wired is practically covered, &c.," "a 9-feet sleeper will cut three stay blocks, say each 36 inches by, &c.," invest iron and old railway sleepers with an activity that certainly has the effect of giving life to the book. The "D.V. insulator," we are told, is a "double Varley," and so we realise that it is not a pious reference to the wishes of Providence; but how many of the average readers will be able to guess what such crisp expressions as "G.I. wire" and "G.P. wire" stand for?

Chapters ii., iii., and iv. deal with "surveying," "posts and wires," and "telegraph instruments and batteries" respectively. The use of the telephone to replace telegraphic signalling is dealt with, the practicability of employing the same line wire for the block bell and the telephone, on not very busy sections of the railway, is pointed out, and the methods of running several circuits on the same telegraph poles so that there shall be little mutual induction between them are described. The author doubts the advantage of replacing Leclanché cells with dry cells, but quotes the results of tests which show that of the two the dry cell polarises less rapidly than the Leclanché cell when each is joined up in series with a resistance of 100 ohms, or "short-circuited" through a resistance of 100 ohms, as the author incorrectly calls it.

Much is told us in Chapter v., and told us well, about "block signalling," of which there are three methods in actual use, viz. the *positive*, the *affirmative*, and the *permissive*. With the first the signal is left indicating "line clear," except when a train is actually on the section in advance; with the second the signal is normally left "line blocked," and it is only on information being telegraphed forward by the signaller that a train desires to enter a section, and on the signaller in advance telegraphing back his consent, that the semaphore arm is lowered. With the third system, two, or more, trains going in the same direction are allowed on one section at the same time, but the rear trains are warned that there are other trains in advance. This last system, which can hardly be called a block system at all, is, however, only employed under exceptional circumstances, such as in the working of station-yards, to enable trains to be brought to a stand at their respective platforms, for interchange of traffic, or for connection with other trains.

The *affirmative* system is the one generally employed with the railways in this country, but on the Metropolitan Railway it is found necessary to resort to the *positive* system, in consequence of the large number of trains; so that the semaphore-arm being up indicates that there is actually a train on the section ahead.

We may take this opportunity of noticing, although Mr. Langdon does not refer to the matter in his book, that the behaviour of the ordinary railway passenger furnishes a striking example of the absence of powers of observation that characterises the average person. A train is at rest, say, at the platform of a Metropolitan Railway station, and the danger signal is obviously up, yet the passengers tear down the stairs, and rush frantically along the line of carriages only to wait, panting for breath, until the train starts. Again, we wonder how many copies have been sold of the photograph of "the Flying Dutchman going at sixty miles an hour," and how few are the purchasers who have noticed that in this photograph the signal is against the train, so that it must have been at rest when the photograph was taken. Or, again, how many persons who obtained season tickets for the Inventions Exhibition remarked that the train stamped, in gold, on the cover of the ticket was running neither on the "up" nor on the "down" pair of rails, but on one of *each* pair, so that there was a single odd rail left on each side of the train for some mysterious and unknown use.

The animated character of the instruments in this chapter is almost suggestive of Rudyard Kipling, for Mr. Langdon says that the tongue of a relay "obtains its magnetic life from a permanent magnet H," and that the indicating portion of an apparatus is locked "in the position last afforded it by the current."

The block instruments devised by Preece, Pryce and Ferreira, Spagnoletti, Tyer, Webb and Thompson, and others, are fully dealt with in Chapters v. and vi., while Chapter vii. brings us to "automatic block signalling" with which the passage of a train works the signal electrically or electro-pneumatically. This subject has made practically no progress in this country, for while Hall's automatic system, requiring only a comparatively small battery for each section of the line, is largely used on the United States railways, it is only on the Liverpool Overhead Electric Railway, where there is plenty of electric

power available, that automatic block signalling has found a footing in Great Britain. To work Timmis' "long-pull electromagnet" used on this line "the energy required is 5 amperes at a pressure of 40 volts (200 watts)"—at least so says the author of this book, making the same sort of confusion between current, energy and power as characterises "Article 12 of the Programme of the International Competitive Trials of Accumulators for Road Traction," which has just been published, and which states: "Besides an ammeter measuring the total quantity of electricity supplied to and from the batteries as a whole, an energy meter (watt-meter) . . . will measure the quantities of energy absorbed by and supplied to each of them."

Unlike automatic block signalling, the interlocking of the mechanical devices, and of the electric and mechanical devices, connected with signalling and shunting, has received much attention in Great Britain during the past twenty-nine years, the earliest attempt in this direction having been made in 1870 by the author himself in conjunction with Mr. Preece, and a large number of illustrations connected with this part of the subject renders the study of Chapter viii. instructive. Some of the illustrations, however, are drawn on too small a scale, and are not well enough executed to enable the reader to clearly understand all the details.

In the next chapter signal repeaters, light indicators, train indicators, lightning protectors, &c., are dealt with. A signal repeater is a device for indicating whether the motion of the arm of a semaphore, which is out of sight, corresponds correctly with the motion given by a signalman to the handle in his box, while a light indicator informs him whether the lamp on a semaphore post has gone out, or has become dim. The action of the latter depends on the *difference* in the expansion, by heat, of a tube of *brass* and of a rod of *steel* inside it; this, however, is not clearly explained, and from the description it would appear as if the action would take place just as well if the tube and the rod were of the same material. These indicating devices are found to be of great use, says the author, "at heavily signalled termini."

"Electric station lighting" and "electric train lighting" come next, and the author mentions that while arc-lighting of goods-yards-sidings is now much used, since it effects economy in capital, men, material and time in loading trucks, it was originally introduced in the Nine Elms yard mainly to stop the robbery which the absence of efficient lighting encouraged, and that the cost of its installation there has been largely defrayed by the diminution of the loss through theft that has resulted.

The author, like so many practical men, talks about "the volts and current," although doubtless he would not say "the feet and weight of a girder" when he meant "the length and weight," nor would he speak of "the pounds of the main boilers," although he does not hesitate to write "the volts of the main dynamos." Since the *generic* name *current* is regularly employed, without reference to any particular unit of current, why should not the expression "*pressure*," "*potential difference*," "*P.D.*," or some other *generic* name, be similarly used. "Current and pressure" if you like, or "amperes and volts" if preferred; but, great as may be our respect for the lineman on a railway, or for the switchboard attendant in an electric light station, it is not compulsory for us to form our technical language by slavishly copying his "current and volts."

To produce a Board of Trade unit inclusive of all charges excepting those for land, taxes and depreciation of buildings, costs the Midland Railway Company (to whom Mr. Langdon is the electrical engineer) from 2·3*d.* at the Birmingham Central Station to 3·5*d.* at the Leeds Hunslet Station. These amounts, although much higher than the corresponding sums at a London large electric light-generating station, are fair, in view of the short time that artificial lighting, even in the winter, is required in a railway goods yard, or in offices which close at 5.30 p.m.

The subject of lighting railway carriages interests every one—or ought to. But the public have for many years tolerated the lamp being placed at the middle of the roof of the compartment of a railway carriage instead of at the back of the reader, and no expression of feeling was manifested when the fixing of penny-in-the-slot accumulators and reading-lamps in the carriages on the Metropolitan District Railway suggested the principle that the Company did not undertake to light even the first class compartments in return for the sum paid for the passenger's ticket.

The author suggests—and we think rightly—whether "it might not yet be advisable to attach to each train a vehicle equipped for the double duty" of lighting and heating, "having for its primary source of power an oil engine."

The short Chapter xii. on "intercommunication in trains in motion" we may pass over—for the author has recently dealt with that subject at length in a paper read before the Institution of Electrical Engineers—and we come to the last, on the "administration of the engineering branch." In this the author suggests (probably unintentionally) the explanation of the special literary style adopted in his book, for he says:

"When we write a letter the conventionalities of society demand a degree of courtesy which is readily excused, and which would seem absurd in a telegram. It is not clear why it should be so; why a letter—especially a business letter—should not be just as acceptable if couched in the same concise terms considered so proper for telegraphic correspondence."

We conclude as we commenced by expressing the opinion that, in spite of minor blemishes such as we have referred to, Mr. Langdon's book is distinctly good on the whole. For of what consequence are a few antiquities of expression, and how easy is it to be critical *now*, and to suggest improvements in the work of men of the older school which can be made *to-day*, when we are revelling amidst a wealth of electric meters, ammeters, voltmeters, coulomb-meters, watt-meters, energy meters, potentiometers, &c., and are enjoying the luxury of the labour-saving appliances with which technical colleges are equipped? Will, however, the young electrical engineer of to-day, with all this vast collection of electrical appliances at his command, succeed in making so deep an impress on electro-technical science as did men like Mr. Langdon thirty years *ago*, and will a practical electrical

treatise written thirty years *hence* by the young electrician of to-day be as much up to date *then* as is "The Application of Electricity to Railway Working" in 1899?

"P. D."

OCTONIONS.

Octonions; a Development of Clifford's Bi-quaternions. By Alex. McAulay, M.A. Pp. xiv + 253. (Cambridge: University Press, 1898.)

FROM a purely formal point of view, apart from any question of geometrical or physical application, the mathematical method known as quaternions may be described as a system of shorthand for dealing with the algebra of certain complex numbers.

Let i, j, k be three independent entities which obey the relations

$$ij = -ji = k,\ jk = -kj = i,\ ki = -ik = j,\quad i^2 = j^2 = k^2 = -1 \quad \ldots \text{(i.)}$$

and those derived from them; and let w, x, y, z be any four real numbers. Then the totality of complex numbers of the form

$$w + xi + yj + zk$$

evidently constitute a self-contained system; in the sense that the result of combining two or more such numbers by addition or multiplication is another number of the system. Moreover, it may be easily shown that the result of dividing any number of the system by

$$w + xi + yj + zk$$

is a definite number of the system unless w, x, y and z are all zero.

Quaternion analysis is a method of shorthand, and an extremely compendious one, for dealing with this system of complex numbers.

Hamilton himself considered, under the name of bi-quaternions, an extension of this particular algebra in which each real number $w, \ldots,$ is replaced by

$$w_1 + w_2\sqrt{-1}, \ \ldots,$$

where $w_1, w_2, \ldots,$ are real numbers.

This is equivalent to dealing with the self-contained system

$$w_1 + x_1 i + y_1 j + z_1 k + w_2\omega + x_2 i\omega + y_2 j\omega + z_2 k\omega \quad \ldots \text{(A)}$$

in which i, j, k, ω obey the relations (i.) and the further relations

$$i\omega = \omega i,\ j\omega = \omega j,\ k\omega = \omega k,\quad \omega^2 = -1 \quad \ldots \text{(ii.)}$$

Clifford introduced two distinct extensions of the algebra of quaternions. In each of them the complex number is of the form (A). In one, i, j, k, ω obey the relations (i.) and (ii.), except that the last equation of (ii.) is replaced by

$$\omega^2 = 1.$$

In the other, i, j, k, ω again obey the relations (i.) and (ii.) with

$$\omega^2 = 0$$

in the place of the last equation of (ii.). To both of these algebras Clifford gave the name biquaternions.

It may be noticed that the formal algebra of Hamilton's biquaternions is quite independent of the supposition that ω is the $\sqrt{-1}$ of ordinary algebra; it depends purely on the laws implied by (i.) and (ii.).

The three algebras thus obtained are the only distinct extensions of the algebra of quaternions that result from introducing a single new unit or entity which is permutable with i, j and k, while its square is an ordinary real number.

What one may call the geometrical counterpart of quaternion algebra is the geometry of rotation round a fixed point, and the parallelism between the algebraical and the geometrical theory is complete. To the general complex number in the algebra corresponds the most general operation on rotations round the point, viz. the operation which will change any one such rotation into any other. There are also geometrical theories standing in the same relation to the three extended algebras, each containing as a part, as it should do, the theory of rotation round a fixed point.

It was, in fact, from the geometrical side that Clifford approached the subject in his published writings. His point of view may be presented briefly as follows.

A velocity system in space (*i.e.* the mode in which a rigid body is moving at any instant) is completely specified by an axis AB, the magnitude a of the velocity of rotation about AB and the magnitude V of the velocity of translation along AB. From the doubly-infinite set of operations which will change any velocity system given by AB, a, V into any other given by A′B′, a', V′, a particular one may be chosen as follows. Let CD be the common perpendicular to AB and A′B′; and let $a' = pa$, and $V' = qV$. There is a definite twist with CD for its axis which will bring AB to A′B′, and at the same time the direction of V along AB to agreement with the direction of V′ along A′B′. The operation which changes the one velocity system into the other may be made up of (i.) this twist, (ii.) an operation which merely changes the magnitude of the rotation velocity in the ratio p to 1, (iii.) an operation which changes the magnitude of the translation velocity in the ratio q to 1; and these three may be carried out in any order. The operation involves in its specification eight distinct numbers, since a twist involves six.

Having thus obtained a definite view of the operation which changes one velocity system into another, Clifford goes on to discuss the laws according to which such operations combine. These of necessity depend on the nature of the space in which the motions take place. He only glances very briefly at the case of ordinary Euclidean space, and develops the theory, so far as he carries it, for elliptic space. He shows, in effect, that the formal laws involved for elliptic space are those of the extended quaternion algebra, for which

$$\omega^2 = 1.$$

The carrying out of the theory for hyperbolic space, in which case the formal laws are those of the extended quaternion algebra where

$$\omega^2 = -1,$$

still awaits treatment.

Prof. McAulay's book deals with the theory for ordinary space, which is found to correspond to the remaining case, viz.

$$\omega^2 = 0.$$

An octonion (the author gives reasons for preferring this word to biquaternion) is in fact, from the algebraical

point of view, a complex number of the form (A), in which i, j, k, ω obey the relations (i.) and (ii.) with $\omega^2 = 0$ in the place of $\omega^2 = -1$. From the geometrical point of view it may be regarded as the ratio of two velocity systems in ordinary space.

The shorthand system expounded by the author for dealing with this algebra follows closely the lines of that used in quaternions, but is, as might be expected, considerably more complicated. Since ω is permutable with i, j, and k, the octonian (A) may be written in the form

$$w_1 + x_1 i + y_1 j + z_1 k + \omega(w_2 + x_2 i + y_2 j + z_2 k),$$

or, $$q_1 + \omega q_2,$$

where q_1 and q_2 are two quaternions. The phraseology and notation adopted turn largely on this division of an octonion into two parts. An octonion for which both w_1 and w_2 are zero is called a motor. Like a vector in quaternions it may be regarded either as an operation or as an object to be operated on. From the latter point of view it is, when interpreted kinematically, a velocity-system. Corresponding to the linear and vector function of a vector in quaternions, there is here the linear and motor function of a motor; *i.e.* from the algebraical standpoint a matrix of six rows and columns. A self-conjugate function is defined somewhat as in quaternions, but it is not the case that a symmetric matrix corresponds to a self-conjugate function. The least convincing part of the book is, perhaps, that in which the author extends to octonions some of the conceptions of the *Ausdehnungslehre*. The inner product of five and of six motors are defined so that the first is a motor and the other a number; and it is apparently implied that the inner product of any given number of motors is a definite quantity of some kind. No expressions, however, for such a product are given except in the two special cases mentioned; and the idea involved does not seem to be utilised in the chapter of applications with which the book ends. This chapter consists of more or less well-known results investigated or expressed in the octonion notation; and it inevitably suggests the question: Is the method one which will lend itself to the purposes of research? It is of course too soon to say. In the meantime it is clear that octonions cannot be used, any more than quaternions, for the purposes of numerical calculations; and that the newer method cannot, from the very nature of the case, claim the beauty and symmetry that are such distinguishing marks of quaternion analysis.

W. BURNSIDE.

THE ALPINE GUIDE.

Ball's Alpine Guide: the Western Alps. New edition, reconstructed and revised on behalf of the Alpine Club by W. A. B. Coolidge. Pp. xlix + 612. (London: Longmans, Green, and Co., 1898.)

THE issue of the first volume of the new edition of "Ball's Alpine Guide" will be welcomed by all those who seek their relaxation in the Alps. Though it is nearly ten years since this enterprise was taken in hand by the Alpine Club as a fitting memorial to John Ball, its first President, the character of the revision is so thorough, and the incorporated matter has been so judiciously assimilated with the original, that any delay will be readily forgiven. The task of producing this edition has fallen to Mr. W. A. B. Coolidge; and that this has been to him a labour of love, carried out on the lines laid down by Ball, there can be no question. What distinguished "Ball's Guide" from all others, and rendered it pre-eminent, was that in it one had, as it were, a companion leading one through the finest scenery in Europe, a man of culture with a true feeling for the mountains, and an accomplished naturalist who found an especial fascination in topography and plant distribution. Nor has Mr. Coolidge fallen from that high plane. With a skill so admirable has he interwoven in the original fabric the results of Alpine exploration of the last quarter of a century, that we have a book absolutely up to date and yet without any indication of patchwork or composite origin. And for this he merits the sincere gratitude of mountain lovers.

The present volume deals with the Western Alps, *i.e.* the Maritime, Cottian (including Dauphiné) and Graian Alps, the range of Mont Blanc, the Central and Eastern Pennines. It is divided into six chapters, dealing with the six main areas or ranges, and these fall into a varying number of sections (there are twenty-one in all) treating of the districts. As examples of the districts may be mentioned the Pelvoux, Grand Paradis, Grand Combin, and Monte Rosa districts. Each district has its introduction, in which especially matters relating to the topography of the district in question are lucidly set forth. "Ball's Guide" being written by an Alpine wanderer for wanderers, the subject-matter is unfolded in the form of routes, *i.e.* intersecting lines selected with a view to serve as a scaffolding for the descriptive matter. In this way some ten or twelve routes serve to exhaust a district. All matter off the line of journey in any route—as, for instance, an account of a peak or some adjacent valley—is enclosed in heavy square brackets. This system works out very well in practice, as indeed it should, seeing that about one-third of the book consists of matter thus enclosed. For the convenience of such as are not wanderers, but who remain for days or weeks at some centre, at least one "route" in each district is largely occupied with notices of the various expeditions that may be conveniently made from its chief centre. And in this matter Mr. Coolidge has kept pace with present-day requirements, for in addition to Zermatt and Chamonix we find the newer centres of Arolla, Val d'Isère, Cogne, La Bérarde, &c., thus treated. In this way the country in each district is very minutely worked out, but concisely and without tedious elaboration. Mr. Coolidge exercises a wise selection in the peaks which he describes: he gives detail when detail is desirable; whilst subordinate peaks, unless of topographical or special mountaineering importance, are merely named. Though there is no pretence to the full detail of a "Climbers' Guide," practically all interesting routes are sketched in or suggested. There is no scamping of out-of-the-way spots. Take, for instance, Grand Paradis District, Route E., Cogne to Pont Canavese by the Val Soana. Here, within the limits of two pages, we find mentioned all the essential features of a tract of country that it could not take less than three weeks to explore, and these stated briefly, clearly and correctly. Yet it is doubtful

whether half-a-dozen travellers stray into this area in the course of a season.

Though the book is good throughout, some regions seem to lend themselves more conveniently to topographical treatment than others. Or it may be that a subtle attractiveness in some countries has not been without its influence upon both author and editor. If it be permissible to discriminate, we would mention the chapters devoted to the Dauphiné Alps and to the Graians as masterpieces of topographical description, as models of what they should be. At the same time, an occasional omission must be noted. A good deal of space is devoted to the Grivola, but no hint is given of the wonderful nature of the ascent by the south-west face from Valsavaranche—an ascent which cannot fail to impress the traveller as one of the most remarkable in the Alps. And there is the less excuse for this omission, as space is wasted by a wholly uncalled for foot-note (p. 307), in which Mr. Coolidge explains that Ball is too enthusiastic in his description of this mountain, as seen from the eastern edge of the Trajo glacier. "Remarkably stumpy and unimpressive" are Mr. Coolidge's words—to us, after several visits to the spot, the very reverse seems the truth, and we take our stand with Ball.

In conclusion, there are numerous ways in which Mr. Coolidge earns our gratitude. Every altitude quoted is given both in feet and metres, a luxury which the climber will not fail to appreciate. Then there is an exhaustive bibliography, and the index is more than satisfactory. Nor has he been unmindful of the historical associations which cling to the mountains. Old traditions, topographical fables, the early ascents of the Fathers of Mountaineering—all these and many kindred subjects are genially yet critically unfolded in the pages of this book. It is hardly necessary to say that blood-curdling stories of Alpine misadventure find no place here. The introduction of six new district maps, on a scale 1 in 250,000, specially prepared for the work, also demands recognition. These are unusually clear and easy to use, whilst the circumstances under which they have been prepared are a sufficient guarantee as to their accuracy. The botanical notes, which occur constantly throughout the pages of the original, have been retained, and additions have been made to them. It may be mentioned that the "general introduction" is not included with this volume; it is to be issued independently in the immediate future. F. W. O.

OUR BOOK SHELF.

Psychology in the School-room. By T. F. G. Dexter and A. H. Garlick. Pp. viii + 413. (London: Longmans, Green, and Co., 1898.)

THE authors describe their book in the preface as an "attempt to apply the laws of mental and moral science to school work." If we can hardly look upon the result of this attempt as an unqualified success, it is because Messrs. Dexter and Garlick are by no means as well acquainted with the principles of "mental and moral science" as they evidently are with the practical requirements of the school-room. A psychologist who comes to them solely for practical hints as to methods of teaching, will find much that is suggestive in their treatment of their subject; but we should hardly recommend a teacher who wishes to acquire a sound, even if elementary, knowledge of psychology to take them as his guides. It would, indeed, hardly be going too far to say that "Psychology in the School-room" is a treatise written by persons who know little psychology for readers who know less. Partly this is due to mere defects of information. Thus the account of the "muscular sense," on p. 63 ff., must have been written in ignorance of the important researches, fully described in so accessible a work as James's "Principles of Psychology," which have profoundly modified our estimate of the psychological significance of these once-vaunted sensations. The account of space-perception given in the same chapter, again totally ignores the "nativistic" doctrine of such eminent authorities as Hering, Stumpf, and James. It may be, as the authors say (p. 81), that "distance is inferred, not seen"; but, in the present state of the controversy, it is a gross piece of presumption to make the statement without explaining that it is denied by many of the best modern authorities. Still more unfortunate is the habitual inaccuracy and vagueness of the writers' terminology. They tell us, for instance, repeatedly, that "vibrations" of ether, air, &c., are transmitted to the brain, and there "interpreted" by the mind as sensations of colour, sound, &c. This is, of course, fiction, and fiction of the most misleading kind; as we are never aware of the "vibrations" at all, it is nonsense to call the sensations, to which they serve as physical antecedents, "interpretations" of them. The way in which, in the chapter on "judgment," judgment is said on one and the same page to be a "higher" process than conception, and to be already involved in conception, the very similar way in which in the following chapter definition is spoken of, first, as having to do with "words," then as concerned with "things," then once more as of "names," the double treatment of what are essentially the same facts, once in Chapter viii., under the head of "Association," and again in Chapter xiii., under the title of "Apperception," are a few instances, from among many, of the authors' inability to form consistent views of their subject, and to express those views with precision. Such looseness of thought and language is intolerable in any work, however elementary, that professes to describe the principles of a science. A. E. T.

Physical Chemistry for Beginners. By Ch. M. van Deventer. Translated by R. A. Lehfeldt. Pp. xvi + 146. (London: Arnold.)

IN a preface written by Prof. J. H. van 't Hoff the object of this work is stated to be the presentation of physical chemistry to medical students in such a fashion as to avoid putting their physical and mathematical accomplishments to too severe a proof. The fundamental laws of combination are dealt with concisely and clearly, prominence being given to the experimental basis for each law. Chemical formulæ, however, are introduced so abruptly into the second chapter, that it is clearly the author's intention that the remarks given are to be considered as supplementary only, either to lectures or a text-book of systematic chemistry. The succeeding chapters deal with the behaviour of gases, thermochemistry, solutions, photo-chemistry, and the periodic system. In the chapter on the properties of gases, *normal* temperature and pressure are defined as 15° C. and 760 mm. of mercury, although later on in the same chapter the more usual 0° C. and 760 mm. are frequently used. The definition of atomic weight as obtainable from the experimental results is very clearly stated, an uncommon feature in an elementary text-book. The section dealing with thermo-chemistry occupies one-half

of the whole book. It contains a full account of thermochemical notation, a selection of the more important data, and an elementary discussion of the law of maximum work. Chemical equilibrium and dissociation are also dealt with, the treatment being non-mathematical, and bearing evidence of the influence of van 't Hoff. The book as a whole forms an admirable introduction to general chemistry; the student who has mastered its contents will have nothing to unlearn, and will be able to proceed at once to the larger text-books of Ostwald and van 't Hoff.

Elementary Hydrostatics. By Charles Morgan, M.A., R.N. Pp. 106. (London: Rivingtons, 1899.)

THIS small text-book contains practically a condensed account of all the leading points in hydrostatics which are usually included in an elementary course, accompanied by an unusually large number of exercises. It makes no attempt at exhaustive treatment, and is rather intended for those studying the subject with tutorial aid. We are sorry to see that the author has gone on the old lines in the dual interpretation of "pressure" as thrust, and also as thrust per unit area, and we should have liked to have seen the notion of "whole pressure" kept in the background, and greater emphasis laid on the use of the formula for the same in obtaining the resultant thrust on a *plane* area. The familiar figure of the air-condenser with the valves resting in their usual impossible upside-down position is here once more reproduced. We like the author's simple treatment of centres of pressure as being instructive and useful to beginners, despite the objections that mathematicians may raise against its validity. For the points which we have criticised, the fault probably lies not so much with the author as with the examinations for which it is his purpose to prepare candidates, and we think that the book will be of great value to all students whose limited time prevents their reading a large treatise. G. H. B.

The Valley of Light.—Studies with Pen and Pencil in the Vaudois Valleys of Piedmont. By W. Basil Worsfold. (London: Macmillan and Co., Ltd., 1899.)

AN author adds to his difficulties by writing a book in the form of letters, especially when he desires to combine instruction with entertainment. Mr. Worsfold has not been more successful than others in overcoming these, and we are not surprised that, as he admits, his fair correspondent found his epistles "not very entertaining." In fact he does not add much to our knowledge of this district. Like his predecessors, he is almost silent on its geology and botany, and devotes himself to the history of the past persecutions and present fortunes of the Waldenses. The former subject is an interesting but hardly a novel one; for it is treated pretty fully in Beattie's "Waldenses" and Gilly's "Narrative." The Waldenses, in fact, have already been the cause of not a few books, if we include those in other tongues than our own, and Mr. Worsfold's does little more than add to their number. We doubt, indeed, whether the best authorities would agree with him in tracing the Waldenses back to early Christian settlements in these valleys, or in the date (twelfth century) which he assigns to the Nobla Leçon. Nothing of special importance seems to have happened in the Waldensian valleys during the last half-century. Their worthy inhabitants have prospered fairly and maintained their high character, but this, though satisfactory, affords but few opportunities to an author. In short, Mr. Worsfold's book has no scientific value, for even the illustrations are poor; and it displays little historical research or originality.

LETTERS TO THE EDITOR.

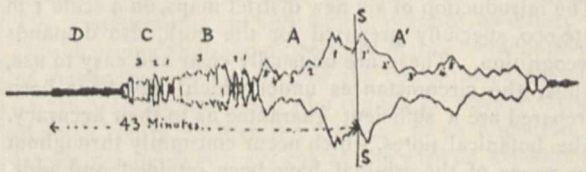
[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Earthquake Precursors.

IN NATURE, February 16 (p. 368), under the title of "Earthquake Echoes," I described the more or less rhythmical series of fading resultants which are seen to succeed many large earthquakes. These earthquake followers, the first of which may sometimes represent the *Uri Kaishi*, or return shaking of the Japanese, are repeated in groups with a decreasing amplitude, an increasing period, and with a smoother and smoother contour. The last of the series may be so small that it is usually difficult to say with certainty when a large earthquake has ceased to exist. As pointed out by Mr. R. D. Oldham, it seems quite possible that certain of the terminal vibrations may have travelled round the world in a direction opposite to that taken by the larger members of the series. The movements to which I now refer are the procession of vibrational groups which run before the main disturbance, with the smaller of which, under the name of preliminary tremors, we are already more or less familiar. These precursors have in several respects characteristics which are exactly the opposite to those of the earthquake followers. They have a definite commencement, and with large earthquakes group after group usually increases suddenly in amplitude and period.

Another feature of the precursors is that, whilst group after group may grow larger, they become more and more larger featured in their contours. The very first of the preliminary tremors have no *frétillements*, or have lost whatever they may have had, whilst those which follow carry serrations which are well marked. This observation, together with that of the growth in amplitude, suggests the idea that the main features of each group of precursors starting from a common origin have reached an observing station by different routes; the first have come along Knott's path of least time, whilst the latter, culminating in the shock, may have travelled along paths continually approximating to that of a free surface-wave.

Now and again, we see in groups of preliminary tremors a likeness in contour and arrangement of what is to follow; but likenesses of this description are perhaps best seen when we compare the shock and its immediate forerunners with the *Uri Kaishi*, or first echo and its successors. Thus, in the accompanying photographic reproduction of the disturbance of



June 29, 1898, if we take S S as a line of symmetry, which lines are not uncommon in seismograms, the shock 1 in the group A is preceded by groups of waves 2, 3, 4 and 5, which are not unlike the echoes 1′, 2′, 3′, 4′ and 5′; whilst in the precursors B and C, 1, 2, 3 are not unlike 1, 2, 3. In group D all likenesses are lost. Our knowledge of the very first preliminary tremors like D is less than that of those which follow. Near to an origin they may have a duration of from one or two up to ten or twenty seconds, and their period has been recorded at from 1/5 to 1/20 of a second. When they are preceded by a sound-wave, we have evidence of a very much higher frequency. If these vibrations have travelled long distances and through our earth, most records indicate a period of three or four seconds. Records from Rome have shown periods of less than half a second, but even these are probably much too large. My own records indicate only a slight switching at the end of a light elastic boom or a very rapid to-and-fro motion of the boom relatively to its steady-point. Until a steady-point seismograph with extremely light multiplying indices like that of Vicentini, or some other special form of apparatus, has been employed as a recorder, our knowledge of this end of the seismic spectrum is not likely to increase.

The last points connected with the earthquake precursors are

the intervals of time which elapse between the arrival of the first tremor and the largest wave or waves corresponding to the originating impulse and the duration of the very first series of preliminary tremors. As measured on seismograms for disturbances which have originated at different distances from the Isle of Wight observing station, these two intervals are given in the following table :—

Origin.	Distance in degrees.	First P.T. to max. motion in minutes.	Duration of first group of P.T.s in minutes.
Iceland	17	4 or 5	1·4
Greece	22	7	7·0
Tashkent ...	48	15	9·0
Hayti	62	30	13·0
Japan	84	47	8·5
Borneo	112	55	6·0

These figures are too few in number to be used as a foundation for any certain conclusions, but they may possibly indicate results to be sought for in future records. With regard to the first set of intervals, we know that for distances up to 8° from an origin the time by which tremors outrace the main movement may be reckoned by seconds. Adding this fact to our list, it seems that here we have a table which indicates that as an earthquake travels the tremors outrace the large waves at a very slow rate on the first part of its journey; but as its distance from the origin increases, this rate increases. This goes on until a point between 48° and 62° distant from the origin has been reached, after which the rate at which the large movements are left behind decreases.

One explanation for this is to suppose that the first precursors came through the earth with an average velocity which observation shows to increase approximately with the square root of the average depth of the chord joining the centrum and the observing station, whilst the large waves travelled round the surface. An objection to this view is that observations exist which show the large waves have apparently travelled over paths varying between 20° and 110°, at rates which rather than being constant have increased from 2·1 to 3·3 km. per second.

The velocities giving this comparatively slight difference were, however, determined on the assumption that the times at which various earthquakes originated were known, and there is, therefore, a possibility that they may be apparent rather than real.

Also it must be remarked, as pointed out by Dr. C. G. Knott, that if we regard the speed of propagation of the large waves as depending on a coefficient of elasticity, mainly distortional and not appreciably influenced by change of pressure and density, it is quite conceivable that the large waves should also pursue a brachistochronic path through our earth. The question then arises whether these larger movements would be left further and further behind their precursors in the manner indicated.

When we come to our second set of intervals which indicate the duration of the first preliminary tremors before they are eclipsed by groups of vibrations which usually grow in size and appear from their periods to be distortional, we see that up to a point about 62° from an origin these figures increase, but beyond that point they grow less.

What we have to explain in addition to this fact is that of the practical continuity and growth in magnitude of what very often forms a long and continuous series of preliminary motions. As I have already stated, their very appearance indicates that they have travelled on different paths. The first have followed a path entirely through our earth, whilst the successors may have travelled shorter and shorter distances through the earth to meet a crust through which they have completed their journey to the observing station. The first followed Knott's brachistrochronic path, or that of least time, whilst the successors took paths the latter parts of which were along arcs of increasing length. The result of this would be that at an observing station vibrations would arrive in series, each group corresponding to an originating impulse. The last of the rabble would be the series representing the main shock which, although it sent waves on brachistochronic paths, may in part have travelled as a surface undulation through the crust.

To illustrate this hypothesis I here reproduce a sketch given to me by Dr. C. G. Knott, showing the probable form of wave-fronts and paths of compressional vibrations passing through our earth.

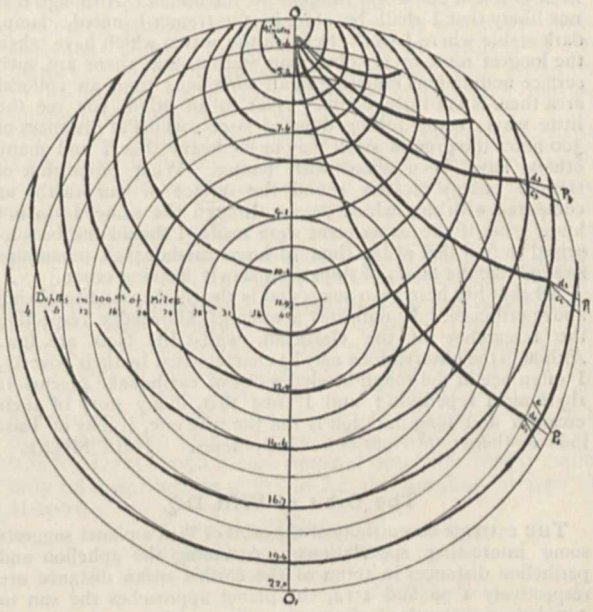
The assumption on which this has been drawn is that the square of the speed of the movements is a linear function of the depth, which closely corresponds, as already indicated, with observation.

The result at which Knott arrives indicates that the square of the speed increases at 0·9 per cent. per mile of descent in the earth, the formula being [1]

$$v^2 = 2{\cdot}9 + {\cdot}026\,d \text{ in mile second units.}$$

With an initial velocity of 1·7 miles per second, the velocities at depths of 400, 800, 1200 . . . 4000 miles become 3·7, 4·9, 5·8, 6·7, 7·4, 8·1, 8·7, 9·3, 9·8, and 10·3 miles per second. The times taken for wave-fronts to reach the positions shown are indicated in the sketch; the time taken to pass through the earth being 22 minutes.

I assume that when a wave has passed from its origin beyond the region vaguely referred to as the crust of our earth, it then spreads in all directions through a mass in which there is only an extremely gradual change in elasticity and density with regard to its centre. All wave-paths, however, before they emerge at the surface, encounter at varying obliquities the under-surface of this crust. For purposes of illustration, we will assume this



region of abrupt change to lie on the 400-mile circle. The path p_1 meets this surface nearly at right angles, whilst p_2 p_3 meet it at decreasing angles less than right angles. After each of these incidences a condensational wave will be refracted and split up into condensational and distortional rays. Now it will be observed that these two waves, which I will call c and d, will have different distances to travel before actual emergence, which distances will increase from p_1 towards p_3. At any station P_1 the first arrival will be c, but as this will be eclipsed on the arrival of d, its duration will always be short, and unless the originating shocks are well separated, seismograms, as we know them, can never show more than one set of condensational tremors.

At some point, like p_3, the duration of the preliminary tremors should reach a maximum, but from this point on towards the origin this quantity will decrease, if only on account of the fact that the velocity along the brachistrochronic ray differs less and less from that of the distortional wave within the crust. Such a view may possibly explain not only the short duration of the first precursors, but also the rise and fall in the values of our last column.

The growth in amplitude of the groups of tremors may be due to the fact that they are usually the outcome of originating impulses which increase in intensity until they culminate in a violent shock.

[1] See *Scottish Geographical Magazine* for January 1899.

As a simple illustration of earthquake radiation, we may imagine a disturbance to originate at O as a single impulse, the resulting vibrations spreading in all directions through the earth, and in all directions over its surface. The former of these may be regarded as elastic vibrations, whilst the latter have the character of surface undulations influenced by gravity. At any station P_1 the first arrivals would be preliminary tremors, chiefly compressional in character. These would be suddenly eclipsed by vibrations, probably distortional, originating by refraction beneath the crust in the vicinity of P_1. The first of them we should expect to find serrated, whilst their followers emerging between P_1 and P_2 would be smoother in outline and larger in amplitude. The last and largest members of the series would be those which have travelled practically as free surface-waves through the crust. The result of such radiation as exhibited on a seismogram would be to show true preliminary tremors, suddenly followed by a series of larger waves, which would gradually grow in size. If at the origin there were several impulses, then these latter precursors would arrive in groups. An alternative hypothesis is to assume that all the vibrations recorded at a station P arrived along their peculiar brachistochronic paths through the earth, an important fact supporting which, is that up to the present we have not with any certainty identified waves which may have reached P passing outwards from O round our world in opposite directions. Although it is not likely that I shall be able, in the tremor-haunted, damp, dark stable where I work, to catch the waves which have taken the longest route to my observing station, that there are such surface undulations radiating in all directions from an epifocal area there is but little doubt. Near to an origin you see the little waves come rolling down a street, whilst at distances of 300 miles the ground swell may be so heavy that I and many others have been seized with nausea. What proportion of seismic energy escapes round the surface of our earth, as compared with that which passes through the same, I do not know; but if the experiment were made, I should not be surprised to find that at the time of large earthquakes, mountains swayed like the masts of ships on a slowly heaving ocean.

All that has here been suggested is clearly very far from being above criticism. It indicates a want of knowledge respecting the researches of the elastician, whilst the facts are few. Although the observations may be characterised by their poverty, I often see in the rough-headed mobs of earthquake precursors rhythmical repetition; and I trust that, if my story of their creation and long duration is not the true one, it may at least induce others to attempt better hypotheses. JOHN MILNE.

The Orbit of Witt DQ.

THE extreme eccentricity of the orbit of Witt's planet suggests some interesting speculations. Assuming the aphelion and perihelion distances in terms of the earth's mean distance are respectively 1·79 and 1·12, the planet approaches the sun in 322 days, a distance of sixty-one million miles, an average of 200,000 miles a day.

Practically this may be considered as a fall, during the half-revolution, of this distance. Now if the planet were a perfectly plastic body, and we knew all its elements, it would be perfectly possible to determine the deforming forces acting on it during the passage. It is evident that the force of gravity acting on the forward point of the syzygial axis would always be in excess of that on the rear, and in consequence that the tendency would be to continually lengthen that axis in a proportion referable to the squares of the distances fallen. On the other hand the force of internal gravitation towards its own centre would always tend to restore the sphericity, and the result would be that a body starting as a sphere from aphelion would find the syzygial axis prolonged and its shape deformed into an increasingly prolate spheroid, till on its arrival at perihelion and its commencement to retreat the reverse phenomenon would occur, and the planet on its return become again a sphere.

Now, of course, we have no reason to suspect that DQ is a plastic body, and the comparative insignificance of its size, would, were it to be composed of matter of equal rigidity with ordinary rocks on the surface of the earth, enable it to successfully resist these deforming influences. We may, however, imagine a case where the strains would be sufficient to break up an ordinarily rigid body, if the eccentricity exceeded a certain amount, and the consequent differential action of gravity became sufficiently great.

A hypothetical planet moving in an orbit of high eccentricity, for instance, between Mars and Jupiter might, so long as it continued plastic, preserve its condition as a single coherent body. If, however, it were cooled to an extent sufficient to become enveloped by a rigid crust, there might come a time when the deforming forces would cause deep and continually proceeding fractures. Eventually we can conceive that these fractures would split the body into fragments, each of which from its own intrinsic rigidity would be able to maintain its shape and cohesion. In such a case each of the fragments would proceed to take up an independent motion of its own. Hence, perhaps, we may see our way, without calling in any extraneous factor, to account for the present zone of asteroids, as well as explain the small size of the individuals.

This tallies, moreover, with observation. The great planets have all orbits approaching a circle; Jupiter, the greatest of all, has, with one exception, the smallest maximum of eccentricity; and Mercury, the smallest, has actually the greatest. The Leonids move in a still more elongated orbit, and they are amongst the smallest celestial objects with which we are acquainted. Altogether the minuteness of the planet and the eccentricity of the orbit have some connection in fact; this connection I cannot believe to be fortuitous, and it seems not altogether presumptuous to refer it to a common law, which we know pervades the universe. This is my excuse for attempting to venture into a hitherto unexplored region of physics, but one pointing to vast possibilities, amongst others in geology.

Shanghai, January 17. THOS. W. KINGSMILL.

The Teaching of Geometry.

I AM sure that all mathematical teachers can thoroughly endorse Prof. Minchin's letter. The difficulty of making a change lies in the University and Civil Service examinations, which still prescribe Euclid. On the continent Euclid has been superseded by modern books, some of which might serve as a basis for a thoroughly reformed English text-book.

I am convinced that the deplorable weakness shown by almost all boys in the solution of geometrical problems, arises in great measure from Euclid; they are utterly confused by its prolixity and verbiage.

And it is not as though this prolixity meant any greater accuracy or better logical sequence. It is not proved till Book iii. that a circle can only cut a straight line in two points; but in (i. 12) this property is quietly assumed, otherwise several perpendiculars could be drawn. I. 13 simply asserts that $a + (b + c) = (a + b) + c$, but is unintelligible to beginners through its verbiage. In i. 16 we practically make an angle equal to the interior one, against the exterior angle, and then ask the pupil to see for himself that one is greater than the other, which is suspiciously like *petitio principii*. In the second Book we have a number of cumbersome proofs, some of which, indeed, are now shortened to an algebraic form. (I have never been able to understand the Cambridge regulation that the sign + may be used, but not the sign −.) The Euclidean definition of proportion is quite unintelligible to beginners, while the conception of similar figures and of *scale* is easily grasped. To insist on young boys entering on the subtleties of the subject, is much as though one made a child beginning arithmetic read, say, the first chapter of Weber's Algebra. What is wanted is thorough ready knowledge of the properties of lines and circles. And for this I would strongly recommend *practical geometry*. I believe it could very easily be made a means of imparting a knowledge of geometry in its highest and widest sense. R. J. DALLAS.

15 Pemberton Gardens, N.

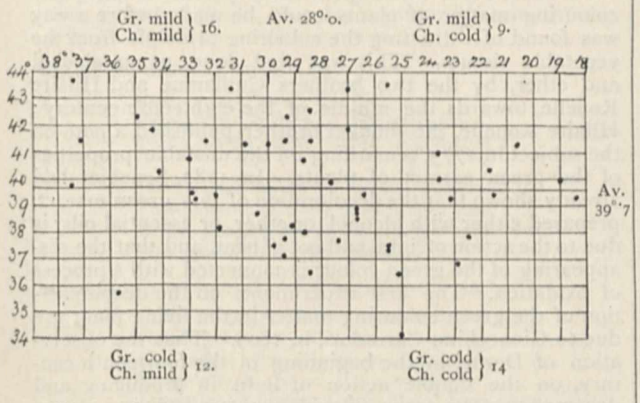
American and English Winters.

WHILE we, in the south of England, this February, have been enjoying weather of extraordinary mildness, we have read in the daily papers of bitter frost in America, and the miseries of a ferocious blizzard. It is by no means uncommon to find opposite winter weather, at the same time, east and west of the Atlantic. Can we form any exact idea as to frequency of the occurrence?

By way of seeking light on this, I have lately compared Chicago and Greenwich weather in the first quarter of the year, in the fifty-one years 1841–91; presenting the facts by a variety of the graphic method, which I do not remember to have seen

much used in meteorology, but which seems capable of various useful applications.

In the diagram herewith, the line of ordinates measures mean temperatures of the first quarters at Greenwich, and the line of abscissæ those at Chicago. The cross-lines represent averages: 39°·7 for Greenwich, 28°·0 for Chicago; and each dot, by its position, indicates the character of a winter (temperature of first quarter) at both places.



The vertical and horizontal scales being alike, one can see by the shape of the diagram how much greater are the variations of winter temperature at Chicago than at Greenwich.

If we call anything above the average *mild*, and anything below it *cold*, we find, on counting the dots in the four divisions, this state of things:—

	Cases.	
Greenwich mild, Chicago mild ...	16	30
Greenwich cold, Chicago cold ...	14	
Greenwich mild, Chicago cold ...	9	21
Greenwich cold, Chicago mild ...	12	

Thus, 21 of those 51 first quarters (say 42 per cent.) were of opposite sign, and 30 of like sign.

The distribution of dots may suggest other points of interest, on which I need not here enlarge. It would be instructive, I think, to make other comparisons of the same kind. Some time ago Prof. Hann compared the winters (December–February) at Jakobshavn, in the west of Greenland, and Vienna (*Met. Zeits.*, March 1890, p. 112), and found a larger proportion of unlike signs than the above—viz. 27 cases, against 15 of like sign.

ALEX. B. MACDOWALL.

DANTE AND THE ACTION OF LIGHT UPON PLANTS.

IN the history of vegetable physiology, sufficient importance has not been given to Dante's observations upon the action of solar light and heat upon plants, and to the ideas upon this action that existed in Italy in the fourteenth century. Sachs, in his "Geschichte der Botanik," ignores Dante and Pier de' Crescenzi completely; observing in a general way: "Of the importance of Light and Heat for the nourishment and the growth of plants, next to nothing is to be found in the authors that wrote before the last decades of the seventeenth century; although certainly the action of these agents must have been known from the oldest times, in plant culture and in several special circumstances."[1] P. A. Saccardo also, in his "Primato degl' Italiani nella Botanica," does not take any notice of the observations and opinions of Dante and of Pier de' Crescenzi on light action.

In such special works as Ottaviano Targioni Tozzetti's "Cognizioni botaniche di Dante," written in 1820: R. de Visiani's "Accenni alle Scienze botaniche nella Divina Commedia," published in 1865: and the quite recent book "Dante Georgico," in which, in a complete and able manner, Count Gastone di Mirafiore has collected all the references to agriculture, and to plants and animals, that are to be found in the "Divina Commedia" and in the minor works of Dante: the historical importance of some of Dante's observations upon light action has been overlooked; and no mention is made of the opinions prevalent upon this subject in Dante's time, as given especially by Pier de' Crescenzi.[1]

The best-known and often-quoted verses, in which the action of solar radiation upon plants is first noted in a modern language are those of "Purgatorio," xxv. 77:

> Guarda il calor del Sol che si fa vino
> Giunto all' umor che dalla vite cola;

or, in Longfellow's translation:

> Behold the Sun's heat which becometh wine
> Joined to the juice that from the vine distils.

Dante, despite his remarkable clear-sightedness in noting and describing natural phenomena, was not emancipated from what Whewell calls the commentatorial spirit of the Middle Ages; and these verses are but a powerful and poetical rendering of a passage in Cicero's "De Senectute," a book which, as may be gathered from the several quotations in the "Convivio," was much studied by Dante. There is no doubt, however, that Dante's verses have a special interest in the history of vegetable physiology; for they drew attention to the importance of their meaning in two such master minds as Galileo and Francesco Redi.

It is not unlikely that the verses of Dante influenced Leonardo da Vinci in believing that "the sun giveth spirit and life to plants, and the soil with its moisture nourisheth them,"[2] leading him to an experiment in which the importance of leaf-function in the nourishment of plants is first noted, two hundred years before Malpighi. In this experiment Leonardo caused a water-fed plant to grow prosperously and bear fruit abundantly, although its roots had purposely been reduced to "only one tiny rootlet" (*solamente una minima radice*). Leonardo thus succeeded in causing a plant to grow chiefly by its foliage, to "*vivere della cima*" ("Paradiso," xviii. 29): an experiment that would have been too dangerous for the experimenter in Dante's days. The "*vivere della cima*" was for Dante such a supernatural condition that it could only be described as possible for the symbolical tree of Heaven:

> . . . the tree, whose life
> Is from its top, whose fruit is ever fair,
> And leaf unwithering.
> —*Cary's Translation.*

The verses of Dante on the action of sunlight on the vine are paraphrased in new verses in the "Bacco in Toscana" of Redi, the poet and naturalist, in describing the growth of wine, "that lovable blood":

> Sì bel sangue è un raggio acceso
> Di quel Sol, che in ciel vedete;
> E rimase avvinto e preso
> Di più grappoli alla rete;

or, as rendered in English by C. H. D. Giglioli:

> That blood so fine is a kindled ray
> From the Sun, in heaven set,
> Entangled and held a prey
> By clustering grapes in their net.

Galileo, as Magalotti tells us, believed that "wine is a compound of light and sap." Magalotti rather diffusely

[1] Sachs, "Gesch. der Botanik," p. 387.

[1] Ottav. Targioni Tozzetti, "Delle Cognizioni botaniche di Dante espresse nella Divina Commedia." Atti dell' Accad. della Crusca. Tomo ii. (Firenze, 1829.) Roberto de Visiani, "Accenni alle Scienze botaniche nella Divina Commedia"; in "Dante e il Suo Secolo." (Firenze, 1865.) Gastone di Mirafiore, "Dante Georgico." (Firenze, 1898.) See also: G. Bottagisio, "Osservaz. sopra la Fisica del Poema di Dante." Nuova ediz. sulla prima Veronese del 1807, a cura di G. L. Passerini, Città di Castello, 1894.

[2] J. P. Richter, "The Literary Work of Leonardo da Vinci." (London, 1883.)

dwells on Galileo's opinion. Starting from Castelli's explanation of how a black surface gets more heated in the sun than a white surface, Magalotti evidently believing the sun's action to be specially powerful on the vine, tries to show how light, "that last subtle impalpable dust of bodies," must be especially entrapped by the ripening grapes, and thus become the cause of fermentation and of the strength and aroma of wine.[1] Giuseppe Del Papa, also a contemporary of Redi, one of the first to experiment on vinous fermentation, and to attempt measuring the heat developed in this process, was also of opinion (and he quotes the authority of Dante), that "both oil and wine" are formed by the action of solar light and heat upon the water contained in plants. Del Papa describes the highly penetrative action of light: "So subtle that it penetrates in every part of our body without causing sensation; but only by acting inside the eyes does light awaken that feeling which we call sight."[2]

Indeed, Newton's theory confirmed the opinion that light may enter into combination with matter. And the action of light upon plants was accounted, before and after the experiments of Ingen Housz, by Lavoisier, Senebier, Carradori and others, as a fixing or combining of light in living vegetable substances, the green colouring matter being the first product of this combination. "Experiments made on vegetation lead us to believe that light gets combined with some part of the plant, and that to this combination are due the green colour of leaves, and the various colours of flowers . . ." Thus wrote Lavoisier in 1789.[3] Senebier, who in 1788 had already noted and experimented upon the antiseptic action of light, accounted for this action by believing that light became in some way fixed upon the organic substances that are preserved from decomposition.[4]

When heat and light were no longer regarded as due to corpuscular emission, but as caused by vibrations of the luminiferous ether, the Dantesque notion of the fixation of solar heat and light died away, or rather became transformed into the notion of the storing up of energy.

An original observation by Dante is that light is the cause not only of the production of the green colouring matter of plants, but also of its decoloration. In a similitude describing the rise and wane of worldly fame, Dante writes ("Purg.," xi. 115):

> La vostra nominanza è color d' erba,
> Che viene e va; e quei la discolora,
> Per cui ell 'esce della terra acerba;

or, in H. T. Cary's translation:

> Your renown
> Is as the herb, whose hue doth come and go;
> And his might withers it, by whom it sprang
> Crude from the lap of earth.

It has been of course a matter of ancient and common observation that the green of vegetation is produced through the action of the sun, and that the sun withers up all vegetation, causing it to fade and dry. But Dante is the first to express the double action of light on the green colouring matter, causing both the production and the bleaching of the "color d' erba." One fancies him observing the rapid bleaching of green seaweed and of other fresh vegetable matter in the sunlight, and distinguishing between the discolouring and the shrivelling action of the solar rays.

We must come down to 1686, to find again observations on the action of light on the production of the green colouring matter in plants. John Ray then distinguished between the heat-action and the light-action of the solar rays, observing that the colouring of foliage cannot be due to heat, often greater in closed dark spaces than in the open, but to the light of the sun.[1]

No exact observation upon the properties of the green colouring matter of plants could be made before a way was found of extracting the colouring principle from the vegetable tissues. This was first done, using alcohol and ether, by the two brothers Guillaume and Hilaire Rouelle, towards the middle of the eighteenth century; Hilaire Rouelle, the younger brother, published a note on the subject in 1773, remarking on the unstable properties of the green extract of plants. In 1782, Senebier had already shown that the decoloration of this green extract, prepared either with alcohol, or ether, or essential oils, is due to the action of light, and not of heat, and that the disappearing of the green colour is connected with a process of oxidation. The first experiments on the decomposition of the green colouring matter in the living plant are due to Gioacchino Carradori, in 1809.[2] Thus the observation of Dante, in the beginning of the fourteenth century, on the double action of light in producing and decomposing the green colouring matter in living plants, forestalls a discovery that was made in our century; and that has been further extended by the recent researches of N. Pringsheim.

Dante connected in a special way the vegetable activity of plants with the green of their foliage; and the effect of the specific virtue of the soul upon the body is compared to the green of leaves, the effect of vegetable life:

> Come per verdi fronde in pianta vita.[3]

And Dante observes that the discolouring of leaves is the sign of sickness in plants, in the vine especially (already subject to many maladies in Dante's time, as Crescenzi teaches us), remarking that the vineyard

> Soon turns
> To wan and withered, if not tended well;

well noting, in the word *imbianca*, the chlorotic change in the plant:

> la vigna
> Che tosto imbianca, se il vignaio è reo.[4]

No one before Dante, nor for many centuries after Dante, has so well noticed the depressive effect upon vegetable life of defective sunlight and persistent rain, by which roots are made to rot in the drenched soil, while leaves become discoloured and fall, and fruit fails to reach maturity:

> Ben fiorisce negli uomini il volere;
> Ma la pioggia continua converte
> In bozzacchioni le susine vere;

or, according to Cary:

> The will in man
> Bears goodly blossoms; but its ruddy promise
> Is, by the dripping of perpetual rain,
> Made mere abortion.[5]

The best comment upon the botany of these verses, not well rendered in the English version, is in the recent experiments of Julius Wiesner, on the effect of continual rain upon different kinds of plants.

The action of sunlight in causing flowers to "awake" and to open was especially remarked by Dante, for he

[1] L. Magalotti, "Lettere Scientifiche ed Erudite" (Venezia, 1740), Lettera v. See also Redi's observations in 1686 on this letter: F. Redi, "Opere. (Napoli, 1778), Tomo v. p. 134.

[2] Gius. Del Papa, "Trattati vari fatti in diverse Occasioni" (Firenze, 1734), p. 58; and "Della Natura dell' Umido e del Secco (Firenze, 1690), p. 174.

[3] Lavoisier, "Traité de Chimie, présenté dans un ordre nouveau et d'après les découvertes modernes" (Paris, 1789), i. p. 201.

[4] J. Senebier, "Exp. sur l'Action de la Lumière Solaire" (Genève, 1788), p. 442.

[1] Joa. Raius, "Historia Plantarum," (Londini, 1686), vol. i. libr. i. p. 15.

[2] G. Carradori, "Sopra la distruzione del color verde operata dalla luce in alcuni Vegetabili viventi," *Giornale di Fisica di Brugnatelli*, vol. iii. 1809.

[3] "Purg.," xviii. 54.

[4] "Paradiso," xii. 86, Cary's translation

[5] "Paradiso," xxvii. 124. Cary's Translation.

forcibly describes these actions in different parts of his poem with well-known verses :

> Quale i fioretti, dal notturno gelo
> Chinati e chiusi, poi che il Sol gl' imbianca,
> Si drizzan tutti aperti in loro stelo;[1]

or, in Cary's translation :

> As florets, by the frosty air of night
> Bent down and clos'd, when day has blanch'd their leaves,
> Rise all unfolded on their spiry stems.

And in "Paradiso," xxii. 55 :

> Così m' ha dilatata mia fidanza,
> Come il Sol fa la rosa, quando aperta
> Tanto divien quant' ella ha di possanza ;

or :

> Have raised assurance in me : wakening it
> Full-blossom'd in my bosom, as a rose
> Before the sun, when the consummate flower
> Has spread to utmost amplitude ;

and more forcibly still in "Purg.," xxxii. 54 :

> Come le nostre piante, quando casca
> Giù la gran luce mischiata con quella
> Che raggia retro alla celeste lasca,
> Turgide fansi ; e poi si rinnovella
> Di suo color ciascuna, pria che il Sole
> Giunga li suoi corsier sott' altra stella ;

but not so happily translated by Cary :

> As when large floods of radiance from above
> Stream, with that radiance mingled, which ascends
> Next after setting of the scaly sign,
> Our plants then burgein, and each wears anew
> His wonted colours, ere the sun have yok'd
> Beneath another star his flamy steeds.

The action of solar radiation in causing the rise of sap in plants, and in producing what nowadays we call vegetable transpiration, was especially noticed in the time of Dante, four hundred years before the experiments of Guettard.

Pier de' Crescenzi, the famous agricultural writer of Bologna, was a contemporary of Dante, and he lays special stress on the action of solar heat and light upon plants. Crescenzi's work, the "Opus Ruralium Commodorum," was written in 1305, when the "Divina Commedia" was not yet finished, and when a part of the "Convivio" had not been written. Crescenzi's book, originally written in Latin, became so popular that in the lifetime of the author, or shortly after his death, it was translated into Italian ; and since then, down to the beginning of this century, that book (it was among the first books printed, the first edition being of Strassburg, 1471) remained the standard agricultural encyclopædia, republished in thirty Italian editions, and translated into the chief languages of Europe.

It is from Crescenzi that we gather best what Dante's ideas were on the action of light upon plants ; and to Crescenzi we must look as the fountain-head of the ideas prevalent on that subject during many centuries. Crescenzi likened the vegetable to a man planted with his head downwards in the soil and all his limbs in the air. For the roots of a plant were considered the really vital part of the organism, its head and heart in one, by which, with many mouths, the roots sucked up with moisture the food prepared in the soil by the corruption of corruptible things. The soil was for plants what the stomach is to animals. Four hundred years later we still find Linnæus writing that *plantarum ventriculus est terra*. According to Crescenzi, not only is solar radiation the cause of the sucking-up action of vegetables, but also of the transformation and assimilation of plant food, separating the water with which it is mixed, the water being then transpired away.

[1] "Inferno," ii. 127.

Thus Crescenzi finds that the growth and ramifying of plants is due to two causes : nourishment from the soil and the action of sunlight : "Branches . . . multiply for two reasons : one of which is material, namely the abundance of nourishment ; and the other is efficient, that is the heat of the sun, which on all sides toucheth the tree, and causeth the sap to boil up, and draweth it forth ; and therefore many branches shoot outwards in the upper parts, where the sap is more straitened, and is rendered more subtle by digestion. And the true proof of this is that plants which are surrounded by many other plants, as happens with trees in thick and shady woods, grow high, and do not produce many branches, nor are their trunks thick, and they have a certain lack and feebleness of branches ; for, by want of sun, their sap is not drawn forth, nor does it boil at their outer extremities ; for the coldness of the shade keeps in the heat which being constrained inside, fleeing from its contrary, sendeth on high all the nourishment."[1]

". . . The sap is a humour which, through the pores of the roots is attracted to nourish all the plant, and by its nourishing power gets distributed in all the parts of the plant ; and it is necessary that it should be changed to the similitude of the plant by digestive heat."

". . . the nourishing humour of plants is more insipid when in the root, but as it goeth farther and farther from the root, the more it gaineth in taste convenient to the plant ; and in the same way as it gaineth in savour, so doth it gain in density and in subtlety and in acidity ; for by the action of heat these changes must occur. . . ."[2]

". . . because fruits require much power of the sun, leaves are placed somewhat distant from the fruits, so that these be not in the shade, and the digestion be not prevented that is done by the sun."[3]

". . . the sun's heat giveth, as it were, perfection and form, and nearly giveth life ; for this reason moisture is formed in plants continually."[4]

The hardening influence of light upon vegetable tissues, and the favouring of growth by heat in the absence of light are, for the first time in the history of plant life, noticed by Crescenzi, who thus shows that he formed some idea of the distinct action upon plants of heat and light : "Plants in warm weather grow in the darkness of night ; and in the heat of the sun they harden and become woody."[5] This is a precise and simple statement of facts, without any reference to the action of the moon, as we find in later writers, such as Levinus Lemnius, the celebrated Dutch doctor, in his curious book, "De Occultis Naturæ Miraculis," published in 1559.[6]

It is by Carradori, at the beginning of this century, that we again find stress laid on the action of light in giving robustness and hardness to vegetable tissues. Indeed, the words of Crescenzi may be paraphrased with those of the most eminent writer on the physiology of plants of our own times : "So far as plants are concerned, warmth chiefly signifies growth ; while light, on the other hand, brings about nutrition."[7]

Even as late as Liebig sufficient importance was not given to the action of light in hardening growing tissues ; and only the experiments of Sachs and of Ludwig Koch have explained to us the reason why thick seeding, or a luxuriant vegetation, is followed by the laying of wheat and other high grasses.

It is evident that in the days of Dante a new spirit of inquiry was beginning, regarding not only the life of

[1] Per de Crescenzi, "Trattato dell' Agricoltura," libr. ii. cap. 5.
[2] *Id.*, libr. ii. cap. 4. [3] *Id.*, libr. ii. cap. 6.
[4] *Id.*, libr. ii. cap. 25. [5] Pier dei Crescenzi, libr. xi. cap. 14.
[6] Lemnius writes : "For we see that plants receive nourishment that is moved by the heat of the sun ; and by night this food is diffused so that the food getteth increase . . . by day, by virtue of the sun, all things ripen ; and by night, by virtue of the moon, they are filled with humour and get swollen.
[7] Julius v. Sachs, "Lectures on the Physiology of Plants," trans. by H. Marshall Ward (Oxford, 1887), p. 198.

plants and the action of sunlight, but all natural phenomena. It would seem as if there were other than a purely theological meaning in the words by which Virgil, the master of the ancient knowledge, emancipates Dante from old learning and art, and opens to him the gates of new knowledge by admonishing him to look for himself, look to the sun shining before him, and to all the plants and trees growing spontaneously around:

> . . . Lo tuo piacere omai prendi per duce;
> Fuor sei dell' erte vie, fuor sei dell' arte.
> Vedi là il Sol che in fronte ti riluce;
> Vedi l' erbetta, i fiori e gli arboscelli,
> Che quì la terra sol da sè produce.
>
> . . . . . .
>
> Non aspettar mio dir più, nè mio cenno:
> Libero, sano e dritto è tuo arbitrio,
> E fallo fôra non fare a suo senno;
> Perch' io te sopra te corono e mitrio;[1]

or, in Wright's rendering:

> Take thou thy pleasure for thine escort now—
> Forth of the steep and narrow way emerged.
> Behold the sun upon thy forehead thrown—
> Behold the trees, the flowers, of every hue,
> In this most happy soil spontaneous sown.
>
> . . . . . .
>
> No more from me expect or sign or word:
> Thy will henceforth is upright, free, and sound:
> To slight its impulse were a sin: then lord
> Be o'er thyself;—be mitred, and be crowned.

The splendour of the ancient literatures, dawning again upon Italy, overpowered the rising of the new science. The generations that followed Dante became more erudite than learned; and the new knowledge slept again through the centuries, just showing life with Leonardo da Vinci, and a few others, until the "unlocking of the gates of sense, and the kindling of a greater natural light," in the days of Bacon and Galileo. ITALO GIGLIOLI.

THE REV. W. COLENSO, F.R.S.

WE briefly announced in our issue of February 16 the death of the Rev. William Colenso, F.R.S., of Napier, New Zealand. The close of so interesting a life, which for more than half a century has been intimately associated with the progress of science and education in the antipodes, is one that demands more than a passing reference in the columns of NATURE.

Mr. Colenso was the son of the late S. M. Colenso, a saddler of Penzance, and was born in that town in 1811. He was put to learn the arts of printing and bookbinding in London, where he was eventually employed for a time on behalf of the British and Foreign Bible Society. In 1833 the Church Missionary Society determined to establish a printing press in the then almost *terra incognita* of New Zealand. Mr. Colenso was selected to take charge of the enterprise, with results that must have more than justified the most sanguine expectations. An account of his early experiences in the joint capacity of printer and missionary was published by him in 1888, under the title of "Fifty Years ago in New Zealand," and a more interesting history of pioneer work of the kind undertaken by Mr. Colenso, performed as it was under exceptionally unfavourable conditions, it would probably be impossible to find. "In December 1837," says the technical journal *Typo* (April 26, 1890), "under difficulties such as perhaps no printer ever had to surmount since the first invention of the art, Mr. Colenso completed his great work (a translation into Maori of)—the entire New Testament, in octavo, small pica type." From about the year 1840 Mr. Colenso devoted himself principally to mission work. In 1844 he took orders, after preparation under Bishop Selwyn. In the same year he settled at Hawkes Bay, where he resided for the rest of his life.

An ardent lover and student of nature, Mr. Colenso has left behind him a distinguished record as a botanist and as an authority upon the natural history of the archipelago. For his services to botanical science he was in 1886 elected a Fellow of the Royal Society, having been previously made a Fellow of the Linnean Society. The wild woods and mountains of his island home, traversed unremittingly by him in his missionary avocations, exercised throughout his life an ever-increasing fascination on his mind. With the Maoris his acquaintance was necessarily of a most intimate character; and he became an authority second to none on the subject of their language, arts, and legendary lore.

On June 25, 1896, a notice appeared in NATURE of the generous scheme for the foundation of a museum that Mr. Colenso had put before a meeting of the Hawkes Bay Philosophical Institute. The enlightened spirit in which the scheme had been conceived is shown by the extract which we printed from Mr. Colenso's address to the meeting. In offering 1000*l.* as a nucleus of the fund required for the establishment of the museum, he imposed the condition, among others, that the museum should be opened on Sunday afternoons as well as on every week-day. It is stated in the Cornish press that the reception accorded to his munificent offer was very disappointing to him, and that the scheme was withdrawn by him in the following year, with the announcement that his books and money would go to his native town. He had already presented 1000*l.* to the borough of Penzance, the income from the investment of which sum is utilised for annual gifts to the deserving poor. At the end of 1898 this fund, known as the "Colenso Dole," was increased by a second donation of 1000*l.*

Mr. Colenso's zeal in the pursuit of science, and his enthusiasm for missionary work did not exhaust his energies. He discharged important public duties from time to time. In the days when the relations between the natives and the colonists were strained he acted as a negotiator in the interests of the Maoris, and was the last survivor of the English signatories of the treaty of Waitangi. He was a member for Napier in the first General Assembly, and retained the seat for many years.

Mr. Colenso was a first cousin of the late Bishop of Natal. There are marked points of resemblance between the spheres in which the two men worked, and it is not surprising that the former felt himself to be in close sympathy with his South African namesake on the subjects which the Bishop had at heart.

This fact, and the untiring energy which sustained Mr. Colenso in his latest years, are evidenced by the following extracts from a letter which he wrote to a correspondent in London barely two years ago. He said: "I am leaving here to-morrow morning by rail for the Bush district (that is the forest country) in the interior, having Church duty at Woodville, 100 miles S., on Sunday next, the Vicar being unwell. Last Sunday I took Church duty here at St. Augustine's, and on the Sunday before at Clive, a village nine miles E. towards Cape Kidnappers. I am far too old (eighty-six) to undertake the duties of a *parish*, but I *love* my *work*, and am always ready to help as far as I am able." He then adds that he had always been "a great admirer and supporter" of Bishop Colenso's "theological works." "I have them here," he writes, "and have often studied them. I particularly like his volumes of Natal sermons, &c., and went with him wholly in the matter of the oppressed and ill-used Zulus."

It is greatly to be hoped that the preparation of a biography of this remarkable man may fall into thoroughly competent hands.

[1] "Purgatorio," xxvii. 131.

NOTES.

LORD LISTER has been elected a foreign associate of the Paris Academy of Medicine.

PROF. E. RAY LANKESTER, F.R.S., has been elected a correspondant of the Paris Academy of Sciences.

PROF. L. CREMONA, of Rome, Prof. Ray Lankester, and M. Alexander Karpinsky, of the Institute of Mines of St. Petersburg, have been elected Associates of the Belgian Academy of Sciences.

WE regret to see the announcement of the death of Sir John Struthers, Emeritus professor of anatomy in Aberdeen University, at seventy-six years of age.

THE Belgian Royal Academy has awarded prizes of 600 francs to M. Georges Clautriau, of Brussels, for his memoir on the macro- and micro-chemistry of digestion in carnivorous plants, and to Prof. L. Cuénot, of Nancy, for his essay on the excretory organs of Mollusca.

REPLYING in the House of Commons on Monday to a question upon the preservation of rare animals in Africa, Mr. Brodrick said: "Steps have already been taken to guard against undue destruction of wild animals by the issue of game regulations, and we are in communication with the German Government as to collective action. It is proposed to hold an international conference in London in the spring."

A PRIZE of 500 francs, founded by Augustin-Pyramus de Candolle for the best monograph on a genus or family of plants, is offered in competition by the Société de physique e d'histoire naturelle de Genève. The monographs may be composed in Latin, French, German, Italian or English, and must be sent to M. Pictet, the president of the Society, before January 15, 1900. Members of the Society are not permitted to compete.

AT a meeting of the Manchester and Salford Trades Council, held on February 16, the following resolution was passed:—"That this Council desires to again express its sympathy with the objects of the Decimal Association, believing that by their adoption the interests of commerce and industry throughout the United Kingdom will be much benefited." All the leading Trades Unions in Great Britain strongly support the movement for the adoption of the metric weights and measures by this country, and on two occasions at the Congress of Trades Unions resolutions in favour of this reform were unanimously passed.

A RECENTLY issued number of the *Nouvelles Archives* of the Muséum d'Histoire Naturelle of Paris contains a full description, accompanied by coloured figures, of a very remarkable new monkey lately discovered by the French missionaries in Eastern Tibet, and proposed to be named *Rhinopithecus bieti*, after Mgr. Biet, the head of the Mission. It inhabits the western slope of the chain of mountains which separates the valley of the Mekong from that of the Yang-tze, in the district of Tsékou, where it is known to the natives as the *Tchru-tchra*, or "snow-monkey." This is the third species of monkey now known to inhabit high altitudes in Eastern Tibet.

DURING the last week or ten days the weather over the British Isles has partaken both of winter and summer, the nights being characterised by sharp frost, while the days have been bright and warm. From about February 19 an anti-cyclone has enveloped most of the country and the greater part of Western Europe. The early mornings especially have been densely foggy in the neighbourhood of the metropolis; the day temperature in the screen has reached 55°, while at night the sheltered thermometer has fallen to 22°. No rain has been recorded over a large part of England since February 15, and in the *Daily Weather Report* issued by the Meteorological Council on February 27 the unusual occurrence was recorded of the absence of rain over the whole of Western Europe, between Bodö, within the Arctic circle, and Lisbon.

THE British Fire Prevention Committee, the establishment of which was the outcome of the Paris Charity Bazaar and Cripplegate fires, has now become a fully incorporated scientific society under the special sanction of the Board of Trade.

MR. ROBERT J. ALEY contributes to the *Proceedings* of the Indiana Academy of Science (1897) a list of seventy-one collinear sets of points connected with the geometry of the triangle, with references for proofs to well-known text-books. The list should prove useful for purposes of reference.

IN the *Atti dei Lincei*, viii. 1, 2, Signor P. Pizzetti contributes two notes on the intensity of gravity on Mont Blanc. The values for g observed on the slopes on the mountain lead the author to conclude that the attraction of the mountain is only to a small extent compensated for by deficiencies in internal mass. Such deficiencies cannot be much below those represented by a stratum of 1000 metres thickness. At Chamounix, on the other hand, the deficiency seems to be far smaller.

WE learn from the *Pioneer Mail* that preparations for the introduction of the electric light into Calcutta are going on apace. Mains are being laid, and the central station, where fifteen hundred horse-power will be employed in generating the current, is approaching completion. The dynamos will shortly be running, and the current available for the supply of private houses; so that electric fans driven by the current will soon replace the coughing, slumbering punkah coolie. The engines which are being set up will be entirely devoted to the production of the electric light and the driving of electric fans, a further installation being contemplated for the trams when these come to be driven by electricity.

IT has been resolved that the memorial to the late Prof. Coats, of Glasgow University, shall take the form of a University prize or scholarship in connection with pathology. To carry out this a sum of at least 1200*l.* will be required. Circulars are being issued calling for subscriptions, which will be received and acknowledged by Dr. David Newman, honorary secretary, 18 Woodside Place, Glasgow, or Mr. James J. MacLehose, honorary treasurer, 61 St. Vincent Street, Glasgow.

NUMEROUS friends of the late Prof. Kanthack have expressed the wish that his work should be commemorated in some suitable way. It is proposed to raise a fund, the interest of which shall be devoted to the use of Mrs. Kanthack during her life, whilst the capital amount can eventually be employed in founding some permanent memorial to the late Dr. Kanthack. All who desire to contribute to the fund are requested to send subscriptions to Dr. J. H. Drysdale, 25 Welbeck Street, London, W.

REFERRING to the late Dr. Alexandre Laboulbène, professor of the history of medicine in the University of Paris, who died recently at the age of seventy-three, the *British Medical Journal* remarks that he had won great distinction as a pathologist and an entomologist before he was appointed to the chair which he occupied for the last twenty years of his life. He was the author of a large number of papers on pathological and entomological subjects, presented not only to the Académie de Médecine, but to the Société de Biologie, the Société Anatomique, and the Société Entomologique de France. Prof. Laboulbène was president of the Académie de Médecine in 1893.

THE Association of American Anatomists has accepted the propositions of the editors of the *Journal of Anatomy and Physiology*, and have adopted the journal as the official organ of the Association. Dr. G. S. Huntington, professor of anatomy, Columbia University, New York City, has been nominated as the American editor. At the recent meeting of the Association, the president, Dr. Burt G. Wilder, discussed "Misapprehensions as to the Simplified Nomenclature." He urged especially a fuller recognition of what had been done by the English anatomists, Barclay, Owen, Pye-Smith and T. Jeffery Parker, and hoped the nomenclature of the future would be called the "Anglo-American."

WE learn from the *American Naturalist* that the department of scientific investigation of the United States Fish Commission is being developed by Prof. Bumpus. The laboratory at Woods Holl is to be kept open throughout the year, and students are welcomed there at any time. The facilities of the various stations are placed at the command of those who wish embryological or other material. In the line of research, it is stated that the department has arrived at the conclusion that the late increase in the number of starfish in the oyster-beds of Southern New England, and especially in Narragansett Bay, is directly related to the capture of the menhaden and other fishes for the oil and fertiliser factories. These surface-feeding fishes formerly destroyed large numbers of starfish eggs and larvæ; but since they have been caught so persistently, the starfish have got the upper hand.

THE first year of the marine biological station at Millport appears to have been a satisfactory one. The Committee of the Millport Marine Biological Association report good progress, not only in regard to the numbers who visited the Robertson Museum, and to the degree in which the facilities afforded by the laboratory were utilised by scientific workers, but also in regard to the measure of public support accorded to the scheme. There were over 8000 visitors to the museum during the past year, and tables in the laboratory were utilised for terms varying from a week to a month on thirty-eight different occasions. While the Committee have reason to be gratified with the present degree of equipment of the station, and with the facilities it affords for biological work, they recognise that, in order to take full advantage of the surrounding sea area, and to bring the station into line with the best-equipped institutions elsewhere, some considerable additions were still required. It is hoped that as the station becomes better known its complete equipment will follow. It would be extremely gratifying to the Committee were this end accomplished before the meeting of the British Association in Glasgow in 1901.

TO afford the members of the Franklin Institute, Philadelphia, the opportunity of cultivating an interest in photography and microscopy, with especial reference to the branches of photographic optics and mechanics, photo-micrography, photochemistry, and their manifold applications to the various branches of the arts and manufactures, a photographic and microscopic branch of the Chemical Section is being organised. Of interest in connection with this movement, is the fact that the Chemical Section of the Institute has lately become the residuary legatee of the large and valuable accumulation of scientific books and physical and chemical apparatus of the late Mr. Mathew Carey Lea.

THE historical sketch of the first federated institute, which included mining engineers from all parts of the world, given by Mr. Bennett H. Brough in a paper read before the Institution of Mining Engineers, at the general meeting held on February 22, is of interest to other societies besides that before which it was read. The original idea of forming such an institute is said by Mr. Brough to have been due to the distinguished Austrian mining engineer and metallurgist, Ignaz von Born. The society was established in 1787 under the name Societät der Bergbaukunde, and it was the prototype of the mining institutes of the present day. The object of the society was to afford a means of communication between mining engineers of all nationalities, on matters bearing upon the mining industry. Mining experts from all parts of Europe, and even from Mexico and South America, were enrolled as members. Only two volumes of *Transactions* were published, the first in 1789; and, probably owing to the death of von Born, which occurred at the age of forty-eight, at Vienna, on July 24, 1791, and to financial difficulties, the society soon came to an end.

AT the meeting of the Franklin Institute, Philadelphia, on February 15, Mr. L. E. Levy exhibited and described the acid blast process invented by him to facilitate the etching of photo-chemical engravings. The invention consists essentially in the application of a spray of finely atomised etching liquid instead of the immersion bath at present in use, the spray being driven against the plate by a powerful blast of air from an air-compressor. Under the impulse of the blast the etching proceeds very rapidly. The heat evolved by the rapid chemical decomposition of the metal is absorbed by the expansion of the compressed air as it escapes into the etching compartment, and this results in keeping down the temperature of the plate and the etching liquid to a normal degree. As each succeeding globule of acid impinges on the metal in the direction in which the etching is required to proceed, the process can be continued to a depth beyond which the finer and closer lines of the design would become too frail to bear the strain of printing, and at that point the etching is stopped and the finer lines are protected by powdering in the usual way, after which the etching can be carried to the requisite depth. Attached to the etching box is a washing compartment, into which the plate carrier is slid when the etching liquid is to be washed away from the plate.

THE committee appointed by the council of the Society of Arts to inquire into the requisite conditions of safety in acetylene gas generators, and to report on the various apparatus shown at the exhibition held at the Imperial Institute, has just published their results and conclusions. The committee classified the generators into three groups: (1) those in which the gas is generated by water being allowed to drip or flow on to the carbide; (2) those in which the water is allowed to rise in contact with the carbide, the rise being regulated by the increase of pressure in the generating chamber; (3) those in which the carbide drops into the water. These are again subdivided into—automatic generators, whose storage capacity is less than the total volume which the charge of carbide is capable of generating, and which, therefore, require automatic regulation; and non-automatic, whose holders can receive all the gas produced by the charge of carbide. It is concluded that the tests have clearly demonstrated that many types of acetylene gas apparatus can be so constructed as with ordinary precautions to be absolutely safe, and that lighting by acetylene need be no more fraught with danger than any other form of artificial lighting in general use. But though the committee consider acetylene gas to be safe when generated in a properly constructed apparatus outside the building to be lighted, and in accordance with the rules and suggestions contained in the report, they point out that the generation of gas within the house, and the use of hand lamps, cycle lamps, &c., is not unattended by danger, except in skilled hands.

THE Trustees of the Indian Museum have just distributed an important memoir by Major A. Alcock, superintendent of the Museum, and professor of zoology in the Medical College, Calcutta, containing an account (with plates) of the deep-sea

Madreporaria collected by the Royal Indian Marine Survey ship *Investigator*. This is the first independent report upon a single group of the zoological collections made by the *Investigator*, and accumulated at the Indian Museum since 1885. It must, however, be remembered that the deep-sea dredging operations only form a small part of the work of the officers of the Marine Survey, rarely more than twenty deep-sea hauls being made in one year. Only the deep-sea Madreporaria dredged at a depth greater than 100 fathoms are included by Major Alcock in his memoir. In this collection there are only twenty-five species and fourteen genera. In the Indian Seas, "deep" forms of Madreporaria are found to occur in greatest abundance at a depth of between 400 and 600 fathoms, where the bottom temperature generally ranges from about 48° Fahr. to 44° Fahr. The sea in which corals were found in the greatest abundance and variety was the narrow basin between the Laccadive and Maldive Islands on the west, and the Malabar coast on the east. With regard to the geographical distribution of the corals, the lists of species prepared by Major Alcock show so many intimate affinities of the fauna of the Indian Seas and the North Atlantic fauna, that the conclusion is arrived at that there was formerly a direct sea connection between the Atlantic and Indian Oceans, the connection being by way of the Mediterranean.

MR. JOHN WHELDON, Great Queen Street, W.C., has issued a catalogue of scientific books and papers offered for sale by him.

ILLUSTRATIONS of the good work done at the Hull Botanical Laboratory (U.S.A.) are furnished by two papers, of which we have received reprints, from the *Botanical Gazette*—the effect of aqueous solutions on the germination of fungus-spores, by T. L. Stevens; and the life-history of *Lemna minor*, by Otis W. Caldwell.

THE first part of the *Transactions* of the English Arboricultural Society for 1899 contains three papers on practical forestry: on the different methods adopted in the measurement of standing and felled timber, by Mr. T. Bright; on the planting, maintenance and management of a plantation for the first twenty-five years, by Mr. J. E. Dalgleish; and on the felling and barking of oak and larch timber, and the preparation of the bark, by Mr. A. J. Ross.

IN the *Bulletin International* of the Academy of Sciences of Cracow for January 1899, we have a full German translation of the important paper by W. Rothert, to which we have already referred, on the structure of the vegetable cell-wall. He sums up the general results in the statement that a reduction of the typical structure may take place in two ways—either by the attachment of the thickening bands by their greatest breadth: in other words, the replacement of bordered by simple pits; or by the imperfect formation of the thickening bands, and in their looser arrangement.

THE following items of information in regard to biological stations are taken from the *American Naturalist*:—The University of Indiana will locate its biological station this year at Warsaw, Ind.—Cornell University will maintain summer schools during the coming summer in botany, entomology, geology, and zoology.—The Natural History Society of St. Petersburg has established a biological station on the shores of Lake Bologoy.—It is under contemplation to establish a permanent biological station on the shore of Casco Bay (U.S.A.), which is remarkably rich in animal life.

IN the *Journal* of the Royal Microscopical Society for February is an interesting paper by Mr. J. Newton Coombe, on the reproduction of diatoms, in which the author supports the view of Mr. George Murray, that certain diatoms may reproduce themselves, either by a rejuvenescence of the cell and the excretion of a new frustule within the parent, or by the formation, by division of the protoplasm, of a number of new individuals within the parent.—Mr. A. W. Waters contributes a paper on Bryozoa from Madeira.—In the summary of recent researches is a translation of Dr. H. Harting's highly technical paper on formulæ for small-apertured objectives; and one of a paper by Herr Karl Strehl on the theory of the microscope.

AT the last meeting of the Anatomical Society of Great Britain and Ireland, some important additions were made to our knowledge of the morphology of the liver of higher Primates. It has always been rather a moot point whether the rather solid, slightly fissured liver of man and the anthropoid apes corresponds to the whole of the multilobulated liver of the lower Primates, or only to its central part. From the specimens and drawings of human fœtal and anthropoid livers, shown by Prof. Arthur Thomson, of Oxford, at the Anatomical Society, there can be no doubt that the liver of the higher Primates has been evolved out of the multilobulated organ of the lower Primates by a process of fusion. He was able to show that even in the liver of man there were always minute fissures on the under surface of the right lobe, indicating a more primitive form of lobulation, and which were much better represented in the liver of the gorilla. It is strange that the gorilla, which shows in so many points the nearest approach to man of all the anthropoids, should in this organ stand furthest away from him and approach the lower apes. According to Prof. Thomson, the liver of the gorilla is rather variable in its fissuring, and so is that of the orang. The anthropoids show every stage of the caudate lobe, intermediate to its development in ordinary monkeys and its vestigial state in man. On the other hand, Prof. Parsons and Dr. G. F. Rogers drew attention to abnormal fissuring and lobulation of the human liver that did not correspond to any forms found amongst the Primates.

ACCORDING to Dr. Arthur Keith, the peculiar shape and structure of the human and anthropoid liver is an adaptation to erect posture. With the assumption of this posture by the higher Primates, all the organs of the abdominal cavity acquired a much more extensive fixation to the roof and posterior wall of that cavity. The liver no longer rested on the belly wall, as it does in the lower Primates, but was extensively fixed by its posterior surface to the back and roof of the abdominal cavity. The more extensive fixation of the liver led to the obliteration of its deep fissures. The fissures of the liver are certainly of physiological importance to the lower forms, for they allow the lobes of the liver to glide upon each other, and separate as that organ descends in inspiration.

AT the meeting of the Anatomical Society already referred to, Mr. R. H. Burne communicated an account of the curious biliary net-work formed by the cystic and hepatic ducts of the common otter, shown by no other mammal, and which recalled the arrangement found in certain reptiles.

THE third part of the "Catalogue of the African Plants collected by Dr. Friedrich Welwitsch in 1853–61," by Mr. W. P. Hiern, has been published by the Trustees of the British Museum (Natural History). The volume contains descriptions of the natural orders of Dicotyledons from Dipsaceæ to Scrophulariaceæ. A short description of the Catalogue appeared in NATURE of May 1897 (vol. lvi., p. 52).

A NEW edition—the fifteenth—of the volume on "Telegraphy," by Mr. W. H. Preece, C.B., F.R.S., and Sir James Sivewright, K.C.M.G., in Longmans' Text-Book of Science Series, has just been published. The work originally appeared in 1876, but the advances since then have been so great that it has been reconstructed several times. The present edition con-

tains a large amount of new information, and the whole work has been thoroughly revised.—In the new form in which Messrs. Henry Holt and Co. have published the fifth edition of Prof. Newell Martin's clearly-written work on "The Human Body," the book will probably meet with increased success. The work has been revised by Dr. George W. Fitz, and several chapters have been rewritten. The directions for demonstrations and experiments has been greatly enlarged and collected in an appendix. Many new illustrations have also been included. The volume is now published in the American Science Series, and it makes a text-book of convenient size on anatomy, physiology, and hygiene.—A fifth edition of Marshall and Hurst's well-known and widely-used "Junior Course of Practical Zoology," revised by Mr. F. W. Gamble, has been published by Messrs. Smith, Elder, and Co. The plan of the work has not been changed, but the chapters on technique have been recast, and a few alterations and additions have been made.

OUR knowledge of the molecular weights of inorganic substances is in great part derived from the classical researches of Victor Meyer and his pupils on vapour densities at very high temperatures. A few determinations of the molecular weights of inorganic salts have also been made by the boiling-point method, the most interesting conclusion obtained in this way being that cuprous chloride and bromide are represented by the simple formulæ CuCl and CuBr. In the current number of the *Gazzetta Chimica Italiana* the problem is attacked by N. Castoro by the cryoscopic method. A satisfactory solvent was found in urethane, in which a considerable number of inorganic substances can be dissolved. The lowering of the melting point was determined for silver nitrate and the chlorides of mercury, cobalt, copper, cadmium, zinc, tin, and manganese. Of these, cupric and cobalt chlorides had the double formulæ Cu_2Cl_4 and Co_2Cl_4 quite clearly marked; manganese chloride showed some tendency to the formation of double molecules; whilst the remaining salts gave figures closely agreeing with those calculated on the assumption of the simple formulæ.

THE additions to the Zoological Society's Gardens during the past week include a Long-tailed Marmot (*Arctomys caudatus*) from Gilghit, presented by Mr. A. H. McMahon; a Rough-legged Buzzard (*Archibuteo lagopus*), European; a Virginian Eagle-Owl (*Bubo virginianus*) from North America, presented by the Hon. Walter Rothschild, M.P.; two Common Herons (*Ardea cinerea*), European, presented by Mr. F. G. Bridgman; a Pale-headed Parrakeet (*Platycercus pallidiceps*), a Rose Hill Parrakeet (*Platycercus eximius*) from Australia, presented by Mr. W. F. Clayton; a Cockateel (*Calopsittacus novae-hollandiae*) from Australia, presented by Mr. Edward Hawkins; a Camboyan Turtle Dove (*Turtur senegalensis*) from Africa, presented by Mr. D. Seth-Smith; a Common Paradoxure (*Paradoxurus niger*) from India, presented by Mr. W. O. Sheppard; a Brazilian Tortoise (*Testudo tabulata*) from South America, presented by Mr. John Gordon; a Great Eagle Owl (*Bubo maximus*), European; two Black-backed Piping Crows (*Gymnorhina tibicen*), four Laughing Kingfishers (*Dacelo gigantea*), two Black Swans (*Cygnus atratus*) from Australia, deposited; two Yellow Conures (*Conurus solstitialis*) from Guiana, purchased.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MARCH:—

March 3. 12h. 21m. Minimum of Algol (β Persei).
3. 13h. 5m. to 14h. 2m. Occultation of the star B.A.C. 5254 (mag. 5·4) by the moon.
6. 9h. 10m. Minimum of Algol (β Persei).
March 15. Venus. Illuminated portion of disc 0·644. Apparent diameter 18″·2.
Mars. Illuminated portion of disc 0·922. Apparent diameter 9″·7.
Jupiter. Apparent Polar diameter 38″·9.
16. Saturn. ,, ,, 15″·4.
Outer minor axis of outer ring 17″·34.
20. 5h. 32m. to 6h. 50m. Occultation of 56 Geminorum (mag. 5) by the moon.
20. 8h. 50m. to 9h. 59m. Occultation of 61 Geminorum (mag. 5·7) by the moon.
20. 8h. Sun enters Aries. Spring commences.
24. 9h. 48m. to 10h. 47m. Transit of Jupiter's Sat. III.
24. 11h. Mercury at greatest elongation, 18° 36′ East.
25. 16h. 52m. to 17h. 45m. Occultation of *e* Leonis (mag. 5·1) by the moon.
26. 10h. 52m. Minimum of Algol (β Persei).
27. 10h. to 10h. 56m. Occultation of DM − 10°, 3570 (mag. 6) by the moon.
28. 9h. 57m. to 10h. 49m. Occultation of 83 Virginis (mag. 5·8) by the moon.
30. 11h. 59m. to 12h. 40m. Occultation of DM − 22°, 3989 (mag. 6) by the moon.
31. 13h. 11m. to 14h. 10m. Transit of Jupiter's Sat. III.

Mercury will be very favourably displayed as an evening star from about March 17 to 27. The times of his setting and the intervals by which he follows sunset are as under:—

1899	Sunset	Mercury sets	Interval
	h. m.	h. m.	h. m.
March 17	6 6	7 38	1 32
18	6 7	7 45	1 38
19	6 9	7 51	1 42
20	6 10	7 56	1 46
21	6 12	8 1	1 49
22	6 14	8 5	1 51
23	6 15	8 9	1 54
24	6 17	8 12	1 55
25	6 19	8 14	1 55
26	6 20	8 15	1 55
27	6 22	8 16	1 54

NEW NEBULÆ.—We learn from *Harvard College Observatory Circular*, No. 38, that Dr. De Lisle Stewart, who is in charge of the Bruce photographic telescope, has found recently an interesting group of nebulæ, hitherto unknown, on plates taken October 14 and October 20, 1898.

Comparison examinations of both plates show the presence on each of forty-six objects, which are given in a table showing their coordinates and a short description of each. The group is situated within the limits of right ascension 3h. 10m. to 3h. 50m. (1900), and declination −49° 50′ to −53° 40′ (1900).

Of the whole group only two are identical with the nebulæ given in Dreyer's New General Catalogue, viz. N.G.C. 1311 and N.G.C. 1356. Four of the new nebulæ appear to be distinctly spiral. One is described as having a "bright elongated centre, and others as faint nebulous wisps in ellipses or spirals." Three are nebulous stars surrounded by nebulosity.

NEBULOSITIES OF THE PLEIADES.—For several years there has been some controversy between various authorities as to the real or spurious nature of certain wisp-like forms which are obtained on plates exposed on the region surrounding this star cluster. Prof. Barnard maintains that the appearances are due to real nebulosity, and supports his case by showing identical forms on various plates taken with widely different lenses and with varying exposures; while Dr. Roberts, who cannot find these markings on his plates, attributes them to surface markings due to sky glare or defects of the plates. Mr. H. C. Wilson, of Goodsell Observatory, Minn., supports Prof. Barnard's case by an article in *Popular Astronomy*, vol. vii. No. 2 (February), which he illustrates with three photographs of the region taken by himself. Two of these were taken with a camera of about 36 inches equivalent focus, the objective being a quadruplet six inches in diameter. One of the plates was taken in October 1894, with an exposure of 11h. 15m., the other in November 1898, with an exposure of 5h. 35m. The regions of nebulosity to which he draws attention are quite easily seen on the reproduction, lying chiefly to the north-east of the star cluster, and the boundaries of the hazy masses are exactly

similar in the two plates. Moreover, the author states that the forms shown on his plates agree very closely with those obtained by Prof. Barnard in 1893; so that there being at least three photographs showing identical forms, the evidence is greatly in favour of their being true cosmical matter, as it is inconceivable that chance markings could exhibit such coincidences. To explain their absence on Dr. Roberts's plates, the author thinks that the atmosphere at Goodsell Observatory must be much clearer than is the case in England, giving as his reason the fact that the star images on his plates are much less surrounded by atmospheric glare than those of Dr. Roberts. Indeed, even with the long exposure of over eleven hours, the star discs are still easily discernible on the reproductions, showing that the observing conditions must have been extremely perfect.

METEOR PHOTOGRAPHY.—Those who may be interested in this branch of astronomy will find the illustrated description, by Mr. W. L. Elkin, of the apparatus used for this purpose at the Yale University of considerable value (*Astrophysical Journal*, vol. ix. p. 20, January).

The instrument consists of a long polar axis, driven by clockwork, and provided with means of attachment for from eight to twelve cameras round its circumference. The lenses used for this purpose are selected for their rapidity; hence we find that portrait lenses are in nearly all cases chosen. During the last November Leonid shower eight cameras were used with the instrument; six of these carried portrait lenses of from six to eight inches aperture and from twenty-seven to thirty-six inches focus, the remaining two being provided with lenses four inches in diameter.

It is, however, not indispensable to have an expensive clock-driven mounting, and for the same meteor shower a simpler apparatus was also used, having a wooden polar axis turned intermittently at intervals of ten minutes by means of a toothed wheel. By also displacing the axis slightly at each movement of the wheel, the successive star trails fell alongside each other, making a kind of time scale, which made it possible to refer any meteor trail to its position among the stars if the time of its appearance had been noted.

The article is illustrated by a photograph of the instrument in position at the observatory, and one of the successful plates showing a Leonid passing near Mars and the star-cluster Præsepe.

THE TRADE IN TORTOISESHELL.

AMONG the number of misnomers current in popular language, and more especially in that relating to natural history, few are more unfortunate than is the application of the term "tortoiseshell" to the substance which should properly be designated turtleshell, or perhaps rather turtle-skin. It is, however, far too late in the day to attempt a change; tortoiseshell it always has been, and tortoiseshell it will doubtless remain. In its manufactured state, whether in the form of inlaid buhl-work, as the handle of a fan, or as a comb, the translucent plates of tortoiseshell, with their rich mottlings of golden yellow and warm chestnut, are familiar to all. The particular species of reptile, or reptiles, from which it is derived, the part that it plays in the economy of these creatures, and the methods of the manufacture, to say nothing of the enormous volume of the trade, are, however, less matters of common knowledge.

To begin with, tortoiseshell, in the widest sense of the term, may be taken to include the horny superficial plates or shields overlying the bony case of the great majority of tortoises and turtles, although in the popular and trade sense it is restricted to those of the latter. Anatomically it corresponds to the scarf-skin or epidermis of the human integument, the underlying bony case or shell representing, to a great extent, the true skin. Turtles differ from tortoises, among other features, by the heart-shaped form of the upper half of the shell, or carapace, and the conversion of the limbs into paddles adapted for swimming. The upper part of the shell carries a median row of five large superficial horny plates, flanked on each side by a row of four or five still larger flat plates; these thirteen or fifteen large plates, affording some of the most valuable commercial tortoiseshell in the particular species whose "shell" is most in demand. On the front and hind edges of the upper bony shell and the portion connecting the latter with the plastron, or lower shell, are a series of smaller horny plates, generally twenty-four in number, which are sharply bent in the middle, and are known in the trade as "hoof." They form the least valuable portion of commercial tortoiseshell. The under surface of the shell of a turtle carries six pairs of large, more or less flat, horny plates, for which the trade term, derived from their uniform colour, is "yellow-belly." In value they sometimes exceed all but the very finest of the large upper plates, generally known simply as "shell." The term "shell" has thus a very different signification in commerce from that which it bears in natural history, where it is applied to the whole solid case of the reptile, including both the overlying horny plates and the subjacent solid bony structure.

Of the host of land and fresh-water tortoises, most of which are of comparatively small size, the horny plates (which, by the way, are altogether wanting in the so-called soft tortoises of tropical and subtropical rivers), on account of their thinness and opacity, are now of no commercial value whatever, at least in England.

Moreover, it is by no means all the species of marine turtles which yield commercial tortoiseshell. Of these marine turtles, exclusive of the great leathery turtle, which has no horny plates at all, there are three well-marked and perfectly distinct types, severally represented by the green, or edible turtle, the hawksbill, so named from the form of its beak, and the loggerhead. The latter, which is the largest of the three, taking its name from its huge ungainly head. Of the green turtle the plates are so thin and so badly coloured as to be of little or slight manufacturing importance, so that they do not apparently figure at all in the trade circulars of Messrs. Lewis and Peat. In this species the horny plates on the back, which have a dull pale brown ground-colour with streaks of black, meet together by their edges, like the tiles in a pavement, or the plaques in a mosaic. On the other hand, the much thicker and more beautifully-coloured plates on the back of the hawksbill, which afford the most valuable commercial shell, overlap one another like the slates on a roof during the greater part of their owner's life, although in very aged individuals they are joined by their edges. The largest and best plates, which are those in the middle of the sides of the back, are about a quarter of an inch thick in the centre, and measure about thirteen by eight inches; their weight being from about half-a-pound each to as much as one pound. Their translucency and beautifully mottled colours have been already mentioned. The lower plates, or "yellow-belly," on the other hand, are of a uniform golden yellow tint; while the connecting marginal plates, or "hoof," are partly plain yellow and partly mottled. In size the hawksbill is somewhat inferior to the green turtle; the length of the carapace being about thirty-two inches in the former, as against forty-two in full-grown examples of the latter. Both are found in all tropical and subtropical seas; and both resort to flat sandy shores for the purpose of depositing their eggs.

From a dead turtle the plates of tortoiseshell can be readily detached from the underlying bony framework by the application of heat. Sometimes boiling water is used, but more generally the whole shell is placed over a fire. In the West Indies one method, which may or may not be still in use, was to bury the whole shell in the ground for ten or twelve days, when the plates became readily detachable. It is stated, however, that the removal is too often effected by the cruel method of applying heat to the living animal, after which the unhappy turtle is returned to the sea to grow a fresh suit of plates. Formerly it appears to have been the custom to bore each plate of the upper shell, and to fasten together the whole series furnished by each individual turtle with wire or string; such bundles being sold together. Now, however, the samples offered at the London sales on string or wire are comparatively few, although the practice is maintained with Macassar and sometimes Ceylon shell.

In the trade circulars of Messrs. Lewis and Peat, hawksbill tortoiseshell is divided into the following geographical classes, viz.: (1) West India; (2) Zanzibar and Bombay; (3) Mauritius and Seychelles; (4) Singapore and Macasar; (5) Sydney and Fiji; and (6) Ceylon. Most of these classes are again subdivided into "shell," "yellow-belly," and "hoof"; while these latter subdivisions are again split up according to size, thickness, colour, and condition. Nos. 1 and 2 always send very arge imports; next come Nos. 4 and 5, which, however, exhibit very marked seasonal oscillations; while those of Nos. 3 and 6 are much smaller.

In order to ascertain how the trade of the present day in this

commodity compares with that of thirty years ago, reference may be made to some statistics quoted by Dr. P. L. Simmonds in 1878. From these it appears that in the year 1870 the total imports of tortoiseshell (apparently of all descriptions) into the United Kingdom were 49,332 lbs., valued at 32,503*l.* It is also stated by the same writer, that in some years prior to 1878 the amount of the imports had reached the enormous total of thirty tons, with an estimated value of 74,000*l.* In 1870 the average price per pound was between thirteen shillings and fourteen shillings and sixpence; except Indian shell, which was only worth 7*s.* 9*d.* the pound. Dr. Simmonds likewise mentions that whereas about the year 1845 selected samples had realised as much as 3*l.* 3*s.* per pound; between that time and 1870 there had been a great fall in values, although towards the latter date they showed a tendency to rise. For instance, somewhat before that year good coloured shell from Zanzibar and Singapore had fetched from 28*s.* to 29*s.* 6*d.* per pound, and fair to good qualities of West Indian from 31*s.* to 41*s.* the pound.

According to the reports issued by Messrs. Lewis and Peat for 1898, the total amount of hawksbill tortoiseshell (that is to say exclusive of loggerhead shell, which is referred to later on) offered for sale in London during that year was about 76,760 lbs., practically all of which was sold. To arrive at the average price realised at these sales, would involve long calculations without affording any very compensative advantage. Attention may accordingly be directed to certain special values. The highest prices realised during the year were at the May sale, when selected Zanzibar and Bombay shell sold at from 67*s.* 6*d.* to 112*s.* 6*d.* per pound, while two pounds weight of specially selected Sydney and Fiji were disposed of at the rate of 100*s.* per pound. Whether these are record prices, we have no information; but they are certainly ahead of any of those quoted by Dr. Simmonds in 1878, 80*s.* per pound being the maximum value mentioned by him. The next highest price during 1898 was 95*s.* per pound for selected heavy Zanzibar and Bombay shell of a reddish tint, which was disposed of in the September sale. This value is followed by prices ranging between 45*s.*, 62*s.* 6*d.*, and 75*s.* for selected Nassau and Honduras shell in the West Indian class; Jamaica and Havana shell touching, however, as much as 77*s.* the pound. Of West Indian "hoof," the best Nassau and Honduras pale-coloured descriptions realised from 18*s.* to 27*s.* at their top price; while ordinary West Indian was a few shillings cheaper. On the other hand, Zanzibar and Bombay "hoof" ranged between 6*s.* and 17*s.* 6*d.* Some of the highest prices were realised by Nassau and Honduras "yellow-belly," which fetched between 67*s.* 6*d.* and 80*s.* in September, but had fallen to between 45*s.* and 65*s.* per pound by November. "Yellow-belly" is, or was, extensively used by Spanish ladies for large hair-combs, being often much more esteemed for this purpose than the mottled upper shell. Among all the classes of hawksbill tortoiseshell, that from Ceylon seems to have the lowest value; the general quotation being between 14*s.* and 17*s.*, although as much as 34*s.* has been obtained for selected samples.

The tortoiseshell yielded by the loggerhead turtle, of which 8200 lbs. were offered and about 7300 lbs. sold by Messrs. Lewis and Peat during 1898, is a much less valuable commodity than the produce of the hawksbill. During the year in question, the usual price per pound ranged between one and three shillings, although as much as 4*s.* 9*d.* was obtained in March. The upper plates of the loggerhead are much thinner than those of the hawksbill, and of a more or less uniform dark chestnut-brown, without marked translucency.

The statistics quoted above afford a good general idea of the vast extent and value of the London tortoiseshell trade. Unfortunately, it is impossible to give the total British imports and their value, since in the Board of Trade returns tortoiseshell, together with mother-of-pearl, is lumped with other shells, and the value of the mixed imports alone given. In addition to the British trade, the imports of other European countries (although, of course, some of these may have come from Britain) are very large. France, for instance, is a very large importer of tortoiseshell, the average annual amount taken during the ten years ending with 1876 being 42,306 kilogrammes, with a value of 2,078,910 francs. China and Japan are likewise large consumers of tortoiseshell, as is also America. The annual destruction of hawksbill turtles to supply the demand for this shell must therefore be enormous; but since, like most marine creatures, these reptiles are exceedingly prolific, it by no means follows that they are in any imminent danger of extermination.

As regards its employment in the arts and manufactures, tortoiseshell being very similar in its nature to horn, is in like manner made partially plastic before working by immersion in hot water in which salt has been dissolved. The natural curvature of the plates is removed by placing them under pressure between smooth boards while in this semiplastic condition, and allowing them to cool. But, in addition to its plasticity, tortoiseshell possesses the valuable property of welding; so that when a large superficies is required, two or more plates can be readily joined together in this manner. The *modus operandi* is first of all to bevel the adjacent edges of the two plates to be united in opposite directions, and then pressing the overlapping edges together in a metal press under the action of boiling water. So intimate is the union, that when the operation is properly performed, no trace of the division is visible. Nor is this all, for by the application of moist heat tortoiseshell may be made to receive impressions of any form by being squeezed between metallic moulds. Neither are the dust and shavings made in the course of the manufacturing processes useless, for these are placed in brass moulds, where, under moist heat and pressure, they become consolidated into a homogeneous mass of any form that may be desired. Necklaces and many other small fancy articles are made in this manner.

From its high price, it is important to economise as much as possible the material used in the manufacture of tortoiseshell objects. The following ingenious example of this is described by Dr. Simmonds. "In making the frames for eye-glasses, narrow strips of tortoiseshell are used, in which slits are cut with a saw; the slits being subsequently, while the shell is warm, strained or pulled open, until they form circular or oval apertures, by the insertion of tapering triblets of the required shape. The same yielding or flexible property is made use of in the manufacture of boxes, a round flat disc of shell being gradually forced, by means of moulds, into the form of a circular box with upright sides." The only objection to this process is that the colours become so darkened as to be almost black.

In the manufacture of small combs, again, a pair of these are cut out of a single piece of shell by means of a vertical cutter, working in such a manner, that the cores left between the teeth of one comb form the teeth of the other. Similarly in buhl-work cabinets, in which tortoiseshell is inlaid with brass, both portions of the former material cut out by the fret-saw are employed. Hence in a pair of cabinets the pattern of the inlaying is reversed; the tortoiseshell forming the ground-work and the brass the inlaying in one, while in the other the opposite arrangement occurs.

Formerly the manufacture of ladies' combs, especially those made for Spain and South America, formed a very important feature in the tortoiseshell industry, some of these being a couple of feet in width, and from six inches to a foot in height. In England, at any rate, large combs are now disused. Although for veneering purposes, when the colouring of the shell is intensified by a layer of coloured varnish or metallic foil beneath it, thin tortoiseshell is employed; the thick descriptions are those most favoured at the present day in the English market.

Finally, it may be mentioned that on the continent the shell of various species of land tortoises is employed more or less extensively for buhl-work, its colour being always intensified by a substratum of bright foil; and it is said that the same material has occasionally been employed for inlaying purposes in England. Imitation tortoiseshell is made by painting horn with a paste of lime, litharge, and soda, which is allowed to dry and then rubbed off. Dark spots of lead sulphide are thus formed in the horn, giving it a mottled appearance.

R. L.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof. W. F. R. Weldon, F.R.S., has been appointed to the vacant Linacre Professorship of Comparative Anatomy, in succession to Prof. Ray Lankester, F.R.S.

Reading College, Reading, has been admitted to the privileges of an affiliated college.

Natural Science scholarships are announced for competition at the following colleges:—Jesus College, on April 18; Merton College, New College, and Corpus Christi College, on June 27.

The Curators of the University Chest have been authorised to guarantee an annual stipend of 100*l.* to a Demonstrator in Mineralogy, and to expend 90*l.* upon sanitary improvements in the Physiological Laboratory.

The annual grant to the Hope Department has been raised from 100*l.* to 110*l.*, and that to the Pitt Rivers Museum from 150*l.* to 200*l.*

The Board of the Faculty of Natural Science has issued new regulations relating to the special subjects of crystallography and mineralogy.

Mr. H. T. Gerrans has been elected a Delegate of the University Museum, and Mr. C. Leudesdorf a Visitor of the University Observatory. Mr. D. R. Wilson has been appointed lecturer in Chemistry at Magdalen College.

The 198th meeting of the Junior Scientific Club was held on Friday, February 24.—Mr. E. H. J. Schuster, New College, read a paper on "The heredity of acquired characters."—Mr. H. B. Hartley, Balliol, read a paper entitled "Notes on the origin of the Japanese." The author held that four waves of population have swept over Japan. The original inhabitants were a race of people who possessed the art of making pottery and lived in holes in the earth, roofed over with branches. These were completely driven out in prehistoric times by the Ainus, to whom the art of pottery making is still unknown. The Ainus were, in their turn, driven northwards or exterminated by an invasion of Mongols from Corea, and the latter now constitute the bulk of the population,—the round-faced type. Later still, apparently a second invasion of Mongols took place, and these, constituting the oval-faced type of Japanese, are now the aristocrats of the land. The antiquity of the first Mongol invasion is plainly evident; it is considered that the early Japanese, up to the fifth century, did not possess the art of writing.

CAMBRIDGE.—Mr. G. W. Walker, of Trinity College, has been elected to an Isaac Newton Studentship in Astronomy and Physical Optics.

The subject for the Adams Prize, 1901, open to all graduates of the University, is "Electric Waves." The successful candidate will receive about 225*l.*

Prof. Lewis has acquired for the Mineralogical Museum the Carne collection of Cornish minerals with their cabinets. The cost (475*l.*) has been almost entirely defrayed by contributions from members of the University and their friends, together with donations from the Clothworkers' and Fishmongers' Companies.

The Museums and Lecture Rooms Syndicate report on the urgent need of new buildings for the department of Botany, and propose that immediate steps be taken for their erection on the site recently assigned by the Senate.

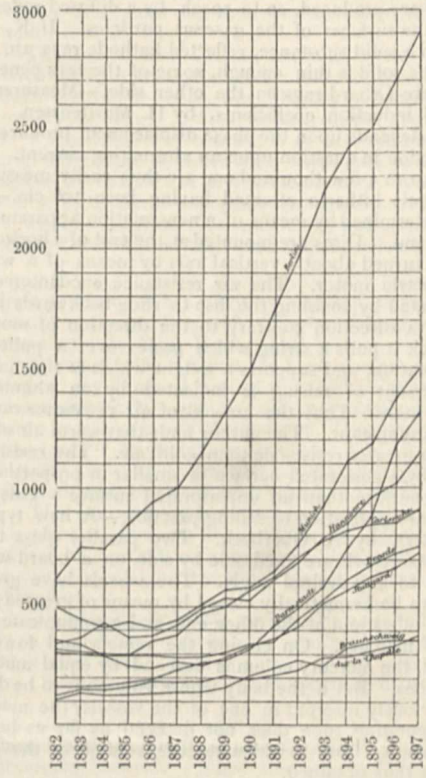
The Antiquarian Committee in like manner press for a new archæological museum, the present building, which was originally but a makeshift, being now utterly inadequate for the valuable ethnological and other collections.

A grant of 300*l.* from the Works Travelling Scholars Fund is to be made to Mr. Skeat in aid of his scientific expedition to the Malay Peninsula.

WE understand that there is a vacancy in the Examinations Department of the City and Guilds of London Institute, for the post of assistant to the superintendent, from whom particulars of the appointment may be obtained. Applicants are expected to have graduated, and to have a sound knowledge of some branch of science and educational experience.

A COPY of the Calendar, for 1899, of the University of New Brunswick, Fredericton, has been received. Among the University medals, prizes and scholarships, we notice that a gold medal is offered for competition among undergraduates this year for the best essay on "The aims and methods of modern science." As showing how the alumini help their alma mater, we may mention that the Alumini Association has founded several scholarships and prizes, and that the graduation classes of 1894 and succeeding years have contributed various gifts to the University.

THE steady increase in the number of students who have taken up advanced courses of technical science in Germany during the past fifteen years is shown in the accompanying diagram, reproduced from an article on the new laboratories of the Zürich Polytechnic, contributed to the *Revue Générale des Sciences* by M. Pierre Weiss. There are in Germany nine polytechnics—it is hardly necessary to explain that they are concerned with much more advanced work than our polytechnic institutions—the one having the smallest number of students



Number of students in German Polytechnics every year from 1882 to 1897

being Brunswick, with 363 students, while Berlin, with 2906 students, is the most frequented. The total number of polytechnic students is 10,000. If the average period of study is taken to be three years, the number of trained technical men who become available every year is thus about three thousand. The diagram shows clearly the uniform rise in the number of students of industrial science in all the German polytechnics since about 1886 or 1887.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, February.—Results of meteorological observations at Camden Square (North-west London) for forty years, 1858-97. This is a second series of tables containing the means and other details for each separate year, while the former series contained only the averages, &c., for the whole period. The results now published will be very valuable for reference. The present number contains the observations for January.—Climatological records for the British Empire in 1897. The table contains the results for sixteen representative localities. Most of the extremes have occurred at the same stations in other years. The highest temperature in the shade was 110°·8 at Adelaide, and the lowest −41°·0 at Winnipeg; the former was also the driest station, mean humidity 59, and had the highest temperature in the sun, 166°·3. The dampest station was Esquimalt, mean humidity 86. The greatest rainfall, 83·64 ins., occurred at Grenada, and the least, 14·22 ins., at Malta. Strange to say, Grenada had the least cloud, average amount 2·5. This value is unprecedented in the last twenty-one years, the nearest approach to it being 2·9 at Malta, in 1885.

Wiedemann's Annalen der Physik und Chemie, No. 1.—Susceptibilities of some metals, by E. Seckelson. The magnetic susceptibility of all metals examined is independent of the field in a direction normal to the lines of force.—Structure of the kathode light and nature of Lenard's rays, by E. Goldstein.

Following up his studies of the triple structure of the kathode light, the author finds that the third kathode layer consists of rectilinear rays, which, however, do not proceed from the kathode itself, but from every point along the path of a ray of the second layer. They are produced, so to speak, by a diffused reflection produced at the surfaces of the gaseous particles. If K_2 rays impinge upon a solid substance, reflected kathode rays are produced. If the solid is thin enough, some of the rays penetrate it, and we have Lenard rays on the other side.—Measurement of very small induction coefficients, by H. Martienssen. The method used depends upon the phase displacement produced by the self-induction in question upon an alternating current. Coefficients down to a few thousand cm. are thus easily measured, the inferior limit hitherto attained having been 10^6 cm.—Air resistances determined by means of a new rotation apparatus, by O. Mannesmann. Discs are mounted at the end of a horizontal arm, and are turned about a vertical axis by means of a water-power or electric motor. The air resistance encountered by them is indicated by enabling the disc to slide backwards in its mounting, in a direction contrary to the direction of motion. In sliding back it pulls a string which passes over a pulley on the axis of rotation, and supports a weight which is thus pulled up. The amount of raising is indicated by an aluminium pointer on a scale. Thus the amount of air resistance can be read off at any instant. The author finds that warm air offers, if anything, a greater resistance than cold air. The resistance encountered by a perforated surface is smaller in proportion to its remaining surface than an unperforated surface This fact has a practical application to sailing practice.—A new type of volumenometers, by A. Oberbeck. Two parallel glass tubes ending in glass vessels are fixed side by side on a board which can be tilted to any desired angle. The vessels have ground edges, and can be hermetically closed by means of greased glass plates. The tubes join at the other end and communicate with a reservoir of mercury. On closing the vessels and lowering the other end, the mercury columns descend by equal amounts in the two tubes. But if the body whose volume is to be determined is previously inserted in one of the vessels, the mercury in the corresponding tube does not descend as far as before. The author shows how to calculate the volume of the body from the data thus obtained.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 26.—"On the Nature of Electrocapillary Phenomena. 1. Their Relation to the Potential Differences between Solutions." By S. W. J. Smith, M.A. Communicated by Prof. A. W. Rücker, Sec. R.S.

The discrepancy between the Helmholtz theory of the capillary electrometer and the Nernst-Planck theory of the potential differences between solutions is discussed in this paper. A detailed examination of the relation between the phenomena from which the discrepancy arises, shows that these phenomena serve to corroborate the Nernst-Planck theory, and that they further throw considerable light upon the nature of electrocapillary phenomena.

It is shown that if the Nernst-Planck theory be true, the surface tension variation in the "descending" branches of the capillary electrometer curves is not solely due to an electrostatic effect of the kind discussed by Helmholtz; but that there is a further effect, dependent upon the nature and concentration of the solution employed in the electrometer.

The extent to which the Helmholtz theory may be true is discussed. It is concluded that this theory only suffices, in general, to give the variation in the potential difference at the capillary electrode. Whether the assumption is ever true, that the potential fall at the capillary electrode is zero when the maximum surface tension is reached, will depend upon whether there is any case for which, when the potential difference between the solution and the capillary electrode is very small, the non-electrostatic effect upon the surface tension can be neglected.

The non-electrostatic effect in the "descending" branch would appear to be practically independent of the nature of the anion, while that in the "ascending" branch is probably for the most part independent of the nature of the kation. Experiments have been made with the object of determining quantitatively the manner in which the surface tension variation depends upon the chemical nature and concentration of the solution, and the conditions under which such dependence may become negligible. The nature of these experiments is indicated in the paper.

February 2.—"On the Effects of Strain on the Thermo-Electric Qualities of Metals." By Magnus Maclean, M.A, D.Sc. Communicated by Lord Kelvin, F.R.S.

1. Seebeck (*Pogg. Ann*, 1826) discovered the great effect that hardness, or softness, or crystalline structure, has on the thermo-electric properties of metals. Magnus made a number of experiments by winding a hard-drawn wire on a reel. Parts of this wire were softened and annealed. When heat was applied to the parts of the wire which were between unannealed and annealed, a thermo-electric current was obtained. In this way Magnus found that the current passed from soft to hard through the hot junction for silver, steel, cadmium, copper, gold, and platinum; and that it passed from hard to soft through the hot junction for German silver, zinc, tin, and iron.

2. Lord Kelvin describes, in vol. ii. of his "Mathematical and Physical Papers," a number of qualitative experiments to determine the direction of thermo-electric currents in the same metal when one part of it is left unstrained, and the other is—

(1) Permanently affected by application and removal of longitudinal stress;
(2) Permanently affected by application and removal of lateral pressure;
(3) Under a longitudinal stress (*a*) within its limits of elasticity, and (*b*) beyond its limits of elasticity;
(4) Hardened by twisting;
(5) Annealed.

3. He showed that for iron and copper permanent longitudinal extension gave the same effect as permanent lateral contraction; and that this effect for both was opposite to that experienced by them when under a stress which caused a temporary strain. Thus for a copper wire under a longitudinal stress the current was from the strained copper to the free copper across the hot junction, and the magnitude of the current increased with the increase of the longitudinal stress. If the stress were removed and the wire left with a permanent strain, the current was now from the free copper to the strained copper through the hot junction. Similar results were got with iron, only the direction of the current was in each case opposite to the direction of the current in the corresponding case for copper. The highest temperature used in these experiments was about 100° C.

4. To determine the *magnitude* of the thermo-electric effects obtained from any one metal, strained and unstrained, was the object in view in these experiments.

The metals so far tried are:—

(1) Copper wire from Messrs. Johnson and Matthey. This was pure electrotype copper wire with no impurity detected except an unweighable trace of iron.
(2) Copper wire, ordinary commercial, from Messrs. Johnson and Matthey. This was analysed [1] in the chemical laboratory of the University, and was found to contain:—

Copper	... ...	99·4 per cent.
Arsenic	... ...	0·44 per cent.
Lead	... ...	0·08 per cent.
Bismuth	... ...	trace.
		99·92 per cent.

(3) Copper wire, used for alloying with gold and silver, from Messrs. Johnson and Matthey. This also was analysed, and it contained 99·85 per cent. of copper.
(4) Copper wire from Glover. Chemical analysis showed that it contained 98·35 per cent of copper.
(5) Copper wire of Glover's manufacture, and supposed to be soft, and to have a very high conductivity. It contained 99·08 per cent. of copper and 0·22 per cent. of lead.
(6) Copper wire used in laboratory experiments. It contained 98·51 per cent. of copper.
(7) Lead wire, commercial. It contained 98·9 per cent. of lead.
(8) Lead wire, pure.[2] It contained 98·97 per cent. of lead.

[1] All the chemical analyses stated in this paper were given by Mr. Anderson, of the Chemical Laboratory of this University.

[2] These specimens of commercial and pure lead wires were obtained from Messrs. Baird and Tatlock of Glasgow. Other specimens have been ordered elsewhere for a fresh determination.

(9) Platinoid wire obtained from Messrs. Glover.
(10) German silver wire obtained from Messrs. Glover.
(11) Reostene[1] wire obtained from Messrs. Glover.
(12) Manganin wire obtained from Messrs. Glover.

5. The size of the wire used, except for (5) (7) (8) above, was about No. 18 standard gauge. A piece of the wire was taken and drawn through a draw plate till it was reduced to about No. 24 standard gauge. This process of wire drawing subjects the wire to longitudinal extension and to lateral compression. Lord Kelvin in his experiments ("Mathematical and Physical Papers," vol. ii., and section 3 above) showed that thermo-electric differences were in the same direction for longitudinal extension and transverse compression. For drawn and undrawn wires the direction of the current through the hot junction is from *undrawn to drawn* for copper, reostene, and lead, and from *drawn to undrawn* for platinoid, German silver, and manganin. The magnitude of the thermo-electric difference per degree difference of temperature is given in the following table :

Metal	Resistance in international ohms of 60 cm. of wire		Total resistance external to galvano-meter	Total resistance in circuit	Thermo-electric difference in mikrovolt per degree of difference of temperature up to 100° C.
	Undrawn	Drawn			
Copper, Johnson & Matthey, No. 1 ...	0·0086	0·0462	0·0548	1·555	0·0089
Ditto, No. 2 ...	0·0239	0·1254	0·1493	1·649	0·0460
Ditto, No. 3 ...	0·0095	0·0536	0·0631	1·563	0·0163
Copper, hard, Glover	0·0091	0·0523	0·0614	1·561	0·0106
Copper, soft, Glover	0·0155	0·0417	0·0572	1·557	0·0483
Copper, laboratory	0·0089	0·0431	0·0520	1·552	0·0675
Lead, pure ...	0·1088	0·5043	0·613	2·113	0·0184
„ commercial .	0·1123	0·5517	0.664	2·164	0·0273
Reostene	0·4058	1·831	2·237	3·737	0·6465
Platinoid	0·2186	1·052	1·271	2·771	1·477
German silver ...	0·1673	0·845	1·013	2·513	0·2638
Manganin... ...	0·212	1·008	1·210	2·720	0·0843

6. The effect of hardening by twisting has been partially tried. Thus two pieces of laboratory copper wire were taken, and one was in successive experiments twisted 1 turn, 3 turns, 5 turns, 7 turns, 8½ turns per cm. The wire with 8½ turns per cm. got quite brittle, and broke when an attempt was made to put more twists into it. The twisted wire was then heated red-hot by an electric current, and allowed to cool. This partially annealed it.

The results are given in the following table :—

Number of turns in twisted wire per centimetre.	Thermo-electric difference between untwisted and twisted copper wire in mikrovolt per degree.
1	0·0054
3	0 0223
5	0·0262
7	0·0419
8·5	0·0594
8·5 and partially annealed ...	0·0345

7. The effects of twist on the drawn copper wire were also tried, and it was found that 1, 2, 3 turns per cm. in the drawn wire slightly diminished the thermo-electric difference obtained between the undrawn wire and the drawn wire ; but that 4 and 5 turns per cm. in the drawn wire gave the same thermo-electric difference as was found between the undrawn wire and the untwisted drawn wire.

8. The drawn and twisted copper wire was annealed by putting a gradually increasing current through till it got red-hot, and then, without breaking the circuit, the current was gradually reduced till the wire was at the temperature of the laboratory. Trying it in this condition along with the undrawn and untwisted copper wire, the current through the hot junction was found to be reversed, being from the drawn twisted and annealed wire to the undrawn wire. The thermo-electric difference was 0·0081 mikrovolt per degree.

9. Similar experiments on platinoid wires as those described in Section 7 on copper wires gave similar results. Thus 1, 2, 3 turns per cm. in the drawn platinoid wire diminished the thermo-electric difference obtained between the drawn wire and the undrawn wire ; but 4 and 5 turns per cm. in the drawn wire gave the same thermo-electric difference (1·477 mikrovolts per degree) as was found between the untwisted drawn wire and the undrawn wire.

10. The drawn and twisted platinoid wire was partially annealed, and the thermo-electric difference between it and the undrawn platinoid wire was thereby reduced from 1·477 mikrovolts per degree to 0·567 mikrovolt per degree.

11. A beginning has been made of determining the thermo-electric differences between free wires and wires previously permanently elongated 1, 2, 3, &c., per cent. by a simple longitudinal stress ; also wires while (*a*) under stress, stretching them within their limits of elasticity ; and (*b*) under stress, stretching them beyond their limits of elasticity.

[1] Reostene belongs to the nickel steel group, with certain other metals as an alloy.

February 9.—"On the Recovery of Iron from Overstrain." By James Muir, B.Sc., Trinity College, Cambridge (1851 Exhibition Science Research Scholar, Glasgow University). Communicated by Prof. Ewing, F.R.S.

It is known that iron which has been overstrained in tension —that is to say, strained beyond the yield-point so that it suffers a permanent stretch—possesses different elastic properties from the same iron in its primitive condition. Ultimately, the material is "hardened" by stretching, its elastic limit being raised and its ductility diminished ; but first of all very imperfect elasticity is exhibited, and the elastic limit may be found to be reduced to zero. The material, in fact, assumes a semi-plastic state ; so that a stress-strain curve obtained from a recently overstrained bar of iron or steel, shows a marked falling away, even for small loads, from the straight line which would indicate obedience to Hooke's law.

It is the recovery from this semi-plastic state induced by overstrain to a condition of perfect or nearly perfect elasticity with raised elastic limit, that is referred to in the title of this paper. Such recovery is known to be effected by mere lapse of time.

This slow recovery of elasticity with lapse of time is first illustrated in the paper by means of stress-strain curves obtained at succeeding intervals of time. Recovery under continued stress is next considered, and the marked hysteresis in the relation of extension to load, exhibited by overstrained iron, is illustrated by means of a closed cycle. It is then shown that by exposing an overstrained specimen of iron or steel for three or four minutes to a temperature of 100° C , a very perfect restoration of elasticity is effected ; in the case of semi-mild steel, a more perfect restoration than was brought about by a fortnight's rest at the normal atmospheric temperature. So moderate a temperature as 50° C. is also shown to have a large influence in hastening recovery from overstrain.

It is next shown that by striking a recently overstrained specimen with a hammer so as to make it ring, the material of the specimen becomes less elastic. That is, the effect of mechanical vibration is opposite to that of increase of temperature.

The influence of magnetic agitation was also tried, but with a coil giving a field strength of 140 C.G.S. units at its centre, no effect was found to be produced on the elastic condition of recently overstrained material ; the process of recovery seemed to be neither accelerated nor retarded.

Compression experiments are also described in the paper ; an instrument specially designed by Prof. Ewing having been employed to measure the small compressional strains. The semi-plasticity of recently overstrained iron is thus shown, and the effect of moderate temperature in restoring elasticity demonstrated, by means of compression curves. The lowering of the compression yield-point which accompanies the raising of the tension one (due to tensile overstrain) is also indicated.

Physical Society, February 24.—Prof. Perry, F.R.S., Vice-President, in the chair.—A paper by Mr. E. F. J. Love, on the Joule-Thomson effect and its connection with the characteristic equation, and some of its thermo-dynamical consequences, was read by Mr. Watson. The author points out that the results of the original Joule-Thomson investigation of the thermal effects of fluids in motion has been utilised hitherto almost exclusively for the one purpose of determining the relation between various gas-thermometer scales and the absolute scale of temperature. He proceeds to deduce further consequences from those results, indicating the relation between the formula assigned to the Joule-Thomson effect, regarded as a

function of temperature, and the particular form adopted for the characteristic equation of a gas. He further attempts to supply a theoretical basis to the various formulæ of Van der Waals, Rose-Innes, and others, at the same time insisting upon a very high degree of accuracy for the original experimental work of Joule and Thomson. Then follows a discussion of the relation between the intrinsic energy of a gas and its volume, and a method is given for calculating the ratio of the principal two specific heats of a gas. Lastly, the author considers some points in the thermodynamics of substances at their temperature of maximum density. It is shown that (1) the Joule-Thomson effect for every substance at maximum density is zero ; just as it is, though for a different reason, in the case of an ideal perfect gas. And (2) that the infinite number of specific heats possessed by every substance are, at the temperature corresponding to maximum density, reduced to one specific heat. Mr. Rose-Innes congratulated the author on having written an interesting paper on a difficult subject. At the same time he felt bound to acknowledge that he was out of sympathy with the general idea contained in the paper. The experimental difficulties that occurred in carrying out the Joule-Thomson investigation were so enormous, that it was better to rely on them as little as possible, notwithstanding the great skill of the experimenters. The Joule-Thomson results could not be disregarded altogether, since they were necessary for the establishment of the thermodynamic scale ; but once that scale had been set up, it was better to have recourse as much as possible to such experiments as those of M. Amagat on the compressibility of gases. He also pointed out that one of the deductions given in the paper from Van der Waals's formula, had already been given by Van der Waals himself.—Mr. Watson replied, and the Vice-President proposed a vote of thanks to the author for his valuable paper. —The meeting then adjourned until March 10.

Chemical Society, February 16.—Prof. Dewar, President, in the chair.—The following papers were read :—On the absorption spectrum and constitution attributed to cyanuric acid, by W. N. Hartley. The author attributes his previous observation of an absorption band in the spectrum of cyanuric acid between wave-lengths 2747 and 2572 to impurity in the specimen examined. — A study of the absorption spectra of isatin, carbostyril and their alkyl derivatives in relation to tautomerism, by W. N. Hartley and J. J. Dobbie. A very close resemblance is observed between the molecular absorption curves of carbostyril and methyl- and ethyl-pseudocarbostyril, and also between those of isatin and methylpseudoisatin ; this indicates that all these substances have the lactam constitution. The absorption spectra of methylcarbostyril and methylisatin differ greatly from those of carbostyril and isatin respectively.—The estimation of nitrites and nitrates by means of ferrous chloride, by A. W. Blyth. On addition of ferrous chloride, solutions of nitrites immediately yield nitric oxide ; with solutions of nitrates, however, one to two minutes elapse before nitric acid is evolved. Applying these facts the author has devised an apparatus for estimating nitrites and nitrates, either singly or together, as nitric oxide.—Estimation of boric acid mainly by physical processes, by A. W. Blyth. The author uses the well-known increase of the specific rotation of tartaric acid which occurs on adding boric acid, in estimating the latter. On boiling boric acid with sodium carbonate solution, reaction occurs in accordance with the following equation :—

$$Na_2CO_3 + 4H_3BO_3 = Na_2B_4O_7 + CO_2 + 6H_2O ;$$

on employing certain precautions the reduction in electrical resistance yields the necessary data for estimating the boric acid used.—The interaction of ethylic sodiomalonate and mesityl oxide, by A. W. Crossley.—On Lössner's benzoylethyloxysulphocarbamic acid and the formation of pseudoureas, by A. E. Dixon. It is shown that the substance regarded by Lössner as benzoylethyloxysulphocarbamic acid $COPh.NEt.CO.SH$, has the constitution $COPh.NH.CS.OEt$; the supposed benzoylethylurea $COPh.NEt.CO.NH_2$ obtained from it is a pseudourea of the constitution $COPh.N:C(OEt)NH_2$.—On certain isomeric tertiary benzylthioureas, by A. E. Dixon.—Is camphene unsaturated, by J. E. Marsh.—Formation of α-pyrone compounds and their transformation into pyridine derivatives, by S. Ruhemann.

Entomological Society, February 15.—Mr. G. H. Verrall, President, in the chair.—Mr. B. A. Bower exhibited perfectly black, melanic examples of *Boarmia abietaria*, Hb., bred from ova laid by a female of the ordinary Box Hill form, which was captured on July 9, 1897. They were part of a brood of seventeen, seven of which were of the black aberration ; and for comparison with them, he showed specimens from Box Hill, South Devon and the New Forest. Mr. Blandford exhibited some small lumps of common salt burrowed by larvæ of *Dermestes vulpinus*, to which he had incidentally referred in a letter appearing in NATURE. He had on various occasions called attention to depredations of *Dermestes vulpinus*, arising from a habit the larvæ had of burrowing through different materials in order to find a shelter in which to undergo pupation, though this was the first time that salt, as a substance attacked in that way, had come under his notice. Mr. J. J. Walker said he believed one of the earliest references to injuries caused by *Dermestes* was to be found in "The Last Voyage of Thomas Candish," where there was an interesting account of certain worms which, bred from a stock of dried penguins, proceeded to devour the whole of the ship's stores and then to gnaw into the timbers, creating great alarm lest the ship should spring a leak. This voyage took place in the year 1593 ; and the worms, he thought, could only have been the larvæ of *Dermestes vulpinus* or some closely allied species. —Dr. T. A. Chapman read a "Contribution to the life-history of *Micropteryx* (*Eriocephala*) *ammanella*, Hubn."

CAMBRIDGE.

Philosophical Society, February 6.—Mr. J. Larmor, President, in the chair.—On the inheritance of variation in the corolla of *Veronica Buxbaumii*, by Mr. W. Bateson and Miss D. F. M. Pertz. In a former paper (*J. Linn. Soc.*, xxviii.) it was shown that in *Veronica Buxbaumii* there is commonly a high percentage of variation in the form of the corolla. Certain symmetrical forms having two posterior petals, two anterior petals, or three petals, respectively, are especially abundant. The frequency of these forms and of other forms of corolla has since been observed continuously in the case of certain chosen plants during the period of flowering. The statistics thus obtained are given in the present paper. A special attempt was made to determine whether any difference occurs between offspring raised from seed produced in normal and abnormal flowers borne by the same plant, both being alike self-fertilised. So far as the experiments went there was no evidence that such a difference exists. There is very great difference in the percentage of abnormal corollas borne by different individuals raised from the same self-fertilised capsules ; and after the self-fertilisation had been continued for four generations the same absence of uniformity persisted. But in the offspring both of normal and abnormal flowers the percentage of abnormality found in the family to which the parent belonged was on the whole maintained.—On the anatomy of a supposed new species of *Coenopsammia* from Lifu, by Mr. J. Stanley Gardiner. The skeletogloea, or structureless lamella, is directly attached to the corallum at the bases of the mesenteries and of the dividing walls of the cœnosarcal canals by fibrillated bundles. These were shown to be identical with the calicoblasts of von Heider, and it was contended that the corallum is formed completely outside the animal. It was further contended that the stomodœum together with the mesenterial filaments is homologous with the whole gut of the Triploblastica, and that the so-called endoderm is homologous with the mesoderm. The Actinozoon polyp then must be regarded as a Triploblastic form.

DUBLIN.

Royal Dublin Society, January 18.—Prof. G. F. Fitzgerald, F.R.S., in the chair.—Mr. J. Holms Pollok read a paper on the large deposits of kieselguhr, or diatomaceous earth, in the county of Antrim. They occur on both banks of the lower Bann, and are of exceptional purity just at the point where the Bann emerges from Lough Neagh. Analysis shows the kieselguhr to be of good quality and suited for many industrial purposes. It is seen under the microscope to be composed of little cubical box-shaped diatoms, with a few of radial and elongated shapes. It is not suited for making dynamite, but it makes an excellent non-conducting lining for safes and refrigerators, and could be used for covering boilers and steam-pipes. As kieselguhr is made up of the siliceous remains of low forms of aquatic plants, it is in the highest degree probable that the whole bottom of Lough Neagh is covered with such a deposit ; and if this be the case, it would be a very valuable addition to the economic resources of Ireland.—Sir Howard Grubb, F.R.S., read a paper in which he suggested

the utilisation of the "Marconi" system of wireless telegraphy for the control of public and other clocks, and explained how this could be effected. He also communicated a note upon the results that may be expected from the proposed monster telescope at the Paris Exhibition of 1900.—Prof. T. Preston, F.R.S., made a communication upon the perturbations suffered by the spectral lines in a strong magnetic field. The various types of effect were explained by theory, and a general law, which appears to govern all the phenomena, was laid before the Society.—Prof. J. Emerson Reynolds, F.R.S., exhibited the new Geissler tube, illustrating the beautiful colour-effects obtained under the kathode rays, and Prof. T. Johnson showed a series of specimens of rubber-producing plants and their products in various stages of manufacture.

EDINBURGH.

Royal Society, January 23.—Sir Arthur Mitchell, K.C.B., in the chair.—Lord McLaren presented a communication on the symmetrical solution of the ellipse-glissette elimination problem.—Prof. Cossar Ewart read a second instalment of his experimental contributions to the theory of heredity, in which facts and theories of reversion were taken up in considerable detail. The question was as to how far the resemblance of offspring to a recent or remote ancestor was a mere coincidence, or due to chance, or governed by what may be termed the law of reversion. Instances were very familiar in which the offspring, instead of displaying characteristics intermediate to those of the parents, strongly resembled one or other, or some grandparent, or even a more remote ancestor. Thus, it was a notorious fact that the children of mulattoes varied greatly, some being almost white, while others were darker than their parents. This was clearly a case of reversion. The mental, moral and physical peculiarities of many half-castes might also be explained as being due to reversion, to which there was a strong tendency when the parents belonged to two distinct types of race.

February 6.—Lord Kelvin in the chair.—Prof. Crum Brown, in a note on Nernst's "osmotic experiment," in which a water septum fixed in bladder separates pure ether from a solution of benzol in ether, gave what seemed to him the simple explanation of the phenomenon in terms of diffusion as determined by the gradient of concentration, and described and exhibited a new form of experiment in which the semi-permeable septum moved up as osmosis proceeded. A sufficiently dense solution of calcium nitrate was separated from a solution of phenol in water by a layer of phenol. As the water diffused through from above, the layer of phenol gradually rose. Basing on his view of the action, Prof. Crum Brown gave a new definition of osmotic pressure which had the merit of being purely experimental without any reference to molecular theories. This definition was to the effect that if two solutions of a given substance are formed at different pressures, they will be of the same concentration when this difference of pressure is equal to the osmotic pressure. Prof. Crum Brown also gave an account of an old proposal of the late Prof. Andrews as to the nomenclature of the anhydrides of acids. The proposal was to use carbonica, sulphurosa, sulphurica, as the ordinary every-day names of CO_2, SO_2, SO_3, which are often erroneously called *acids*, and have other more technical but less convenient names. These names would fall into line with such old familiar words as silica, soda, lithia, &c.—Lord Kelvin read a paper on the application of Sellmeyer's dynamical theory to the dark lines D_1 D_2 produced by vapour of sodium. It was suggested by Becquerel's recent discovery of anomalous dispersion in sodium vapour, the broadening out of the D lines being indicated by Sellmeyer's theory when worked out for a dynamical system of two concentric spherical atoms enclosed in an ether sheath.—In a second communication Lord Kelvin gave some additional theorems on the motion of liquid in an ellipsoidal hollow—a continuation of his paper on the same subject of 1885. One result referred to the great force required to keep the prolate ellipsoid fixed in position when the axis of molecular rotation was inclined at an angle of 45° to the principal axis of figure.—Messrs. A. J. Herbertson and P. C. Waite read a paper on the mean annual rainfall of Australia, being Part I. of a series of papers on the rainfall of Australasia. The results, which cover a period of fifteen years from 1881–95 inclusive, were shown on charts. In years of drought (*e.g.* 1888) about three-quarters of the whole continent had a rainfall of less than 10 inches per annum; but in years of heavy rainfall (such as 1893–94) this region was much diminished in area. The 10-inch line was the limit of sheep-rearing; the 15-inch line, of wheat-growing; the 25-inch line, of maize; and the 40-inch line, of sugar-cane.—Dr. Thomas Muir presented a communication on the multiplication of an alternant by a symmetrical function of the variables.

February 9.—Prof. Copeland in the chair.—At the request of the Council, Vice-Admiral Makaroff, of the Imperial Russian Navy, gave an address on some important oceanographic problems and novel modes of research. He exhibited his own forms of hydrometer and thermograph for ocean work, and described some of the more important results he had obtained in regard to temperature and salinity of the ocean. For example, the isotherms of the surface waters in Formosa Channel run parallel to the mainland, and in certain months the change of temperature is so rapid as we pass across the strait that a seaman could use temperature readings as a guide for steering his craft. A large model was exhibited of the Admiral's "ice-breaker," *Ermack*, which has just been completed to his design by Armstrong, Whitworth, and Co., of Newcastle. There were three screw-propellers in the stern, and also a screw in front for "breaking" the ice. There were special arrangements for moving 150 tons of water from one end of the ship to the other, and for moving 100 tons of water from one side to the other, thus enabling the navigator to change the lie of the ship at will. One of the practical ends for which the ship had been designed was to clear the Kara Sea of ice in early summer, so as to facilitate approach to the Obi and Yenisei Rivers. If this were successfully accomplished, then in all probability a trip to the North Pole would be attempted.

Mathematical Society, February 10.—Dr. Morgan, President, in the chair.—The following papers were read:—The eight queens' problem, by Dr. Sprague; on a problem of Lewis Carroll's, by Prof. Steggall.

PARIS.

Academy of Sciences, February 20.—M. van Tieghem in the chair.—The work of the soil, by M. P. P. Dehérain.—An experimental study of the relations existing between the state of aeration, and capacity of holding water possessed by a soil and plant growth.—Heat effects produced by stretching india-rubber, under conditions which may be realised for the elasticity of a muscle under contraction, by M. A. Chauveau.—Estimation of carbon monoxide, by M. Armand Gautier. A reclamation of priority in reply to some remarks by MM. Schlagdenhauffen and Pagel.—Some remarks on the claim to priority by M. J. Winter on the cryoscopy of urine, by M. Ch. Bouchard.—On the growth of functions defined by differential equations, by M. Émile Borel.—On divergent series and functions defined by a Taylor's series, by M. Le Roy.—On some forms of differential invariants, by M. Émile Cotton.—On the coefficient of expansion characteristic of the perfectly gaseous state, by M. Daniel Berthelot. From a comparison of the results of Amagat and Regnault, the author concludes that the limiting value of the coefficient of expansion of hydrogen is ·0036625 when the pressure is indefinitely reduced, and hence that the absolute zero is −273°·04 C.—On the complex oxides of the rare earths, by MM. G. Wyrouboff and A. Verneuil. Although the ceroso-ceric oxide is quite insoluble in nitric acid, it dissolves very easily when mixed with a certain quantity of lanthanum or didymium oxides. In the present paper the authors have investigated the limits between which the foreign oxides possess this peculiar property, and find that the percentage may vary between 10 and 43 per cent. These results are attributed to the formation of complex oxides of the type $Ce_3O_4.MO$.—Action of oxidising agents upon some amides, by M. Œchsner de Coninck.—On the law of dilution of electrolytes, by M. P. Th. Muller. The difference between the molecular conductivity μ and that at infinite dilution μ_∞ was shown by Oswald to be a function of the volume only. According to the author, if $\delta = \mu_\infty - \mu$, then when the volume $v = 2^n$, the expression for δ is of the form $\delta = A\left(\frac{3}{4}\right)^n$, A being a constant. From this is deduced a formula for molecular conductivities of neutral salts formed of monovalent ions, $\mu = \mu_\infty - 52{\cdot}72\ v^{-(0{\cdot}41504)}$.—On a new method of preparing mixed alkyl-phenolic phospheric ethers, by M. Albert Morel. The mixed ethers are prepared by acting upon $PO(OC_6H_5)_3$ with sodium ethylate.—Action of fermentation amyl alcohol upon its sodium derivative, by M. Guerbet.

In the use of boiling amyl alcohol and sodium as a reducing agent, it was found that the regenerated amyl alcohol had its boiling point raised. This was found to be due to the presence of a new alcohol, $C_{10}H_{22}O$, and its isovaleric ether. A second acid of the composition $C_{10}H_{20}O_2$ is also produced in the same reaction.—Distribution of carbon in humic materials, by M. G. André.—On the embryogeny of *Stoecharthrum Giardi*, by MM. Maurice Caullery and Félix Mesnil.—Contribution to the study of elements peculiar to the general cavity of the Phymosome, by MM. J. Kunstler and A. Gruvel.—On the earthquake at Triphylie of January 22, by M. D. Eginitis.

DIARY OF SOCIETIES.

THURSDAY, MARCH 2.

ROYAL SOCIETY, at 4.30.—Perturbations of the Leonids: Dr. G. J. Stoney, F.R.S., and Dr. Downing, F.R.S.—On Flapping Flight of Aeroplanes: Prof. M. F. Fitzgerald.—On Hydrogen Peroxide as the Active Agent in producing Pictures on a Photographic Plate in the Dark: Dr. Russell, F.R.S.

ROYAL INSTITUTION, at 3.—Toxins and Antitoxins: Dr. Allan Macfadyen.

LINNEAN SOCIETY, at 8.—On the External Nares of the Cormorant: W. P. Pycraft.—On the Irish *Carex rhynchophysa*: G. C. Druce.—On the Fertilisation of *Glaux maritima*, Linn.: Edward Step.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Wireless Telegraphy: G. Marconi.

CHEMICAL SOCIETY, at 8.—Bromomethylfurfuraldehyde: H. J. H. Fenton and Mildred Gostling.—The Action of Metallic Thiocyanates on certain Substituted Carbamic and Oxamic Chlorides, and a New Method for the Production of Thiobiurets: Dr. Augustus Edward Dixon.—Ethylic ββ-Dimethylpropane Tetracarboxylate: W. Trevor Lawrence.—The Action of Alkyl Iodides on Hydroxylamine: Prof. Wyndham R. Dunstan, F.R.S., and Ernest Goulding.

FRIDAY, MARCH 3.

GEOLOGISTS' ASSOCIATION, at 8.—Honeycomb and other Forms of Surface Weathering of Sandstone and Limestone: George Abbott.

QUEKETT MICROSCOPICAL CLUB, at 8.

SATURDAY, MARCH 4.

ROYAL INSTITUTION, at 3.—Mechanical Properties of Bodies: Lord Rayleigh, F.R.S.

MONDAY, MARCH 6.

SOCIETY OF ARTS, at 8.—Cycle Construction and Design: Archibald Sharp.

VICTORIA INSTITUTE, at 4.30.—The Nature of Life, Part II.: Prof. Lionel Beale, F.R.S.

TUESDAY, MARCH 7.

ROYAL INSTITUTION, at 3.—Morphology of the Mollusca: Prof. E. Ray Lankester, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—Exhibition and Remarks upon Specimens of the *Medusa* of Lake Tanganyika: J. E. S. Moore.—On the Chimpanzees and their Relationship to the Gorilla: Dr. A. Keith.—On the Myology of the Edentata: Dr. C. A. Windle and Prof. P. G. Parsons.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Water-Tube Boilers for Marine Engines: J. T. Milton.—Recent Trials of the Machinery of War-Ships: Sir. A. J. Durston, K.C.B., R.N., and H. J. Oram, R.N.—Monthly Ballot for Members.

WEDNESDAY, MARCH 8.

SOCIETY OF ARTS, at 8.—Cornish Mines and Miners: J. H. Collins.

GEOLOGICAL SOCIETY, at 8.—On the Evolution of the Genus *Micraster*: A. W. Rowe.—On a Sill and Faulted Inlier in Tideswell Dale (Derbyshire): H. H. Arnold-Bemrose.

THURSDAY, MARCH 9.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: A Preliminary Note upon certain Organisms isolated from Cancer, and their Pathogenic Effects upon Animals: H. G. Plimmer.—On the Gastric Gland of Mollusca and Decapod Crustacea: its Structure and Functions: Dr. MacMunn.

SOCIETY OF ARTS (Indian Section), at 4.30.—Leprosy in India: H. A. Acworth.

MATHEMATICAL SOCIETY, at 8.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Subject announced at Meeting of March 2.

FRIDAY, MARCH 10.

ROYAL INSTITUTION, at 9.—Measuring Extreme Temperatures: Prof. H. L. Callendar.

ROYAL ASTRONOMICAL SOCIETY, at 8.

PHYSICAL SOCIETY, at 5.—(1) A Study of an Apparatus for the Determination of the Rate of Diffusion of Solids dissolved in Liquids; (2) Note on the Source of Energy in Diffusive Convection: Albert Griffiths.—An Exhibition of Dr. A. Wehnelt's Electrolytic Current Interruptor for Ruhmkorff Coils: A. A. Campbell Swinton.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Construction of the Elan Aqueduct, Birmingham Waterworks: H. Lapworth.

MALACOLOGICAL SOCIETY, at 8.

SATURDAY, MARCH 11.

ROYAL INSTITUTION, at 3.—Mechanical Properties of Bodies: Lord Rayleigh, F.R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Telegraphy: W. H. Preece and J. Sivewright, 15th edition (Longmans).—The Tutorial Dynamics: W. Briggs and G. H. Bryan (Clive).—Matriculation Directory, January (Clive).—Verhandlungen der Deutschen Zoologischen Gesellschaft auf der Achten Jahresversammlung zu Heidelberg den 1 bis 3, Juni 1898: Prof. J. W. Spengel (Leipzig, Engelmann).—Calendar, &c., of the Department of Science and Art, 1899 (London).—The Science of Life: J. A. Thomson (Blackie).—Allgemeine Biologie: Dr. M. Kasswitz, Zweiter Band (Wien, Perles).—Practical Work in Physics: W. G. Woollcombe, Part 4 (Oxford, Clarendon Press).—Die Medial-Fernrohre: Prof. L. Schupmann (Leipzig, Teubner).—Vertebrate Remains from the Port Kennedy Bone Deposit: E. D. Cope (Philadelphia).—Cambridge Natural History. Vol. ix. Birds: A. H. Evans (Macmillan).—The Chemistry of Coke: O. Simmersbach, translated, &c., by W. C. Anderson (Glasgow, Hodge).—Practical Dictionary of Electrical Engineering and Chemistry: P. Heyne (Grevel).—History of the New World called America: E. J. Payne, Vol. 2 (Oxford, Clarendon Press).—L'Audition et les Organes: Dr. M. E. Gellé (Paris, Alcan).—La Céramique Ancienne et Moderne: E. Guignet and E. Garnier (Paris, Alcan).—Recueil de Données Numériques, Optique, Deux. Fasc. (Paris, Gauthier-Villars).—Lectures on Theoretical and Physical Chemistry: Prof. J. H. van 't Hoff, translated by Prof. R. A. Lehfeldt, Part 1 (Arnold).—Year-Book of the Royal Society, 1899 (Harrison).—Proceedings of the London Mathematical Society, Vol. xxix., 2 parts (Hodgson).—The Great Salt Lake Trail: Colonels Inman and Cody (Macmillan).—Volcanoes, their Structure and Significance: Prof. T. G. Bonney (Murray).—The Penycuik Experiments: Prof J. C. Ewart (Black).—*Electrician* Electrical Trades Directory, 1899 (*Electrician* Company).—The Story of the British Race: J. Munro (Newnes).—Researches into the Origin of the Primitive Constellations of the Greeks, Phoenicians, and Babylonians: J. Brown, jun., Vol. 1 (Williams).—Under the African Sun: Dr. W. J. Ansorge (Heinemann).

PAMPHLETS.—Regeneration und Entwicklung: Dr. H. Strasser (Jena, Fischer).—Die Lehre vom Organismus und ihre Beziuhung zur Sozialwissenschaft: O. Hertwig (Jena, Fischer).

SERIALS.—American Journal of Science, February (New Haven).—Astrophysical Journal, January (Chicago).—Zoologist, February (West).—American Naturalist, February (Boston).—Botanische Jahrbücher, &c., Sechr Band, 3 and 4 Heft (Leipzig).—Plantæ Europeæ: Richter and Gürke, Tomus ii. Fasc. 2 (Leipzig).—Physical Review, January (Macmillan).—Journal of the Franklin Institute, February (Philadelphia).—Engineering Magazine, February (222 Strand).—Annales de l'Observatoire Météorologique, &c., du Mont Blanc, Tome 3 (Paris).—Brain, Part 84 (Macmillan).—National Geographic Magazine, January (Washington).—Le Monde Moderne, February (Paris).—Popular Astronomy, February.—Northfield, Minn.).—Memoirs of the Geological Survey of India, Ser. xv. Vol. 1. Part 3 (Calcutta).—Chambers's Journal, March (Chambers).—Journal of the Chemical Society, February (Gurney).—Good Words, March (Isbister).—Sunday Magazine, March (Isbister).—Century Magazine, March (Macmillan).—Journal of the Royal Microscopical Society, February (London).—Photogram, March (Dawbarn).

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