THURSDAY, MARCH 23, 1899.

THE ART OF TOPOGRAPHY.

Recherches sur les Instruments, les Méthodes et le dessin Topographiques. Par le Colonel A. Laussedat. Vol. I. Pp. xi + 449. (Paris: Gauthier-Villars, 1898.)

IN his first volume on the art of topography Colonel A. Laussedat gives us an excellent sketch of the history and development of modern survey instruments, and an epitome of the opinions expressed by the best continental authorities on the subject of topography during the present century. The object of his comprehensive work is apparently to introduce to the scientific world the latest developments in the application of photography to the purposes of rapid delineation of topographical features, a comparatively new art which demands the attention of scientific surveyors in this country; but the present volume does not do more than touch this branch of his subject slightly.

The history of the evolution of the theodolite and other modern instruments is especially interesting, for it shows how very little the principles of construction have altered during the last three centuries. We have made enormous progress in the improvement of old instruments and in the application of old methods to surveying purposes, but the governing principles of triangulation, and of delineating country by means of the planchette, or plane-table, are so old as to be beyond even the historical evidence collected in Colonel Laussedat's book. Anything approaching to exact information only commences with the Arab geographers of the middle ages. They adopted the ancient instruments of the Alexandrian school, and improved on them. They even went to war with Greece in 829 A.D. because the Greek Emperor declined to lend them the services of a *savant* to extend their knowledge of mathematics. They borrowed their system of enumeration from India, and the magnetic compass from China; they observed their latitudes with the astrolabe (a very clear description of which instrument is given by Colonel Laussedat), and their longitudes by observations of the eclipse of the moon; and with these acquirements they made themselves masters of the Eastern seas. It is certain that Vaso de Gama made use of Arab pilots when he "discovered" the Cape route to India. Many authors attribute the invention of the plane-table to Pretorius, a Wittenburg professor, in 1537; but there is evidence of its existence in much earlier days to be found under classical authority. So obvious a method of map making, indeed, could hardly have escaped the Roman engineers, who were quite capable of turning out excellent plans of their cities in days anterior to our era.

The theodolite, which is only an adaptation of more ancient instruments, was reduced to something like its present form by Digges in 1571, and we find an alidade fitted with a vertical circle in use in 1590 in connection with the plane-table, so that, for three centuries, we have made no radical change in our principles of geographical surveying; although the introduction of the system of measurements by traverse and offset which are first recorded in the field book and then plotted in the office, has for many years superseded the more ancient use of the plane-table by the Ordnance Surveyors of England, for cadastral purposes. The history of the discussion on the relative value of these two methods of field work—"l'antique lutte entre la méthode du trace et du rapport immédiat des mesures sur le terrain, et cette des mesures inscrites sur un carnet et rapportées dans le cabinet"—is excellently well summed up by Colonel Laussedat. He is, however, mistaken in supposing that the discussion commenced in England with the lecture given by the American surveyor, Mr. Pierce, at the Civil Engineers Institute in 1888. Nearly ten years before that date, the advantages of the planchette, or plane-table, system of topography had been advocated at the R.U.S. Institute by Colonel Holdich, and instruction in this system had already been introduced into our military schools. England, in fact, has adopted this system for all countries and colonies with which she has surveying relations, outside England, but within her own borders the Ordnance Survey still maintains its position against all other civilised communities. But the use that is made of the plane-table (universal as it has once more become) is not quite the same all over the world; and in this branch of his researches Colonel Laussedat might, perhaps, have extended his review with advantage. The difference in its application to the various fields of continental or colonial survey lies chiefly in the amount of independence which is admitted of other and more exact methods of triangulation. Russians and Americans, for instance, by making use of a complicated plane-table, claim for it nearly all the potentialities of a small theodolite. English surveyors use it absolutely for topographical delineation, but subordinate it to primary triangulation with the theodolite. Its independence is not carried further than the limits imposed by triangulated and computed points or positions. What Colonel Laussedat fails to appreciate, is the advantage of mathematical proofs of the correctness of all that preliminary framework of fixed positions which is attained by the use of the theodolite. The correctness of such fixed positions is capable of mathematical demonstration quite apart from any survey process in the field. Within these limits no accumulation of error can occur, and it may be said that the demonstrable accuracy of the triangulated points is the gauge of the general accuracy of all details in the map. No position should be more inaccurate than the points from which it is interpolated. Where this proof supplied by computation is missing, there is no ready test of accuracy available. The surveyor who uses his plane-table only for graphic triangulation may accumulate error indefinitely, and no absolute check is applicable.

The net result of Colonel Laussedat's examination into topographical methods is that he gives his approval to the use of the plane-table in close alliance with the theodolite; and in this opinion he has the support of nearly all continental and most English surveyors.

When he comes to the consideration of the best method of representing the inequalities of ground, *i.e.* of giving proper value to the scales of shade indicating greater or less slope to be employed in cartography, there is very much in the book that is worth attentive study. Doubtless the system of continuous contours at equidistant vertical intervals is the most scientific and the most practically useful. But it was long ago recognised in France that this system is only applicable to certain scales, and it was definitely laid down by the "Commission of 1826" that for scales smaller than 1/10,000 this system was insufficient. Then was introduced the expedient of "hachures" following the direction of greatest slope (*i.e.* what we call vertical hachures), and rules were laid down for the spacing of the strokes between the contours. As this is a subject which forms matter for constant discussion even now, it is interesting to note this first endeavour to deal with the problem systematically. No reference is made to horizontal hachuring, which we may presume has never been adopted by the French, although it is found of the greatest practical value in the geographical and military cartography of India.

The artistic effects gained by the assumed incidence of light is also dealt with; and here it is quite apparent that Colonel Laussedat's artistic perceptions have dominated his judgment. He is all in favour of adopting an affectation of oblique light to gain the effect of relief. And there is no doubt that the most perfectly artistic maps yet produced (the Swiss maps of the Alps) owe much of their effect to this expedient. But all theory of a true "diapason" (Colonel Laussedat's own expressive word) of shade to express slopes must disappear, if shadows are to be cast on the sides of mountains for the purpose of rendering them picturesque. Strong shade represents steep declivity or precipitousness, and if it is used for artistic effect only, it must lose its proper cartographic significance. It cannot be made to answer both purposes. With Colonel Laussedat's view of the utility of elevations and landscapes to illustrate a map we entirely agree, and it is here that the camera lucida and the photograph become effective. The former instrument is often used by geological surveyors in India with most admirable results, and it would be impossible to illustrate the accidents of rock formation in connection with geological maps by any more satisfactory method. The art of photography has not yet been applied to topographical purposes with similar success, but there may be a future awaiting it, with the development of which we trust that Colonel Laussedat will have something to say.

Incidentally the nature and use of barometric instruments are discussed in this book. Just at the present time, when the value of the aneroid barometer is under trial in connection with Colonel Watkins' new invention for throwing the instrument out of gear when not actually in use, this part of Colonel Laussedat's treatise is of special value. It indicates certain irregularities in the recording of instruments which he has personally tested, which do not appear to be in accordance with those of later observers (Whymper and others) in England. It may be *apropos* to this part of the subject to observe that the use of the aneroid for determining the orography of districts in India and Africa has been largely discontinued lately. With a certain number of fixed altitudes obtained trigonometrically, it has been found far more satisfactory to use a clinometer in connection with the plane-table. The alidade (or plane-table "ruler") has not been in any way modified for this purpose (although the introduction of a scale along the bevelled edge would be an obvious advantage), but a separate instrument carrying a level and a tangent scale is used for interpolating altitudes from fixed points by direct observation.

T. H. H.

GOLD MINING.

The Gold-fields of Australasia. By Karl Schmeisser, Obergrath, assisted by Bergassessor Dr. Karl Vogelsang; translated by Henry Louis, M.A., A.R.S.M., F.G.S., &c., Professor of Mining, Durham College of Science. Pp. 254 + xx. With 13 maps and plans in a separate volume. (London: Macmillan and Co., Ltd. New York: The Macmillan Company, 1898.)

The Witwatersrand Gold-fields Banket and Mining Practice. By S. J. Truscott. Pp. xxiii + 495. (London: Macmillan and Co., Ltd. New York: The Macmillan Company, 1898.)

Transactions of the Institution of Mining and Metallurgy, London. Seventh Session, 1897–98. Vol. vi. Edited by Arthur C. Claudet, A.R.S.M. Pp. vi + 348. (London: Broad Street House, 1898.)

THE boom in the Witwatersrand gold mines in 1895 has been attributed, in part at least, to the famous Report made by Herr Schmeisser to the Prussian Government in 1893. Moreover, it is always refreshing to the investing public, weary of the perennial optimism of the ordinary mining expert, to come across an unprejudiced account of a gold-field written by a man whose reputation and experience give his statements the prestige of a Government Report. A peculiar interest therefore attaches to the appearance of this book, seeing that, with the recent enormous increase in the production of gold, it might have had a great effect on the fortunes of West Australia. It may, however, be said at once that Herr Schmeisser does not take any definite stand with regard to the land of "sand and sorrow." Certain districts, indeed, he condemns utterly as containing only lodes which pinch out and disappear completely at a very moderate depth, so that they may be expected to cease producing before long. As to other cases, he is still more pessimistic, believing that they depend entirely on pockets of rich ore, which are worked out almost immediately. Moreover, he fears that the generally patchy nature of the lodes will cause many disasters to companies now at work with available capital so small that development and prospecting are checked, and the miners will presently have barren reefs only in sight and no money to search for further rich deposits.

But, on the other hand, Herr Schmeisser waxes almost enthusiastic over the "composite" veins of Kalgoorlie, and over the possibility of new discoveries which the great unexplored tracts in the interior offer. The composite veins consist of a mixture of quartz veinlets and of clayey or talcose ferruginous rock, passing down at a depth of about 150 feet into undecomposed rock containing sulphides and tellurides of gold and of gold and silver. Very rich ore, containing from one to ten ounces of gold per ton, is found in many of the lodes in a space about three-quarters of a mile wide and a mile and a quarter long, and seems likely to continue or increase in richness as depth is gained. Even from so small an area there is room for the production of millions of ounces, and if, as E. F. Pittman indicates, discoveries of similar deposits of tellurides are made along a line stretching for fifty miles from S.S.E. to N.N.W., the future of West Australia as a gold producer is guaranteed for many years to come.

One of the most interesting discoveries in this district was that of a lump of gold weighing 303 ounces in a quartz lode at Black Flag, six feet below the surface. Almost the only difficulty in accounting for the formation of placer gold, by supposing it to be derived from auriferous lodes by denudation, has been that large masses of gold occurred in gravels which had no counterpart in lodes. This difficulty has now been removed.

It might, perhaps, have been better if Herr Schmeisser had concentrated his attention on West Australia, and left the rest of Australasia alone. After quitting West Australia, his time was so limited that he could make only flying visits to a few localities, and has made scarcely a single original observation about one of them. Nevertheless the whole book is eminently readable, all the most interesting points in the subject being well brought out and dwelt upon. A striking picture of the contrast between the dry, hot, sandy plains of Australia and the deep ravines, splashing waterfalls and luxuriant vegetation of New Zealand is drawn in a few vigorous lines. The structure of the continent, too, is tersely indicated—a huge tableland, dipping from the sides towards the middle, and consisting of tertiary sands and Jurassic sandstones and limestones, flanked on the east and west by masses of granite and eruptive rocks. Finally, mention must be made of the admirable maps and plans, some of which are reproduced from the Government Reports issued by the various Colonies.

Another fine volume of a splendid mining series is Mr. Truscott's work on the Witwatersrand gold-fields. Some of the ground has been already covered in Messrs. Hatch and Chalmers' "Gold Mines of the Rand," but Mr. Truscott has done much more than bring that well-known book up to date. He has not confined himself to a popular account of his fascinating subject, but has treated it in a technical manner which makes his book of great value to mining engineers and students. There is little that is new in the account of the geology of the district, though it is perhaps surprising to find the view finally accepted that the gold in the banket was deposited there by infiltrating solutions, as in the genesis of auriferous quartz veins. Certainly no auriferous veins are so strikingly regular in value as the Witwatersrand conglomerates.

The greater part of the book, however, deals exhaustively with the mining practice as it existed in 1897, and this is almost entirely new ground. Not that the practice in the Transvaal differs greatly from the best work in other parts of the world, but there is here a picture of the latest and most approved methods of mining, modified as they have been by the local conditions of work. The chapters on sampling, on machine drills as compared with hand labour, and on sorting and ore dressing are particularly interesting, and much may be learnt in other countries from the results set forth; but, indeed, the whole book is well worth careful study.

The third volume of which the title is given at the head of this notice affords further evidence that, though the Institution of Mining and Metallurgy is one of the youngest of the technical societies, it publishes a capital journal, containing many interesting papers. There is a dearth of communications on the iron and steel industry, on coal-mining, and, indeed, on the industries of this country generally. These are all well looked after by other societies. The members of the Institution devote their attention mainly to gold and silver mining, and the extraction of these metals from their ores. Some of the papers have already been noticed from time to time in NATURE. The sixth volume, like its predecessors, is well printed, but would be perhaps improved if there were more diagrams to illustrate the papers.

OLD ENGLISH PLANT LORE AND MEDICINE.

Medical Works of the Fourteenth Century; together with a List of Plants recorded in Contemporary Writings, with their Identification. By the Rev. Prof. G. Henslow, M.A., F.L.S., &c. Pp. xv + 278. (London: Chapman and Hall, Ltd., 1899.)

SINCE the publication of Cockayne's "Leechdoms and Wortcunning," &c., and Prof. Earle's excellent little book on the "English Names of Plants," no work of the kind has been published until this volume of Prof. Henslow's; an important contribution which will be most welcome to philologists and botanists. The author is to be congratulated on the possession of so important a MS. as the one marked (A), which gave origin to his book.

Its philological value is well described in the preface by Prof. Skeat, who finds in it new and interesting features.

In the beginning of MS. (A) occur a number of recipes for the "steynyng of lynne cloþ," "to make red water" and "scarlet water," &c. One of the most striking of these recipes is that (p. 4) "to make soursikele water." This, says the note, is better spelt "saussicle, salsequium, or heliotrope, rendered in the list as ? *Cichorium Intybus*, ? *Tragopogon porrifolius*," both more than doubtful, " or *Calendula vulgaris*," a more likely plant to produce the required colour. The recipe says: "Take a tre that is like brasel, but it is more yellower in colour." . . . "Take it as thou dost brasel and lay that on thy cloth and do ye it in all manner as thou doust brasel." It is not clear in what this likeness consisted. It could not have been to the *plant Caesalpinia sappan*, which had been in use throughout Europe for centuries before King Emmanuel of Portugal gave the name of Brazil to the newly-discovered *Brazil* in the year 1500. It could therefore have been only in the colour of the dye that a resemblance was found.

Another recipe was "To make ȝelewe watere,—take goud englis woldes," which is not, what might be supposed, "woad," but "weldes," *Reseda luteola*.

Many other recipes for various shades of colour are given, and there must have been in early days a vast number of these plant-colours in use, if we may judge from the amount of delicate and lovely tints which are to be seen in the wonderful "Book of Kells," supposed to date from the eighth century, and now in the library of Trinity College, Dublin. A collection of recipes for these and other stains would be very interesting in explanation of the illumination-tints of the Anglo-Saxon period.

The remainder of MS. (A), as well as the whole of the three others—Harl. MS. (B), 2378; Sloane, 2584 (C); and Sloane, 521 (D), consist mainly of medical recipes similar in character to the "Leechdoms."

These have comparatively little interest in modern medicine except as literary curiosities, for it is remarkable how very few English plants remain as "survivals of the fittest" in the Pharmacopœia. Amongst this small number may be named *Hyoscyamus niger*, *Conium maculatum*, *Papaver somniferum*, *Spartium scoparium*, used *for staunching blood*, and not for the same purpose as in the present day; mugwort or wormwood, *Artemisia*, of which three species are given in the "Leechdoms," as well as in Prof. Earle's book. Besides these there are but few others in Mr. Henslow's list which have much value at the present time. It is not a little strange to find how almost completely English plants have been superseded in modern medicine by newly-invented compounds or by drugs imported from other countries, and it is to be regretted that more careful observation and trial of British plants are not made, as doubtless others might be discovered of marked value, as has been the case with *Convallaria* and *Taxus*.

Following the MSS. is a list of the medical and other plants of the fourteenth century, which is a model of its kind, containing all plant-names alphabetically arranged, the scientific names with which they have been identified, and the Old English sources from which they have been derived, reference being made to the page and line in each instance. If a book could be written on the same plan, including all the early English works, such as the "Leechdoms" and other similar writings, it would be of great value both to Anglo-Saxon scholars and to botanists, and would be an immense saving of trouble to the reading public, who would be under great obligations if so able an authority as Prof. Henslow would undertake the task.

There are singularly few exceptions which can be made to the present list; but it might be well under *Cyclamen*, which Earle gives as *Orbicularis* or "*Slite*," to note that the English word is omitted in it.

Gaytre, without much apparent reason (except the mention of *Cornel* in Chaucer, who, though he also speaks of "*Gaître-berries*," does not sufficiently identify them), referred to *Cornus sanguinea*. Might it not perhaps as fairly be assigned to the Gueldre rose, *Viburnum opulus*, a more harmless and edible fruit, of the *Sambucus* family?

It does not appear that *Cockel*, *Lolium temulentum*, is correctly referred to (A) 21^{18}.

One cannot part with this book without a word or two on the excellent style in which it is sent out. The binding and type, especially that of the specimen page of the MS., are attractive.

OUR BOOK SHELF.

The Chemistry of Coke. By O. Simmersbach; translated &c. by W. C. Anderson. Pp. viii + 159. (Glasgow and Edinburgh: William Hodge and Co., 1899.)

THIS excellent little work is a translation by Mr. W. Carrick Anderson of Simmersbach's "Grundlagen der Kokschemie," containing several important additions, notably a chapter on the methods employed for the examination and analysis of coal and coke. The work is rendered more valuable than most technical books of this character by the references, which make it a fairly complete bibliography of the subject. In a future edition it would be well to devote a special chapter to gas coke, which now only receives an occasional and inadequate mention, whilst a summary of the processes for the recovery of the bye-products of coke ovens would be a welcome addition to readers who do not possess Lunge's standard work on the subject.

The work is well and carefully done, whilst the statements made are mostly fully supported by the evidence adduced. On p. 76, however, the loss of carbon during quenching is represented by the equation

$$C_2 + 2H_2O = CH_4 + CO_2,$$

this statement being apparently made on the authority of an analysis by Frankland, who found in the gases evolved from Derbyshire coke and steam 56·9 per cent. of combustible gas, which he returns as a mixture of hydrogen and methane; but if Mr. Anderson analyses the gas produced under these conditions, he will find that the methane is a mere trace, and manifestly not produced in the way indicated by his equation.

The book can be heartily recommended to all interested in the manufacture and application of coke.

Class Book of Physical Geography. By Wm. Hughes, F.R.G.S. New edition, revised by R. A. Gregory, F.R.A.S. Pp. 328 + viii. (London: George Philip and Son, 1899.)

SO much alteration in arrangement and text has been made in this new and enlarged edition of Prof. Hughes' well-known class book that it is practically a new work. In all directions we note additional matter which seems well adapted to meet modern requirements, and many new illustrations of exceptional merit have been introduced. A clear and comprehensive account is now given of the earth as a member of the solar system, and of the methods of ascertaining its form and size, as well as the positions of points upon its surface. The treatment of the various physical features of the earth is both clear and complete, and moreover is bright enough to make the subject attractive even to the general reader. Among the subjects which merit special mention are eclipses, winds, and climate, the first-named being illustrated by some excellent diagrams. The book has greatly gained in value in the hands of the present editor, and we confidently recommend it to the notice of pupil teachers and others interested in the subject.

English-French Dictionary of Medical Terms. By H. De Méric. Pp. vi + 394. (London: Baillière, Tindall, and Cox, 1899.)

THIS dictionary, in which the French equivalent is given for words and terms used in English medical science will be particularly valuable to French practitioners and students of medicine. The dictionary has been prepared upon a comprehensive plan, and includes, in addition to purely medical words, other words used in pathology, surgery, anatomy, and physiology, and also biological, botanical and zoological words met with in medical literature generally. The second part of the work (French-English), completing the dictionary, will appear shortly.

LETTERS TO THE EDITOR.

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

Radiation in a Magnetic Field.

THE application by Prof. Michelson of his interferometer to the study of the structure of the spectral lines has raised two important questions regarding the performance of this instrument; and it is to be hoped that perfectly satisfactory answers to both of them may be forthcoming in the near future. These questions are:

(1) Is the complex structure of the lines indicated by the interferometer a real structure existing in the light emitted by the source; or is it imposed, in part or altogether, by the apparatus employed?

(2) Supposing the structure referred to in (1) not to be spurious, but to be real, or partly real and partly spurious, can the interferometer be relied on as a measuring instrument for the purpose of determining the distribution of light in the complex line by estimation from the visibility curve?

With regard to (1), I may say that although it has been suggested that the structure indicated by the interferometer is entirely due to diffraction effects (or other unknown instrumental troubles), yet I personally am of opinion (from the study of Prof. Michelson's work) that the structure indicated is in the main real. It is possible, and indeed probable, that diffraction effects influence the final results in some small degree; but the main character of the indicated structure agrees, no doubt, with a real structure existing in the light emitted by the source.

The modifications introduced by diffraction (if any) ought to be detected from the fact that such effects are the same in character for light of all wave-lengths, and their magnitudes for different spectral lines depend on the wave-length only, and in no way on the nature of the radiating substance. For this reason I believe, with Prof. Michelson, that the structure indicated by the interferometer as existing in certain spectral lines, even when uninfluenced by the magnetic field, is a real structure; but as to whether it is all real, or to some small extent spurious, has not yet been placed beyond all doubt. The discovery of this structure adds one more to the already long list of achievements in the advance of science for which we are indebted to Prof. Michelson, and I trust he will place it beyond all doubt as to whether diffraction, or other causes, exert any appreciable influence in the instrument, or in any way mask the true structure. It is not sufficient to reply, as he does on p. 440 of this journal (March 9), that the explanation of this structure by diffraction effects "would be very difficult to accept, in view of the very great constancy of the results, with instruments of different construction and dimensions, with different observers, and with different forms of vacuum tubes employed"; for whether the effects are due to diffraction or not, they ought to remain the same under the circumstances here related, unless the "instruments of different construction" differ in principle and are not all interferometers. Diffraction cannot be the main cause if the character of the effect differs for different wave-lengths, and Prof. Michelson finds that it does differ for different spectral lines; and in the same way, I think, it might be determined if it intrudes itself as a modifying influence.

With regard to question (2) above, the charge against the interferometer remains most serious; nor is it diminished in any way by Prof. Michelson's further explanations given on p. 440. The case is this—the interferometer, when applied to the study of the splitting up of the spectral lines by the magnetic field, yields the law that the magnetic separation of the constituents "is *approximately* the same for all colours and for all substances." Now the facts of the case are that no such law holds, even as the roughest *approximation*. The magnetic separation is quite large for some lines, and very small, almost unobservable, in the case of others, and this even in the case of lines of nearly the same wave-length in the same substance. In fact the law yielded by the interferometer is not at all supported by the facts, and what remains to be done is to determine the causes of error in the instrument, or to standardise it, so that it may be employed as a measuring instrument. Of course, as I have already mentioned (NATURE, January 5, p. 228), the interferometer might have yielded this law without censure if by chance Prof. Michelson had happened to observe lines which suffer approximately the same amount of resolution in the magnetic field. But this is not the case, for in the case of cadmium the separation for the blue line is more than 30 per cent. greater than for the green line, yet the interferometer gives 0·41 for the green line and 0·40 for the blue. Similar remarks apply to the corresponding lines of zinc and magnesium; and what person, who has had even the slightest survey of these effects, can have any doubt as to the great difference in the magnitudes of the magnetic effects in the case of the green lines of magnesium and the green lines of copper?—and so on *ad infinitum*.

In conclusion, it may be well to mention that the relative intensities of the light in the components of the magnetically resolved lines, as observed by the eye in a good spectroscope (21·5-foot grating), are not by any means the same as those indicated by the interferometer. Thus in the figures reproduced on p. 440, the central components A (Fig. 1) are shown by the interferometer as possessing greater intensity than the lateral components B. But when the resolved line is observed by the eye (or photographed), it is at once seen that the illumination in the lateral components B (types II. and III.) is very much greater than that in the central components A. Type II. shows as a quartet (in which A is double) if the field is not very intense; but this quartet becomes resolved into a sextet, owing to the side lines B splitting up into doublets when the field becomes very intense. There is no trace of the further little "humps" pictured by Prof. Michelson, but the lines are clear and sharp—and it is possible that these little humps may be due to diffraction effects (?). Similar remarks apply to the relative illumination in type III.; and in this connection I may mention that although I did not give an illustration of the general type on p. 226, viz. that in which each constituent of the normal triplet is itself a triplet (figured by Prof. Michelson, p. 441, Fig. 3), yet I stated in the text of my article (p. 226) that "all the variations so far noted may be embraced in the general statement that each line of the normal triplet may itself become a doublet or a triplet." Indeed, these various types of effect were observed by me as early as November 1897, and have been communicated to the Royal Dublin Society from time to time.

THOMAS PRESTON.

Bardowie, Orwell Park, Dublin, March 16.

The Phenomena of Skating and Prof. J. Thomson's Thermodynamic Relation.

IN connection with Prof. Osborne Reynolds's "Notes on the Slipperiness of Ice," read before the Manchester Literary and Philosophical Society (NATURE, March 9, p. 455), the following extract from a brief paper, read by me before the Royal Dublin Society in 1886 (*Proc. R.D.S.*, vol. v. p. 453), may not be without interest.

"To the many phenomena which have found an explanation in Prof. J. Thomson's thermodynamic relation connecting melting-point with pressure, might be added those attending skating, *i.e.* the freedom of motion and, to a great extent, the 'biting' of the skate.

"The pressure under the edge of a skate is very great. The blade touches for a short length of the hog-back curve, and, in the case of smooth ice, along a line of indefinite thinness, so that until the skate has penetrated some distance into the ice the pressure obtaining is great; in the first instance, theoretically infinite. But this pressure involves the liquefaction, *to some extent*, of the ice beneath the skate, and penetration or 'bite' follows as a matter of course. As the blade sinks, an area is reached at which the pressure is inoperative, *i.e.* inadequate to reduce the melting-point below the temperature of the surroundings. Thus, estimating the pressure for that position of the edge when the bearing area has become 1/50 of a square inch, and assuming the weight of the skater as 140 lbs., and also that no other forces act to urge the blade, we find a pressure of 7000 lbs. to the square inch, sufficient to ensure the melting of the ice at $-3{\cdot}5^\circ$ C. With very cold ice, the pressure will rapidly attain the inoperative intensity, so that it will be found difficult to obtain 'bite'—a state of things skaters are familiar with. But it would appear that *some* penetration must ensue. On very cold ice, 'hollow-ground' skates will have the advantage.

"This explanation of the phenomena attending skating assumes that the skater, in fact, glides about on a narrow film of water, the solid turning to water wherever the pressure is most intense, and this water, continually forming under the skate, resuming the solid form when relieved of pressure."

J. Joly.

Geological Laboratory, Trinity College, Dublin.

Mammalian Longevity.

The letter of Dr. Ainslie Hollis in Nature of January 5, on "The Curve of Life," shows that the ratio existing between the periods of maturity and the periods of after-life in various mammals are capable of projection in a regular curve. This led me to inquire if the ratios might not be capable of reduction to a general formula. This seems to be the case, the statement being as follows:—

The full term of life in a mammalian species is equal to ten and a half times the period of maturity divided by the cube root of the period (of maturity), that is

$$\text{f. t. l.} = \frac{10{\cdot}5\,(\text{p. m.})}{\sqrt[3]{(\text{p. m.})}}, \text{ or } 10{\cdot}5 \times (\text{p. m.})^{\frac{2}{3}}$$

in which f. t. l. is the full term of life, and p. m. the period of maturity.

By the full term of life is meant the period that the animal would live, supposing that its existence were not shortened by enemies, accidents, disease, starvation, overwork or nervous strain; and that it passed out of life by senile decay. This, of course, simply represents an average. It is generally accepted that the period of maturity is best measured by finding the age at which the epiphyses are united to the skeleton. It seems to be about from one and a half times to twice the period of puberty: one and two-thirds and twice seem common proportions. Man, for example, arrives at puberty at about fifteen, and is mature at twenty-five; the lion and tiger arrive at puberty at three years, and are mature at six.

A table is given below, showing the periods of maturity and the full terms of life as obtained from the observations of breeders, scientific men, &c.; and, for purposes of comparison, the full terms of life as calculated by the formula from the same periods of maturity. It will be seen that the two agree as closely as could be expected, especially when we bear in mind the difficulty of fixing with precision the normal life of a species, whose individual members will often die at widely differing ages, from different causes. Hence the different results obtained in many cases by different observers.

The approximation of the results of observation and the formula will be noticed. Blaine on the horse, is from the "Encyclopædia of Rural Sports." He seems to have studied the subject of the horse's age very closely. He says: ". . . a horse of five years may be *comparatively* considered as old as a man of twenty; a horse of ten years, as a man of forty; . . . and of thirty-five years, as a man of ninety." Up to ten years of age, then, the horse counts one year proportionately for every four of man, and as man's maturity takes place at twenty-five, this makes the horse's to occur at six and a quarter years. The full term of life given as equivalent to a man of ninety, thirty-five years is almost identical with the result of the formula. Darwin's observations on the elephant are from the "Origin of Species," where he discusses the increase of animals. The other references are from the works of various writers. It should be pointed out in connection with the dormouse, that Dr. Ainslie Hollis gave its full term of life as four years in Nature and four and a half in the *Lancet* of January 21.

Ernest D. Bell.

The editor of Nature has kindly forwarded me Mr. Ernest D. Bell's letter before publication. The formula therein stated is interesting, as it confirms the opinion, given in my previous letter on the subject, that a relationship exists between the duration of adolescence and the length of a mammal's life. Since the publication of the curve of life in Nature, I find that the following domestic animals can be added to those already given. They conform to the requirements of the curve very closely, as may be seen:—

	Observed length of adolescence.	Length of Life. Observed by curve		Computed by form.
Guinea-pig ...	7 months	6–7 years	7 years	7·33 years
English greyhound	1 year	12 ,,	12 ,,	10·5 ,,
Cat (Mivart) ...	1 ,,	12 ,,	12 ,,	10·5 ,,
Cat (Jennings) ...	2 years	15 ,,	18 ,,	16·67 ,,
Hog	5 ,,	30 ,,	31 ,,	30·7 ,,
English hunter ...	6¼ ,,	35 ,,	35 ,,	35·63 ,,

The age at which growth ceases in man differs considerably in different individuals of the same race. Otto observed all the epiphyses separate in the skeleton of a man, aged twenty-seven years (South's "Pathological Anatomy," p. 126). Such a skeleton could not have completed its growth for another ten or twelve years. The man, had he lived, might have truthfully posed as a youth when he was on the verge of forty. I have in skiagrams observed a difference of upwards of three years in the ages of different subjects, at which osseous union of the epiphyses to the finger-bones was effected. As the age of

Animal.	Observations. Authority.	p. m. Months.	p. m. Year. / Years.	f. t. l. Years.	f. t. l. by formula. Years.	Other observations. f. t. l.	Authority.
Dormouse	Ainslie Hollis	3	·25	4–5	4·167	—	—
Guinea-pig	Flourens	7	·583	6–7	7·33	—	—
Lop rabbit—							
Buck	R. O. Edwards, p. m.	9	·75	8	8·67	8	Flourens
Doe	,, ,, p. m.	8	·667	8	8·013	8	,,
Cat	St. G. Mivart		1	12	10·5	—	—
Cat	J. Jennings		2	15	16·67	—	—
Goat	Pegler		1·25	12	12·18	—	—
Fox	St. G. Mivart		1·5	13–14	13·76	—	—
Cattle	Ainslie Hollis		2	18	16·67	15–20. 14	Flourens. Gresswell
Large dogs	Dalziel, p. m.		2	15–20	16·67	—	—
English thoroughbred horse	Ainslie Hollis		4·5	30	28·62	—	—
Hog	James Long		5	30	30·7	—	—
Hippopotamus... ...	"Chambers's Encyclopædia"..		5	30	30·7	—	—
Lion	St. G. Mivart		6	30–40	34·67	—	—
English horse—hunter	Blaine		6·25	35	35·63	—	—
Arab horse	Ainslie Hollis		8	40	42·00	—	—
Camel	Flourens		8	40	42·00	40–50	Grindon
Man	Buffon, f. t. l.		25	90–100	89·77	90–100	Flourens
Elephant	Darwin		30	100	101·4	—	—
Elephant	C. F. Holder and Indian hunters		35	120	112·35	120	De Blainville

twenty-five years for man's cessation of growth is therefore only an average one, in introducing that number as a factor of the curve, I thought that it would be manifestly an error to take examples of exceptionally long lives, when striking an average for length of life. In the curve as published in NATURE (which, although published somewhat before my communication to the *Lancet*, is really a revised curve), I reduced the age of man from eighty to seventy-five years from considerations such as I have just mentioned. Even seventy-five years is somewhat greater than the expectation of life given in Bourne's "Manual," for those who have completed the first half-century of their existence. The age given by Buffon, and quoted by Mr. Bell, is undoubtedly far too long. Similar considerations from some fresh data induced me to reduce the mean lifetime of the domestic mouse from four and a half years to four years, as noticed by Mr. Bell. W. AINSLIE HOLLIS.

Hove.

Barnes' "Plant Life."

In re centrosomes:

Poor misguided Prof. Zacharias! With absolutely no provocation, he now departs from "the almost universal consensus of opinion among good botanists" by saying of centrosomes (*Bot. Zeit.*, 572: 6, 1899):

"However, on an unprejudiced consideration of the literature involved, one may consider it not impossible that, on renewed search, the centrosomes will finally be again discovered where, for the present ('mark, Jew!'), they have been missed."

And Guignard! What a stupid he is to repeat in greater detail the blunder of figuring and describing those "discredited" centrosomes when all *good* botanists (who swear by Strasburger and his young American students) know that there are no such things! And to think of his calling them "Les centres cinétiques chez les végétaux" (see *Annales des Sci. Naturelles, Bot.*, viii. 5, 177–220, 1898), as though they were common! How "amazingly behind the times"!

But there must be more reason than assigned for designating "Plant Life" as "amazingly behind the times." Prof. Barnes would really be under obligations to the reviewer if he could find time to indicate by number of page or paragraph (doubtless marked as the book was yawned over) the statements to which he considers this phrase applicable. This request is made in all sincerity, and in the hope that the number of these passages will not be so great as to make it presumptuous in its demands upon the reviewer's time. C. R. BARNES.

THE reviewer cannot help regretting the evident pain which his remarks (vol. lviii. p. 519) have caused Prof. Barnes, though the latter can scarcely seriously believe that his arguments and assertions meet the original objections to which he has taken exception.

Prof. Barnes appears to be particularly aggrieved at the reference made to the figures and account of centrosomes, but his own explanations merely serve to give force to the reviewer's contention that they ought not to have found a place in an elementary book at all.

If the best final reply he can make is to quote the opinion of Zacharias to the effect that "it is not impossible that on renewed search the centrosomes will finally again be discovered," he should see that his case is parlous indeed. He has, in fact, cast a far greater slur on his own critical judgment than the reviewer would have ventured to do. His further quotation of Guignard's recent work might perhaps be regarded as somewhat *ex parte*, even had that investigator reiterated the old statements on which Prof. Barnes' account was based. As a matter of fact he does not do so, and his silence tells against our author.

The somewhat contemptuous reference to Strasburger (who is nevertheless *facile princeps* amongst botanical cytologists) and to those younger American botanists whose reputations, *pacè* Prof. Barnes, are largely founded on the splendid results achieved by them at Bonn, are scarcely calculated to increase one's regard for Prof. Barnes' power of discrimination.

Prof. Barnes appears to be quite unable to realise the degree of mental confusion which would be the inevitable lot of a student endeavouring to deal with the account given by him of the movement of water in plants. In one place (§ 204) root-pressure is spoken of as the force which causes the movement from the root to the evaporating surfaces of the leaves; but in § 207 the author rightly remarks that root-pressure is practically inoperative at the time when transpiration is most active. But he goes on to add that "recent experiments" indicate that the negative pressure of the gas-bubbles in the tracheids may be "a very important, or even the chief factor in lifting the water." After this one ceases to be surprised that no mention is made of the conclusions reached by Dixon and Joly, or by Askenasy!

But Prof. Barnes asks for further evidence for the reviewer's unfavourable opinion of the book. Only a few instances need be mentioned here, for if "this request is made in all sincerity," the author's own friends will easily supply more.

In a work of this kind, it is astonishing to find no mention of the occurrence of motile antherozoids amongst the lower phanerogams, which is perhaps the most important of all recent botanical discoveries—important for the student as clearly showing the connection between the higher and lower plants.

The account given in § 143 of annual rings is so preposterous as to call for no further comment.

The respiratory quotient of the ordinary plant is still given as unity, when, as a matter of fact, it is nearly always other than 1 in growing plants.

The statement that "true geotropic curvatures are brought about by the acceleration of the growth of the irritable cells" is, as it stands, absurd, for it involves no necessary *curvature* at all.

A student reading the account given in § 230 would naturally fall into the error of concluding that all the rays of light absorbed by chlorophyll are equally active in promoting assimilation.

In view of the evidence here adduced, at Prof. Barnes' own request, the reviewer considers that his judgment of the book was by no means unduly harsh or severe.

THE REVIEWER.

Optical Experiment.

BEING driven past a row of trees, I noticed that their intermittent shadow on the closed eye-lids gave rise to a vivid chess-board pattern of red and black squares arranged horizontally and vertically. These were perfectly regular, each being equal to about one-twelfth of an inch at ten inches distance. Waving the open fingers in front of the closed eye-lids exposed to the sun gave the pattern fairly well, but better by flashing the sun's rays across the lids by means of a vibrating hand-mirror. I see about seven or eight squares each way, the outer ones not well defined; but a younger man, who was not told what to expect, described them as more numerous.

What structure in the eye gives rise to the phenomenon? It is not caused by the eye-lids, because a piece of tissue-paper can be substituted, the eyes then being open. If the paper is white the squares are white and black. The pattern occupies the centre of the field of each eye. THOM. D. SMEATON.

Adelaide, South Australia, February 6.

A SEISMOLOGICAL OBSERVATORY AND ITS OBJECTS.

TEN years ago seismologists practically confined their attention to the movements of the ground which could be felt. In Italy and Japan, where these were frequent and sometimes violent, they attracted serious attention; whilst in Britain, where earth tremors were comparatively unknown, any suggestion that this country should establish a seismological observatory might only have cast doubts upon the mental balance of its author. At that time it was popularly supposed that in our islands earthquakes were of such rare occurrence that a special establishment for seismological investigations was unnecessary. Seismology, however, like several other sciences, has in a comparatively short period advanced with strides, and now stands as foster-mother not only to a Romulus and Remus, but also to a number of other children all filled with promise.

Now we know that in England, or in any other non-seismic region on the surface of the globe, at least seventy unfelt earthquakes, each of which have durations varying between twenty minutes and several hours, may be recorded yearly. The probability is that these movements are transmitted from their origins as compressional and distortional vibrations through our globe, and the rate of transmission of the former is closely connected with the average depth of the path along which they have travelled. When our observations on these movements are more exact and numerous, we shall then know more than we do at present about certain physical characteristics of the planet on which we live.

At Utrecht, Potsdam and Wilhelmshaven, these unfelt movements frequently correspond in time with well-marked perturbations of magnetic needles, but inasmuch as similar needles are not disturbed at other stations, we are not quite certain that the observed irregularities in magnetograms are altogether the result of mechanical disturbance.

Then, again, we have the curious observation that at certain magnetic observatories prior to great earthquakes originating in their vicinity there have been uneasy movements in magnetic needles. When considering whether these observations are merely accidental coincidences, we must remember that the initial impulse or impulses of these disturbances have been sufficient to cause our world to palpitate from pole to pole, that they have sometimes been accompanied by bodily displacements of material sufficiently large to set the Pacific Ocean in a state of oscillation for many hours, and that the displaced material is in every probability highly charged with magnetite. We do not know the nature of the changes which were taking place in this material before its rupture, but we see in the final movement a possibility of sudden local magnetic disturbance.

Other possible connections between the movements of magnetic needles and those of horizontal pendulums lie in the facts that each have diurnal movements, and each may exhibit continuous or nearly continuous movement. The diurnal movements of horizontal pendulums are closely connected with effects accompanying solar radiation. The late Dr. Reinhold Ehlert, of Strassburg, saw in some of these a world distortion; whilst in others, my own observation leads to the supposition that their explanation is to be found in changes of surface-load brought about by evaporation, condensation, precipitation, and transpiration of moisture. To account for the almost unbroken continuity of earth tremors we are at a loss; but when we remember that in the world there is upon the average an earthquake occurring every half-hour which might be recorded, that probably there are many taking place beneath the sea and deep in our earth which are never felt, it does not seem unreasonable to look for their explanation in the vibrations accompanying these frequent adjustments in operation within the earth. If it is admitted that these continually moving materials are magnetic, not only do they suggest an explanation for the minute sinuosities on magnetograms, but they also indicate a possible relationship between hypogenic geological activity and secular magnetic changes.

In Japan, built up as it is round a core of rocks saturated with magnetite, which in their deeper portions are intensely hot, and therefore probably possess a reduced magnetic susceptibility, these earth tremors are apparently, and as we should expect them to be, more pronounced than they are in England or Europe. As to whether the *frétillements* on the magnetograms from that country are more frequent and distinct than those taken under similar conditions in non-volcanic countries, I leave to be answered by those who have the means of making the necessary comparisons.

That the records from a seismological observatory throw light upon sudden movements of magnetic needles at certain observatories is an established fact; but whether the bond connecting magnetic observations and those obtained by the seismologist is closer than is usually admitted, is apparently a matter worthy of consideration.

From a series of seismograms obtained from different stations we should be in a position to locate the site of sub-oceanic changes, and determine positions to be avoided by the cable engineer. A single seismogram may often set our minds at rest as to the cause leading to cable interruption, a matter of special importance to isolated Colonies, whilst it has repeatedly been the means of extending, confirming, or disproving ordinary telegraphic information. Another class of observations to which the seismologist devotes his attention are those indicating secular, seasonal and irregular changes in the vertical, which are of importance to the astronomer, earth pulsations and a variety of instrumental movements, the cause of which is not yet clear.

Although all the above-mentioned investigations can be carried out at a single observatory, the results to which they lead are by no means of equal value. For example, should we wish to know the velocities with which the vibrations of a given earthquake have been propagated along various paths through our earth, it is evidently necessary to have the means of making comparisons between seismograms obtained from similar instruments at widely separated stations. It is a pleasure to state that the necessary co-operation here indicated has been obtained, and in response to an invitation issued by a Committee of the British Association, the directors of observatories at the following places have kindly undertaken to make the necessary observations: Kew, Paisley, San Fernando (Cadiz), Cairo, Beirut, Cape of Good Hope, Mauritius, Madras, Calcutta, Bombay, Batavia, Tokio, two in New Zealand, Cordova (Argentina), Honolulu, Victoria (B.C.), Toronto, Philadelphia, Arequipa, Mexico, Trinidad. Certain of these are already sending in records.

What is now required in Great Britain is not simply a central office where these records can be examined, but also a station at which a variety of seismological observations can be made which will be comparable with the records from corresponding instruments similarly installed in other localities. As illustrative of this, although it would be extremely interesting to note the varying effects of barometrical pressure upon the plains of Lincolnshire, and to compare the magnitude and period of earthquake waves as recorded there with those recorded on a rocky surface, it is extremely probable that the records of diurnal waves from such surfaces, or in fact from any two, but different alluvial or soft foundations, would only yield results of local value. Any haphazard selection of a site for a laboratory might take us to a place where we might find an apparent diurnal or other variation in gravity, and where the same gold bead upon an assayer's balance rapidly changing its zero, might appear to have a different weight at different times. Then, again, if we wish to study the continuous trembling of our earth, we require to be on solid materials at least half a mile from a railway, and some distance from any source of artificially produced vibration. If in addition to this it should ever be found desirable to obtain a highly magnified record of the movements of a magnetic needle, it is obvious that we must be far removed from the possibility of electrical disturbance.

What is required, and especially for earthquake recording, is a platform or foundation which continues downwards as a uniform mass into the interior of the earth. Such conditions may probably be met with upon certain granite bosses, but it is likely that the greatest continuity would be found upon an old volcanic neck, of which we have very many illustrations in these islands. Although these are mere *coup d'épingles* in the crust of our earth, it is not unlikely, especially when their lateral dimensions increase with depth, that they convey more vibrational energy to the surface than is conveyed through discontinuous sedimentary strata.

If in connection with diurnal waves we wish to record sunshine, or to note the rise and fall of stars or distant objects as seen through a telescope at the time of large earth waves, the station should command, especially in an east and west direction, a fairly extensive horizon.

Inasmuch as an observer may, as a means by which "air tremors" can be destroyed, require in one of his rooms a copious ventilation with a minimum of dampness, a precaution of some importance is not to ignore the hygrometric conditions of a locality.

A good site having been found, the remaining requirements for a seismological observatory are small. All that is necessary is a small one-storied structure. It should contain one or two large rooms in which to place some half-dozen instruments, and three small rooms to be used respectively as an office, a workshop and a dark room.

In Italy there are fifteen observatories of this order, and a very large portion of the work is to record movements of the earth's crust, which can be equally well recorded in England. At Strassburg, which is as free from earthquakes as any town in England, a seismological observatory, costing 3500*l.*, with an annual grant for maintenance of 275*l.*, is being erected. Austria and Germany are establishing stations, whilst the great work which for years past has been carried out in Japan is too well known to require restating.

In conclusion, when we consider that the observations made at a seismological laboratory are connected with those made by the meteorologist, the geologist and the astronomer, that they suggest problems to the elastician, shed light upon perturbations of magnetic needles, are of direct importance to the cable engineer, and in the interpretation of certain telegrams, and that in many other directions they are of value both scientifically and practically, it seems strange, especially in the face of the hearty co-operation we have received from abroad, that this country is yet without a definite centre at which these observations can be carried on.

JOHN MILNE.

SATURN'S NINTH SATELLITE.

ON Saturday last, March 18, the astronomical world, somewhat recovering from the excitement incident to the discovery of the remarkable asteroid now named Eros, was again pleasantly surprised by the news of another "find," distributed by telegram from the Central Astronomical Bureau at Kiel. This time it is the planet Saturn which supplies the feature of interest, in that an addition to its already numerous family of attendant satellites has been discovered by Prof. William H. Pickering, assistant astronomer at Lowell Observatory, Flagstaff, Arizona. The name of this station will be familiar to all in connection with the many notable observations of the planet Mars which have been made there by Mr. Lowell, its director, with the 24-inch refractor. Most of this work is so delicate as to need the best conditions for seeing, and it is only the extremely favourable situation of this observatory which has rendered them possible. This is probably to be attributed to the extreme transparency of the air consequent on the high altitude above the sea-level.

The new satellite has been run to earth, as it were, by photography. On examination of four photographs of Saturn, Prof. Pickering found traces on each of a very faint object, the behaviour of which led him to consider it to be a satellite of the planet. The little stranger is estimated to be of the 15th magnitude, so that it is unlikely that it would ever have been discovered by visual observation, even in the huge instruments now at the disposal of our leading astronomers. Measurements of the coordinates of its position from the four plates have furnished the data for computing its period or time of revolution round the parent planet, and this is found to be about *seventeen* months. This indicates that it will take its place as the outermost of the nine satellites, the period of Japetus, the furthest from Saturn of the known ones, being only about 79⅓ days. While the distance of Japetus is 2,225,000 miles, that of the new moon will therefore be about 7,500,000 miles, and this, combined with its extremely slow motion, all tended to diminish the chances of its detection by the usual method of tracking non-stellar objects by the elongated trails they leave on the photographic plate, the stars being shown as symmetrical round dots.

It is interesting to note how the gradual discovery of the attendants of the various planets has influenced the compounding of the "laws" which from time to time have been found to approximately represent the positions of these bodies in the solar system. From the first discovery of Jupiter's four satellites by Galileo in 1610 to the recognition of the already known eight of Saturn by Huyghens, Cassini, and Sir W. Herschel, no regular relationship was perceived. When, however, in August 1877, Prof. Asaph Hall discovered the two moons of Mars, Deimos and Phobos, with the newly-erected 26-inch refractor of the United States Naval Observatory at Washington, it was seen that all the then known satellites were grouped in a geometrical progression, reckoning outwards from the Earth. Thus the Earth had one, Mars two, Jupiter four, and Saturn eight. This seeming regularity was broken by the discovery on September 9, 1892, of a fifth satellite to Jupiter by Prof. E. E. Barnard at the Lick Observatory. This last discovery of a ninth satellite for Saturn will furnish a reason for a new series being formed, as counting from the Earth outward from the Sun, the numbers of satellites to the planets Earth, Mars, Jupiter, and Saturn are now 1, 2, 5 and 9 respectively, and these numbers are very nearly proportional to the distances of those planets from the Sun.

No information is yet to hand as to the diameter of this newly-found member of the solar system. From its brightness it may be from 100-200 miles, but its measurement will be extremely difficult.

The importance of photography in astronomical research is very well illustrated in the case of this event. Although it might be possible to see the satellite under good conditions, it is easy to understand how many times such an insignificant object might be passed over among so many more prominent ones. Once it has impressed its image on a photographic plate, however, it is caught, and its detection is sure, sooner or later, on complete examination of the negative. Then the possibility of duplication removes all doubt of personal error of any kind. Another advantage of the photographic plate over the eye is that the longer it is exposed, so much fainter objects will it record; while, on the other hand the eye only becomes more fatigued the longer it is used in the search.

It should be instructive to notice how most of the astronomical discoveries of late years hail from across the Atlantic. Whether it is that the love of science is more generally developed there, or that the liberal endowment of a scientific institution is considered the most serviceable way of handing one's name down to posterity, it is certain that in the establishment of the Harvard College, Lick and Yerkes Observatories the American people have placed themselves ahead in astronomical matters; and there is little doubt that they are well satisfied with the results obtained by means of their liberality.

A later telegram to the *Standard* states that the discovery was made with the Catherine-Bruce telescope, an instrument of large aperture and short focal length.

C. P. BUTLER.

NOTES.

WE regret to see the announcement of the death of Prof. O. C. Marsh, the distinguished palæontologist of Yale University.

THE French Minister of Public Instruction has nominated Prof. Poincaré president of the Bureau des Longitudes; M. Faye, vice-president; and Prof. Lippmann, secretary.

THE annual meeting of the Iron and Steel Institute will be held on Thursday and Friday, May 4 and 5, commencing each day at 10.30 o'clock a.m. The President-elect (Sir William Roberts-Austen, K.C.B.) will deliver his inaugural address; and papers promised by Prof. J. O. Arnold, Mr. H. Bauerman, Mr. E. Disdier, Messrs. Jeremiah and A. P. Head, Baron H. von Jüptner, Prof. H. Louis, Mr. Bertrand S. Summers, and Prof. Wiborgh are expected to be read and discussed. The annual dinner of the Institute will be held in the Grand Hall of the Hôtel Cecil on May 4. The autumn meeting of the Institute will be held in Manchester on August 15–18.

A DINNER which took place at the Fishmongers' Hall on March 14, possesses especial interest to us, on account of the fact that it was given in honour of science, and that the guests included a great number of scientific men, among them being the Presidents of the following Societies and scientific bodies: Royal, Royal Horticultural, Royal College of Physicians, Royal Geographical, Dermatological, Royal Microscopical, Victoria Institute, Royal Statistical, Royal College of Surgeons, Royal Astronomical, Zoological, Linnean, Chemical, Entomological, Philological, and Clinical. The toast of the evening was "Science," and was proposed in an eloquent speech by the Prime Warden, Mr. J. A. Travers, who pointed out the great advance science had made in the last twelve years; he recommended, further, the special study of preventive medicine, to ensure for Great Britain a safer footing in foreign climates. Lord Lister responded to the toast, and urged City Companies to support pure science; he referred also to the help they had rendered the Jenner Institute. Sir William MacCormac then proposed the health of the Prime Warden. The occasion is noteworthy in that it indicates the growing recognition of the value of scientific work.

ON March 18 the Austrian Society of Engineers celebrated its jubilee in the Municipal Council Chamber, Vienna, under the presidency of Mr. F. Berger. There was a large attendance of members; and representatives of sixty-six kindred societies presented addresses. Congratulatory speeches were delivered by the Austrian Minister of Railways, the Minister of Commerce, the Governor of Lower Austria, the Secretary of the Iron and Steel Institute, London, the Secretary of the French Society of Civil Engineers, Paris, and the Secretary of the Society of German Engineers, Berlin. A paper was then read by Mr. A. Rücker on the part taken by the Austrian Society of Engineers in the technical progress of the past fifty years. The Austrian Society is a very influential one. At its foundation in 1848 it numbered seventy-nine members; at the present time there are 2388.

DR. J. N. LANGLEY, F.R.S., University Lecturer on Histology, Cambridge, has been elected a member of the Athenæum Club under the provisions of the rule which empowers the annual election by the Committee of nine persons "of distinguished eminence in science, literature, the arts, or for public services."

THE anniversary meeting of the Chemical Society will be held on Wednesday, March 29, at 3 p.m. Prof. Dewar has presented to the Society a daguerreotype of Dalton, the portrait being one of two taken in 1842. In expressing thanks for the gift on behalf of the meeting at which Prof. Dewar announced his intention of presenting the daguerreotype to the Society, Prof. Tilden remarked that he believed that the well-known portrait of Dalton engraved by Jeans, and appearing as the frontispiece in Roscoe and Schorlemmer's "Treatise on Chemistry," was prepared from a drawing made from this daguerreotype.

FATHER R. P. COLIN, known for his cartographical works on Madagascar, has been elected a correspondant of the Paris Academy of Sciences, in the section of geography and navigation.

THE Paris correspondent of the *Times* states that the French Minister of Agriculture has created at the Agronomic Institute a chair of biology of plants cultivated in France and her Colonies.

THE steamer *Southern Cross* has arrived at Port Chalmers, New Zealand, from Victoria Land, with Mr. Borchgrevink and the other members of the Antarctic expedition under his charge.

PROF. DUCLAUX, director of the Pasteur Institute at Paris, has had the honour of the second class of the Osman Order conferred upon him by the Sultan.

THE New York Academy of Sciences will hold its sixth annual exhibition in the American Museum of Natural History on April 11 and 12. The exhibition will illustrate the advances in various departments of science during last year.

A DEPUTATION of the Decimal Association to the President of the Board of Trade, in favour of the compulsory adoption of the metric weights and measures in this country, was arranged for yesterday as we went to press.

THE Associated Chambers of Commerce passed the following resolution at one of their meetings last week:—"That, in view of the time wasted in teaching a system of weights and measures which, according to the First Lord of the Treasury, is 'arbitrary, perverse, and utterly irrational,' and in the opinion of Her Majesty's Consuls is responsible for great injury to British trade, this association urges Her Majesty's Government to introduce into and endeavour to carry through Parliament as speedily as possible a Bill providing that the use of the metric system of weights and measures shall be compulsory in this country within two years from the passing of the Bill, and suggests that meanwhile the system should be adopted in all specifications for Government contracts."

THE proposal to place in Corsock Parish Church, by half-guinea subscriptions, a memorial window in memory of Prof. James Clerk Maxwell has already been referred to in these columns. A correspondent informs us that, to complete the window, about 40*l.* more is required. There should be no difficulty in obtaining this amount from admirers of Clerk Maxwell who have not yet subscribed. Subscriptions may be sent to Rev. George Sturrock, The Manse, Corsock, by Dalbeattie, N.B.

A QUESTION was asked in the House of Commons on Thursday as to when the North Sea Fisheries Conference would get to work, how the conference would be constituted, and what instructions would be given to it, In reply Mr. Brodrick said: "The Foreign Office are quite aware of the urgency of this question, and have urged the Swedish Government to hurry on the assembly of the conference. The conference will meet in the month of May, and delegates will be sent by the various Powers concerned. This question will be considered by experts and by practical men sitting together. The programme of the conference is now before Her Majesty's Government."

THE report of the Council of the Scottish Meteorological Society, presented at the general meeting of the Society yesterday, mentions, among other matters, that the observations at the two observatories on Ben Nevis are now ready to go to press, down to December 1896, together with a general discussion of the results, and several other discussions of separate important inquiries raised by the observations. A paper on the meteorology of Ben Nevis, accompanying the hourly observations, was read by Dr. Buchan at the meeting of the Royal Society of Edinburgh on March 6. Among the papers in the number of the Society's *Journal* to be published during the coming summer will be a discussion of the annual rainfall of Scotland from the beginning of the century to 1898, with tables giving the annual amounts at many stations from which long-continued observations are available. Another paper will be a discussion of the observations on fog, made at the Scottish lighthouses for the ten years from 1889 to 1898. The heavy and tedious work of charting on daily maps of Scotland the rainfall at 120 stations, the fog at the lighthouses, the storms of wind reported at the lighthouses as having actually occurred, along with the phenomena of weather noted at the Society's stations, proceeds apace, and already about a year and a half of this work may be regarded as completed. This means the construction of 487 maps, specimens of which were shown to the meeting. Grateful reference is made to the gift of 500*l.* by Mr. J. Mackay Bernard, of Kippenross, for the high- and low-level observatories at Ben Nevis. As the result of this patriotic beneficence, the work of the two observatories is still being carried on by the directors.

THE death of Mr. Jeremiah Head, on March 10, deprives the engineering profession of one who has played an important part in mechanical science during the middle and latter part of this century. From an obituary notice in the *Times*, we learn that Mr. Head was born at Ipswich in 1835, being a descendant of an old Quaker family, and was apprenticed in 1854 to Robert Stephenson at Newcastle-on-Tyne. During the term of his indentures he so distinguished himself that when out of his time he was taken on the designing staff of the great civil engineer. In the year 1864 Mr. Head became a partner in a business for the manufacture of iron plates, and after spending twenty years in it, the works were sold to another firm, and Mr. Head became a consulting engineer. With his son he did some notable work during the last few years in bringing before the notice of British steelmakers some of the more important advances that have been made in America in the manufacture of iron and steel. In 1896 he read a paper before the Institution of Civil Engineers on the American and English methods of making steel plates; and so lately as last month he and Mr. A. Head contributed a joint paper to the same institution on the "Lake Superior Iron Ores." These two papers were a revelation to a large number of people in this country, who had not realised how rapidly the Americans were forging ahead in the production of iron and steel, and the many improvements that had been introduced into Transatlantic practice. Mr. Head was president of the Institution of Mechanical Engineers during the years 1885-86, when the institution was passing through a very critical period of its existence. In 1893 he was president of the Mechanical Science Section of the British Association. He was a member of numerous technical and scientific societies, including the Institution of Civil Engineers. He founded the Cleveland Institution of Mining Engineers in the early sixties. Although this is but a local society, it has had great influence on the iron and steel industry of the kingdom, and has been instrumental in causing the Cleveland district to be considered the centre of the British iron industry.

AGAIN the world's record for kite-flying for scientific purposes has been broken at the Blue Hill Observatory, Massachusetts. On February 21 an altitude of 12,440 feet was reached by a recording instrument attached to a string of tandem kites. This is 366 feet higher than the preceding best record. The flight was begun at 3.40 p.m., the temperature at the surface being 40° and the wind seventeen miles an hour. At the highest point the temperature was 12° and the wind velocity fifty miles an hour. Steel wire was used as a flying line, and the kites, four in number, were of an improved Hargreave pattern, with curved surfaces, made after the pattern of soaring birds' wings. The upper kite carried an aluminum instrument weighing four pounds, which recorded graphically temperature, wind velocity, humidity, and atmospheric pressure. The combined kites had an area of 205 square feet and weighed twenty-six pounds, while the weight of the wire was seventy-six pounds. The upper kite remained above two miles for about three hours.

CHARCOAL has been used for many years in Australia to precipitate gold on a large scale from its solution as chloride, and it is doubtless this circumstance which has led to its employment in Victoria to precipitate gold from cyanide solutions. In a paper by Mr. J. I. Lowles, read at the meeting of the Institution of Mining and Metallurgy on March 15, the details and results of the process are given, from which it appears that the expense and inconvenience are far greater than in zinc or electrolytic precipitation. At a typical cyanide mill in Victoria, 10,000 lbs. of charcoal contained in 198 tubs are in constant use to precipitate 700 ozs. of gold per month. To recover the gold the charcoal is burnt, and the ash melted with borax in crucibles. In the course of the month about 8 cwt. of ash is melted with 16 cwt. of borax, the total cost being over 1*s.* 6*d.* per oz. of bullion 900 fine, exclusive of the waste of cyanide which occurs as the solution passes through the charcoal. The chemical interaction involved in the precipitation is not understood.

DR. ALEXANDER AGASSIZ'S munificent gifts of natural history collections to the Museum of Comparative Zoology of Harvard University have already been mentioned in these columns. In the annual report of President Eliot an extract is given from the records of the Corporation of the University, in which the Corporation specify the gifts and express gratitude for them. It appears from this that Dr. Agassiz has never received any salary for his services to the museum in various capacities since 1860. Between September 1, 1871, and September 1, 1897, he expended for the benefit of the museum from his private means, without making any communication on the subject to the President and Fellows, over seven hundred and fifty thousand dollars, including his expenditures on objects now formally transferred to the Corporation, beside contributing about fifty thousand dollars to other university objects in gifts known at the time to the President and Fellows. Dr. Agassiz has thus shown, by devoted service and generous benefactions, his deep concern for the welfare of the museum in which his distinguished father took so great an interest.

THE last *Bollettino* (vol. iv. No. 7) of the Italian Seismological Society contains a valuable study, by Dr. A. Cancani, of the Adriatic earthquake of September 21, 1897. This was by far the strongest earthquake felt in Italy during that year, its disturbed area containing about 235,500 sq. km. The origin, as shown by the isoseismal lines and the observed directions of the shock, lay beneath the Adriatic, about 20 km. from the coast between Pesaro and Ancona. At least two distinct kinds of undulations were perceptible, even without the aid of instruments—namely, rapid vibrations with a period of from $\frac{1}{7}$ to $\frac{1}{4}$ a second, and slow oscillations with a period about ten times as long. Within the disturbed area, the earthquake-wave travelled with a velocity of 1·6 km. per second, and, beyond its boundary, as far as Utrecht (1050 km.), with a mean velocity of 3·6 km. per second. Dr. Cancani regards the earthquake as one of a series, probably connected with the bradyseisms of the Adriatic coast of Italy, the existence of which has been proved by Issel; and he points out that the stronger earthquakes of the series appear to recur at intervals of about a century, and others at an average interval of about twenty-three years.

THE Meteorological Council have just issued their report for the year ending March 31, 1898; the considerable delay in the date of publication is due to the form of first submitting it to the Council of the Royal Society and its subsequent presentation to Parliament. The Council continue as in past years to collect data relating to the meteorology of the ocean, and to supply instruments to the Royal Navy and to observers in the Mercantile Marine. The investigations in progress in this branch during the year in question were (1) the meteorology of the Southern Ocean, between the Cape of Good Hope and New Zealand, and (2) the meteorology of the South Atlantic and the west coast of South America. Statistics as to the climates of foreign ports are from time to time supplied to the Admiralty for use in various publications. The results of the forecasts which appear in the morning newspapers show a complete or partial success of 81 per cent., the average for the last ten years being 81·3 per cent., while the results of the special forecasts issued during haymaking season show that 90 per cent. were useful. The success obtained for the storm warnings issued to seaports reached the high figure of 91·8 per cent. In the branch relating to climatology, hourly means of observations made at the principal observatories, and results of the observations at stations of the second order, have been published in the same form as in previous years. Among the miscellaneous investigations, the important subject of anemometry has occupied a prominent place, and the subject of atmospheric electricity has been brought under consideration with a view to utilise the records that have been made at Kew Observatory for many years past.

THE Council of the Essex Field Club appeal to those taking an interest in the spread of information on natural science, and in popular education, for donations towards the capital sum of 1000*l.* required for the equipment of the Essex Museum of Natural History at Stratford. It will be remembered that the first stone of this museum was laid in October last. The cost of the building and ground will be about 6000*l.*, towards which Mr. Passmore Edwards contributes 2500*l.*, on condition that the museum shall contain the Essex Field Club's county collections of natural history. The balance of the cost, and the upkeep of the building, will be defrayed by the Corporation of West Ham, acting through their Technical Instruction Committee. The fitting-up of the museum with cabinets, cases, jars, boxes, &c., to contain the various collections, and the numerous and expensive appliances of an educational collection, has to be undertaken by the Essex Field Club, and it is to provide this equipment that the Club makes an appeal to its members and others interested in the extension of scientific knowledge.

AT the meeting of the Anthropological Institute, on February 14, Mr. H. P. Fitz-Gerald Marriott read portions of a lengthy and very complete paper on the secret tribal societies of West Africa. He said that they were merely tribal developments, and not bands of conspirators. He described some of them, such as the Purroh and Kofong, referring to their ritual and dress; but he made known for the first time the few harmless religious societies of the Gold Coast which are unknown to local white residents, not being so highly developed as those in the Sierra Leone or the Niger districts. The societies appear to present a good example of what is generally the case throughout the world, in that the highest grades as a rule are the simplest in externals. Mr. Marriott finished his paper by mentioning a widespread Egyptian or Arabian society called Siri, which existed for the study of magic and occult matters; it had ramified itself all over the western portion of Africa; it is a key to the study of the tribal societies, and it has probably much influenced them. There were also reasons stated to show that monotheism existed in certain portions of Central Africa. The tribal societies must not be confused with murderous leopard societies, which natives themselves regard as we do anarchists; but beyond the civilised boundaries, in many parts where the tribal society was strong, it could be employed for such objects as obtaining labourers, carrying out British laws and other laudable objects by a channel to which the natives were accustomed.

THE Geological Survey of England and Wales has just issued an important practical Memoir on "The Water Supply of Sussex," by Mr. William Whitaker, F.R.S., and Mr. Clement Reid (price 3*s.*). The work deals with the supply of water from underground sources, and is mainly made up of the records of wells and borings. The details of the strata passed through, the grouping of them under the various geological formations, and other particulars are carefully stated; and these records are supplemented by a number of analyses of waters. In the Introduction there is a brief outline of the geology of the county with especial reference to the water-bearing strata. The present Memoir is the first of a series which the Director-General of the Survey proposes to issue, and there can be no doubt that the utility of the institution will be greatly enhanced by these publications.

"THE Geology of the Borders of the Wash, including Boston and Hunstanton," is the title of another Memoir issued this year by the Geological Survey (price 3*s.*). It is the work of Mr. Whitaker and Mr. A. J. Jukes-Browne, with sundry notes by other officers who were engaged in the survey of the eastern counties. A large portion of the area described consists of the alluvial deposits of the Fenland, and there are considerable tracts of Chalk and Glacial drift. The most attractive geological features are those of the famous Red Chalk of Hunstanton, and of the picturesque scarps and warrens of Lower Greensand which border the Fenland, south of Hunstanton, through Snettisham, Dersingham, and Sandringham. The Lower Greensand is here divisible into three portions, of which the Carstone (or "gingerbread" stone) of Hunstanton forms the top, the Snettisham Clay the middle, and the Sandringham Sands the lower portion. Some important additions to our knowledge are contributed by Mr. G. W. Lamplugh, whose observations lead to the conclusion that the Carstone, as a whole, may represent the combined Hythe, Sandgate, and Folkestone Beds of the south of England; that the fauna of the Snettisham Clay agrees with that of the Tealby Limestone of Lincolnshire; while the Sandringham Sands appear to be newer than the Spilsby sandstone, and are presumably equivalent to some portion of the Tealby Clay. Particulars are given of the various divisions of the Chalk and of their fossils; and the appendix contains records of numerous wells and borings in Lincolnshire and Norfolk, and a supplementary geological bibliography of Norfolk.

A SERIES of investigations, to determine the milling qualities of wheats and the nutritive value of flours, has been made by Mr. F. B. Guthrie, chemist to the Department of Agriculture of New South Wales, and special attention is directed to these in the report just issued by the Department. As the immediate result of this work, the Department is in a position to pronounce definitely upon the milling quality of any variety of grain. In conjunction with the purely experimental work, Mr. Guthrie has been enabled to demonstrate the practicability of adjudicating upon wheats entered in prize competition on the basis of their flour product. The agricultural societies in the wheat districts have been so favourably impressed with the utility of the system that it is now customary for wheats, recommended by the judges employing ordinary methods, to be submitted to the milling test before the awards are made.

THE industry of viticulture promises to attain large proportions in New South Wales, the area in the Colony suitable for the production of grapes for wines of all types being practically unlimited. From the report just issued by the Department of Mines and Agriculture, we learn that the appointment of a graduate of one of the large viticultural colleges in Europe, to advise the vignerons as to the cultivation of the vine and the application of more scientific methods of wine production, has been much appreciated by those engaged in the industry. The phylloxera pest, which proved so disastrous a few years ago in Europe, and, unfortunately, appeared in New South Wales also, has received unremitting attention; and in the few places in which the insect has been discovered, the vineyards have been treated with carbon-bisulphide and rigorously uprooted. As a practical measure of protection against the inroads of this pest, the Department has secured from France half a million cuttings of phylloxera-resistant varieties for use as stocks in the planting of new vineyards.

A PRELIMINARY statistical statement of the mineral production of Canada during 1898 has been issued by the Canadian Geological Survey. The total value of the metallic minerals produced is placed at 21,622,601 dollars, while other mineral products have a value of 15,884,596 dollars. The grand total shows an increase of nearly 32 per cent. as compared with 1897, which year showed an increase of 27 per cent. compared with 1896. Whilst these large increases of late years have of course been partly due to the discovery and working of the rich gold-placers of the Yukon, other important mineral industries have also contributed to them, and there is every reason to expect a continued rapid growth in many of them for some years to come, especially as the province of British Columbia continues to develop.

THE "Year-Book and Record" of the Royal Geographical Society for 1899, which has just been published, contains portraits of the first President of the Society, Lord Goderich, and of the present President, Sir Clements R. Markham, K.C.B. The Society now numbers more than four thousand Fellows.

THE thirteenth part of Mr. Oswin A. J. Lee's brilliantly illustrated work, entitled "Among British Birds in their Nesting Haunts," has been published by Mr. David Douglas, Edinburgh. The nests illustrated in the ten plates are of the mistle thrush, great black-backed gull, red-backed shrike, skylark, buzzard, redstart, green woodpecker, linnet, and garden warbler.

THE *Bulletin of Miscellaneous Information* for January, issued by the Botanical Department of Trinidad, and edited by Mr. J. H. Hart, contains papers on the rubber, rice, cacao, and guinea-grass (*Panicum maximum*) industries of the island, and a continuation of the editor's enumeration and description of the Ferns of the West Indies and Guiana.

MR. W. L. DISTANT, the author of "A Naturalist in the Transvaal" and of several well-known entomological works, is about to issue a book called "Insecta Transvaaliensia," in twelve large quarto parts, with coloured plates. It will be mainly founded on the author's own collections and observations, and will be, to a large extent, an epitome of the South African insect fauna, and, we may presume, of the East African insect fauna in general, of which the South African is merely an offshoot.

AN estimate of the importance of electrical industries, and of the large number of people concerned with applied electricity, may be gained from two electrical trades' directories just issued. "*The Electrician* Electrical Trades' Directory and Handbook for 1899"—now in its seventeenth year of publication—testifies to the exceptional progress of the trades connected with applied electricity during the past year, the advance being not only in respect of electric illumination, but also of electric traction in its various forms and electric power supply generally. It has thus been necessary to largely extend the sheet tables of electric lighting and tramway undertakings in Great Britain. All the alphabetical sections have been carefully revised, and the tabular information has been checked. A feature of this handbook is a biographical section containing short biographies of distinguished physicists and electricians, many of them accompanied by half-tone portraits.—"The Universal Electrical Directory" contains the names of the members of the electrical and kindred industries throughout the world, the total number of names of firms and individuals included in it being 25,464. The natural expansion of the electrical industries has caused the addition of nearly two thousand new names to those contained in the volume for 1898. All the names are conveniently classified into nine sub-divisions, so that reference is easy. The volume is invaluable to all who are engaged in the commercial applications of electricity.

A NEW method of preparing Le Verrier's phosphorus suboxide, P_4O, is given by Messrs. A. Michaelis and M. Pitsch in the last number of the *Berichte*. If finely divided phosphorus is treated in the cold with a weak alcoholic solution of caustic soda or potash, it slowly gives off hydrogen, and the liquid becomes an intensely dark red colour. This red solution, when treated with acid, gives a greenish-yellow precipitate, which on analysis proved to be pure P_4O. This can be readily redissolved in weak alkali to a deep red solution, but it appears to be insoluble in all other solvents. As the authors remark, it is curious that the formation of this compound in this way should have so long escaped notice, as the preparation of hydrogen phosphide by the action of hot alcoholic potash upon phosphorus is one of every-day occurrence.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. H. Belier; two Black-backed Jackals (*Canis mesomelas*) from South Africa, presented by the Hon. James D. Logan, jun.; two Squirrels (*Sciurus vulgaris*), British, presented by Miss Dorothy Reynolds; two Nicobar Pigeons (*Calaenas nicobarica*) from the Indian Archipelago, presented by Mr. W. H. St. Quintin; a Reed Bunting (*Emberiza schoeniclus*), European, presented by Mr. F. Chatwin; a Broad-fronted Crocodile (*Osteoloemus tetraspis*) from West Africa, presented by Lieut. Kenneth A. Macdonald, A.S.C.; three Cape Vipers (*Causus rhombeatus*), a Puff Adder (*Bitis arietans*), a Rough-keeled Snake (*Dasypeltis scabra*) from South Africa, presented by Mr. S. B. Carlile; a Clouded Tiger (*Felis nebulosa*) from Northern India, four Waxwings (*Ampelis garrulus*), European; three Wandering Tree Ducks (*Dendrocygna arcuata*) from the East Indies, an Adorned Terrapin (*Chrysemys ornata*) from Central America, an Indian Eryx (*Eryx johni*) from India, purchased; a Macaque Monkey (*Macacus cynomolgus*), born in the Gardens.

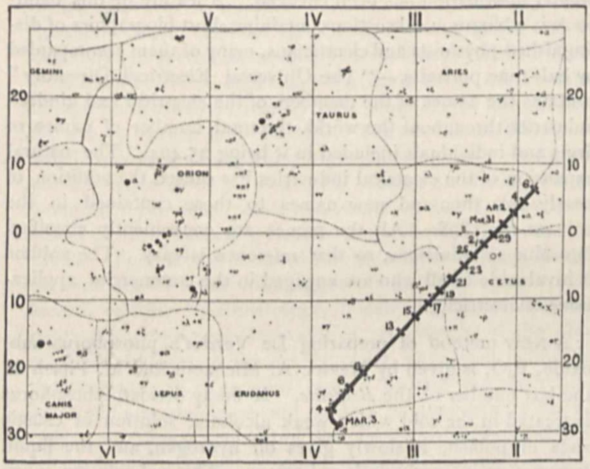
OUR ASTRONOMICAL COLUMN.

COMET 1899 *a* (SWIFT).—The following positions of the comet are taken from a circular received from the Centralstelle at Kiel:—

Ephemeris for 12h. Berlin M.T.

1899.	R.A. h. m. s.	Decl. ° ′	Br.
March 23	2 33 25	−5 7·4	
25	1 27 23	3 26·4	1·40
27	1 21 19	1 50·2	
29	1 15 8	−0 18·3	1·68
31	1 8 44	+1 10·1	
April 2	2 2 1	2 35·5	2·11
4	1 54 54	3 58·6	
6	1 47 19	+5 20·1	2·73

As will be seen from the table, the brightness is rapidly increasing as perihelion is approached; the possibility of observing the comet will depend on the local conditions of the sky near the horizon. It sets now about an hour after sunset. As a



guide for its recognition the accompanying chart of the region is given, which shows the path of the comet from the time of its discovery.

TUTTLE'S COMET.—Mr. J. Rahts continues his ephemeris of this comet in *Ast. Nach.*, Bd. 148, No. 3552. He also gives the elements for the epoch 1899 May 14·0 Berlin mean time.

Elements.

$$M = 359^\circ\ 59'\ 46''{\cdot}7 \qquad \phi = 55^\circ\ 15'\ 23''{\cdot}7$$
$$\left.\begin{aligned}\pi &= 116\ 29\ 3{\cdot}0\\ \Omega &= 269\ 49\ 53{\cdot}6\\ i &= 54\ 29\ 16{\cdot}3\end{aligned}\right\}1900{\cdot}0 \qquad \begin{aligned}\mu &= 259''{\cdot}6234\\ \log a &= 0{\cdot}7571085\end{aligned}$$

It may be interesting to many to recall the past history of this comet. It was discovered by Tuttle at Cambridge, U.S.A., on January 4, 1858 (*Ast. Nach.*, No. 1125). Some time after it was recognised to be identical with the comet 1790 II., and its period determined to be about 13·7 years. Confirmation of this was provided by its return in 1871 and again in 1885, passing perihelion in the latter year on September 11 (J. Rahts, *Ast. Nach.*, No. 2700). It has again this year been observed in a position closely agreeing with that computed from the data obtained in 1885, so that the new values for its elements are probably very nearly correct.

VARIABLE STARS.—*Harvard College Observatory Circular* No. 41 deals with the results of the photometric measurement of the stars + 20° 4200 (U Vulpeculæ) and + 28° 3460 (S.T. Cygni), which were announced to be variable by Müller and Kempf (*Ast. Nach.*, Bd. 146, No. 37). The measures were made by Prof. O. C. Wendell with the photometer with achromatic prisms attached to the 15-inch equatorial. In his case the stars were directly compared with stars of known magnitude in their immediate vicinity, while at Potsdam each was compared with the standard by means of an artificial star, and this fact probably accounts for the greater accordance among the Harvard figures. Apart from this the smoothed curves of both observers agree fairly closely, as is shown in the plotted light curves given in the article.

The period of + 20° 4200 is 7·98 days, during which the magnitude varies from 6·9 to 7·6. The star + 28° 3460 has a period of 3·8 days, its magnitude changing from 6·55 to 7·36.

In the remaining part of the *Circular*, dealing with the variable S Antliæ, the remarkable accuracy attainable with the apparatus is well shown. This star has a period of 7h. 46·8m. (the shortest known except in the case of variables in clusters), and it was doubted whether its period ought to be doubled as was the case with U Pegasi. The differences in magnitude of S Antliæ at minimum and its comparison star for widely differing epochs only varied by ·004 of a magnitude, so that the period of variation as taken is correct, and the star is not of the same type as *β* Lyræ or U Pegasi.

RELATION OF EROS TO MARS.—In a short article in the *Astronomische Nachrichten*, Bd. 148, No. 3542, Herr J. Bauschinger, of the Berlin Observatory, points out the importance of the discovery of the minor planet Eros with reference to the relationship of Mars to the other planets. Hitherto Mars has been regarded as a major planet, and the asteroids as the remnant of a former planet existing between it and Jupiter. Since the recent observation of the new asteroid it is possible to regard Mars itself as having been included in the original planet which filled the gap, this view being supported by the facts of Mars having so small a mass and the great eccentricity of its orbit. If this turn out to be true, we shall in future have to speak of the "Planetoid-ring between the Earth and Jupiter" in discussing the asteroids.

MEASURING EXTREME TEMPERATURES.[1]

THE measurement of extreme temperatures is a subject of great theoretical interest, especially in connection with the determination of the laws of radiation and of chemical dissociation and combination. The temperature in each case is the factor of paramount importance, and without means of measuring the temperature there is no possibility of formulating any rational theories. The subject possesses, in addition, a powerful fascination for the experimentalist, on account of the difficulty of the observations involved, and of the extremely conflicting nature of the results obtained by different observers and different methods of research.

Temperature of the Sun.

Attempts have frequently been made to estimate the temperatures of the electric arc and of the sun, which may be taken as examples of the most extreme temperatures known to science, and afford an illustration of the difficulties to be encountered, and of the methods available for attacking these problems. A brief consideration and comparison of the results will also serve to explain the causes of the remarkable discrepancies existing in the estimates of such temperatures by different observers and different methods.

In the case of the sun it is at once obvious that no terrestrial thermometer can possibly be directly applied. The only available method is (1) to measure the intensity of the solar radiation, and (2) to endeavour to deduce the temperature by determining the law of radiation at high temperatures. The measurement of the intensity of the solar radiation is in itself a sufficiently intricate problem, containing many elements of doubt and difficulty; but by far the greatest source of uncertainty lies in the solution of the second part of the investigation, the determination of the law of radiation. The origin of the discrepancies thus imported into the results may be summed up in the word "Extrapolation."

The method of investigation necessarily consists in taking a series of observations at temperatures within the laboratory range of thermometry, from which to calculate an empirical

[1] Discourse delivered at the Royal Institution, on March 10, by Prof. H. L. Callendar, F.R.S.

formula representing as closely as possible the results of experiment. It is then assumed that the formula may be "extrapolated," or used to estimate the temperature of a radiating source of known intensity *beyond the range* of the observations on which it was founded. This is a perfectly justifiable method, and may lead to very good results if the empirical law happens to be correct; but if the formula happens to be unsuitable, it may lead to the most remarkable conclusions.

Law of Radiation.

The curves shown in Fig. 1 illustrate some of the typical formulæ which have either been proposed for the law of radiation, or been deduced from the results of modern experiments over the experimental range of the gas thermometer, extending to 1200° C., to which trustworthy determinations of temperature on the theoretical scale are at present restricted. In order to obtain a comparison of the formulæ themselves, apart from other issues, the results of different observers are reduced to a common hypothetical value, 10 watts per square centimetre, for the radiation from a black body at 1000° C.

Excluding the law of Newton, which applies only to small differences of temperature, and also the law of Dulong and Petit, which was founded on observations over a very limited range with mercury thermometers, and is obviously inapplicable at high temperatures, there is a certain family resemblance between the remaining curves; but the differences between them are still so considerable that, if sufficiently accurate measurements of temperature were available, it should be possible to decide with certainty which of the formulæ was the most correct. A fairly close agreement is seen to obtain between the formula proposed by Weber and the curves representing the results of the recent experiments of Bottomley, Paschen and Petavel. But, on the other hand, there is strong evidence, both experimental and theoretical, in favour of the fourth power law

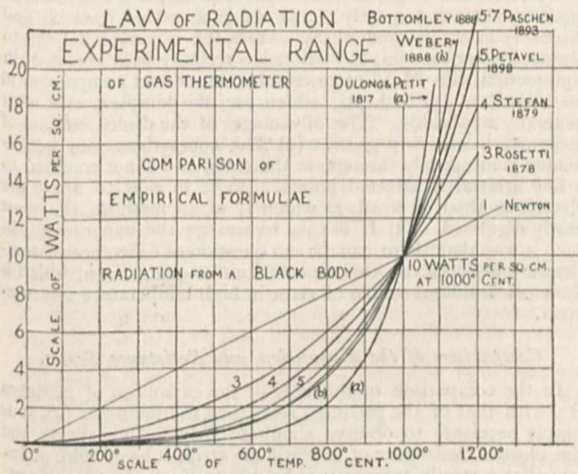


FIG. 1.—Formulæ of radiation. Experimental range.

proposed by Stefan, which differs materially from that of Weber; and many supporters may be found, especially among astronomers, for the very different formula of Rosetti.

Results of Extrapolation.

The importance of choosing a correct formula is most easily realised by reference to Fig. 2, which represents the results of extrapolation as applied to deducing the probable temperature of the sun. On the scale of Fig. 2, the dimensions of the experimental range of Fig. 1 are reduced to the thickness of the line at the lower left-hand corner of the diagram. The line at the top represents the intensity of solar radiation, which is taken at 10,000 watts per square centimetre in round numbers. The points at which the various curves meet this line show the corresponding values of the solar temperature.

The estimates of one million degrees and upwards, which were current in many of the older books on astronomy, were deduced from the law of Newton, and are obviously out of the question. The celebrated formula of Dulong and Petit gives results between 1500° and 2000° C., according to the data assumed, and evidently errs too much in the other direction. At the same time, it must be observed that the recent formula of Weber gives a result which is very little higher. Paschen considered that his results lent support to Weber's formula, and disagreed entirely with Bottomley's. But, according to the writer's reductions, they agree very closely with Bottomley's,

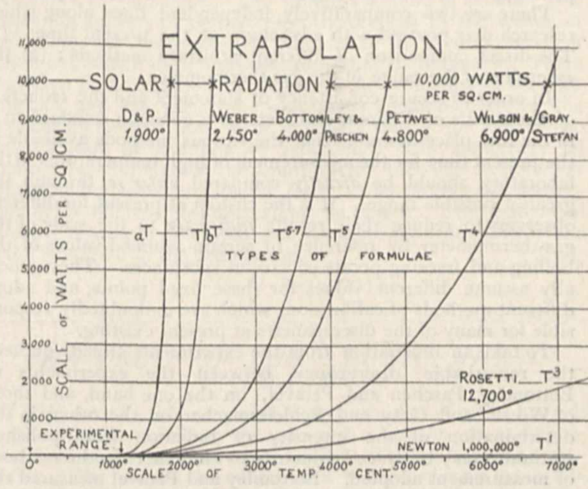


FIG. 2.—Temperature of the sun by extrapolation.

and are best represented by the formula $ET^{5\cdot7}$. The experiments of Petavel agree most nearly with a fifth power law. On the other hand, the experiments of Wilson and Gray, in which the temperature was measured by the *expansion* of a platinum strip, instead of by the increase of its electrical resistance, appear to be in exact confirmation of the fourth power law of Stefan, and give a much higher result for the solar temperature. The formula of Rosetti is approximately a third power law at high temperatures, and would not be admitted as probable, at least by physicists, at the present time.

The various formulæ above mentioned, together with the methods employed and the results deduced, are summarised in the following table.

TABLE I.—*Law of Radiation.*

Observers and date.	Temperature measured by	Radiation observed by	Formula proposed.	Solar temp. deduced.
				° C.
Dulong and Petit (1817)	Mercury thermometer	Rate of cooling in vac.	$E_1\ 1{\cdot}0077^T$	1900
Rosetti (1878)	Mercury thermometer	Thermopile Sb–Bi	E_3T^3 (nearly)	12,700
Stefan (1878)	No experiments made.		E_4T^4	6900
Schlei-ermacher (1885)	Platinum resistance	Heat loss C^2R in vac.	E_4T^4	6900
Weber (1888)	No experiments made.		$E_2T\ 1{\cdot}00043^T$	2450
Bottomley (1888)	Platinum resistance	Heat loss C^2R in vac.	$E_6T^{5\cdot7}$ *	4000
Paschen (1893)	Thermo-couple Pt–Pt Rh	Bolometer	$E_6T^{5\cdot7}$ *	4000
Wilson and Gray (1897)	Platinum expansion	Radio-micrometer	E_4T^4	6900
Petavel (1898)	Platinum resistance	Bolometer	E_5T^5 *	4800

* Formulæ deduced by the writer from the observations.

The above table is not intended to be exhaustive, but merely as a comparison of typical formulæ, reduced to a common standard. It does not contain the results of photometric investigations.

The Necessity of More Accurate Measurements of Temperature.

The conclusion to be derived from the above illustrations appears to be that in order to arrive at any certain knowledge with regard to the law of radiation, and the measurement of such extreme temperatures as those of the arc, and of the sun, the first step must be to secure a higher order of accuracy in the determination of the highest temperatures which can be observed and measured in the laboratory with material thermometers. There are other difficulties which are peculiar to the determination of the law of radiation, but we are at present concerned primarily with those relating to the measurement of temperature.

There are two comparatively independent lines along which research may proceed with advantage at the present time. (1) The direct comparison of different arbitrary methods; (2) the extension of the range of the gas-thermometer.

In order to secure consistency of statement and the reduction of the results of different observers to a common standard, it is in the first place desirable that the various methods available at the present time for the measurement of high temperatures in the laboratory should be *directly* compared *inter se*, through the greatest possible range. It is the custom at present for different observers to reduce their results *indirectly* to the scale of the gas-thermometer by reference to certain assumed values of the boiling and freezing points of various substances. They generally assume different values for these fixed points, and adopt different methods of calibration, which are undoubtedly responsible for many of the discrepancies at present existing.

To take an illustration from the experiments already quoted, the remarkable discrepancy between the experiments of Bottomley, Paschen and Petavel, on the one hand, and those of Wilson and Gray and Schleiermacher on the other, in the determination of the intensity of radiation from polished platinum, may be traced primarily to differences in the methods of measurement adopted. Bottomley and Petavel measured the electrical resistance of the radiating wire itself, and deduced the temperature by the usual formula for the platinum scale. Paschen calibrated his thermo-couple by reference to numerous fusing and boiling points. Wilson and Gray adopted the meldometer method based on the expansion of platinum, which they found to be uniform. The vacuum in Schleiermacher's experiments could not be measured, and was probably vitiated by gas evolved from the heated platinum.

"*Platinum*" *Methods of Pyrometry.*

These and similar discrepancies might be in a great measure removed, so far as they depend on the measurement of temperature, by the direct comparison of the various methods of measurement. The "platinum" methods are among the most important and the most easily comparable by direct experiment. These methods are founded on the characteristic stability and infusibility of the metals of the platinum group, properties which are accompanied by an even more remarkable degree of constancy in their less obvious electrical attributes. The two older methods, based on (1) the expansion and (2) the specific heat of platinum, are of comparatively limited application, but have given very good results in the able hands of Joly and Violle. The more modern electrical methods have the advantage of much wider applicability and convenience. They are of two distinct kinds: (3) the thermo-electric method, represented by the Pt-Pd. thermo-couple of Becquerel, the Pt-Ir. thermo-couple of Barus, and the Pt-Rh. thermocouple of Le Chatelier, and (4) the platinum resistance pyrometer of Siemens. The third method has been naturalised in this country, and brought to great perfection by the work of Sir William Roberts-Austen. The fourth method was that adopted by Bottomley, Schleiermacher, and Petavel in the experiments above mentioned, and has been applied with great success by Heycock and Neville at high temperatures, and by Dewar and Fleming at the other extremity of the scale.

Method of Indirect Comparison.

The usual or indirect comparison of the foregoing methods by means of the fusing points of various metals is illustrated in the annexed table, which contains several of the most recent results. The numbers given in brackets are now published for the first time, and should be regarded as preliminary.

TABLE II.—*Fusing Points by "Platinum" Methods.*

Method.	Observers.	Silver.	Gold.	Copper.	Palladium	Platinum.
(1) Expansion.	(C & E)	(945)	(1061)	(1085)	(1640)	(1980°)
(2) Spec. heat.	Violle (1879)	957°	1045°	1054°	1500°	1775°
(3) Thermo-couples.	Becquerel (1863)	960°	1092°	1224°		
	Barus (1892)	985°	1093°	1097°	1643°	1855°
	,, (1894)	986°	1091°	1096°	1585°	1757°
	Holborn & Wien (1895)	968°	1072°	1082°	1587°	1780°
(4) Resistance.	H. & N. (1895)	961°	1061°	1082°	(1550)	(1820)

The results above given for the expansion method (1) were obtained by assuming the expansion to be uniform, and taking the F.P. of gold as 1061°. The results of Violle by the specific heat method (2) were deduced by assuming a linear formula for the specific heat of platinum. The discrepancies of the various results obtained by the thermo-electric method (3) are partly due to errors of observation, and partly to extrapolation, *i.e.* to differences in the formulæ of reduction. The high value found by Becquerel for the F.P. of copper as compared with gold and silver is probably to be explained by the use of a much thicker wire in the case of copper. The very accurate and consistent experiments of Heycock and Neville leave little doubt that the F.P. of pure copper is at least 20° above that of gold. The much smaller difference of 4° to 5°, given by Barus, may possibly be explained by contamination with oxygen or other impurity. In the case of silver and gold, Messrs. Holborn and Wien adopted the Becquerel method of observing the fusion of fine wires. In the case of copper, they adopted the much more accurate method of observing the freezing point of a large mass of metal in a crucible, which had been employed by the writer in 1892, and was used by Heycock and Neville throughout their researches. The Becquerel method is very liable to give results which are too high.

The determination of the higher fusing points of palladium and platinum is necessarily attended with greater uncertainty because it involves extrapolation, and is therefore more dependent on the particular formula of reduction assumed, in addition to the experimental difficulties of the higher temperatures. Considering all the obstacles to be encountered, it would be unreasonable to expect such different methods to give any closer agreement at these points.

Advantages of Direct Comparison.

Whatever the origin of these discrepancies, there can be no question that they greatly retard the progress of research and discovery at high temperatures. With the object of helping to remove these obstacles, the writer has recently been engaged, in conjunction with Mr. Eumorfopoulos, in a direct comparison of methods (1), (3) and (4), which are the simplest and most generally applicable. The advantages of the direct method of comparison are very great. (1) The comparison may be extended continuously throughout the scale, and is not confined to a few arbitrarily selected points. (2) It is easy to apply the electric method of heating, which is of all methods the most easily regulated. (3) It is easy to arrange the experiments in such a way that there can be no question of difference of temperature between the thermometers under comparison, which is the most insidious source of error in high temperature measurement.

Comparison of the Expansion and Resistance Scales.

In the comparison of the scale of the expansion of platinum (1), with that of the platinum resistance thermometer (4), it is simply necessary to observe simultaneously the expansion and the electric resistance of a platinum strip, tube or wire maintained at a steady temperature by means of an electric current. The expansion may be measured, as in the meldometer of Joly, by means of a micrometer screw; but for lecture purposes it is preferable to adopt the method of the optical lever employed by Laplace in his experiments on expansion a century ago. By employing a direct reading ohmmeter to indicate the changes of electrical resistance, it is thus possible to exhibit the difference between the two methods by the simultaneous advance of two spots of light on a single scale. If the two instruments are adjusted to read correctly at 0° and 1000° C., the resistance thermometer will be in advance at temperatures below 1000°, but will lag behind at higher temperatures, because the rate of expansion increases as the temperature rises, whereas the rate of change of resistance diminishes. As the result of these experiments, it appears that the two scales (1) and (4) differ from that of the gas-thermometer to a nearly equal extent, but in opposite directions.

The resistance of platinum at its melting point is more than six times as great as at 0° C., whereas the whole expansion amounts to only one-fiftieth part of the length. The electrical method is for this reason by far the most accurate and sensitive. It also possesses in a very striking degree the merit of pliability and adaptability to the needs of each particular problem. For this reason the scale of the platinum resistance thermometer has come to be regarded as the platinum scale *par excellence*, and has been adopted as the standard of reference in many recent researches.

Fusing Point of Platinum.

As an illustration of the facility of applying this method, the determination of the fusing point of platinum on the platinum scale may be taken. This is a difficult experiment to perform by any other method. In performing the experiment by the measurement of the electrical resistance, it suffices to take a fine wire of which the electrical constants are accurately known, and to raise it gradually to its melting point by steadily increasing the current. The observation of the resistance of the central portions of the wire at the moment of fusion gives directly the temperature required on the platinum scale. In attempting to perform the same experiment by the expansion method, we are met by the difficulty that the platinum begins to soften and stretch at a temperature considerably below its melting point. Owing to the smallness of the expansion, a very slight viscous extension produces a relatively large error. In the resistance method it is not necessary to subject the wire to tension, and a small strain would in any case produce an inappreciable error on account of the very large increase of resistance with temperature. To obtain an equal degree of accuracy by the calorimetric method (2), or the thermo-electric method (3), it is necessary to use a furnace in which relatively large quantities of platinum can be melted. This has been done by Violle for method (2), and by Barus and Holborn and Wien for method (3). The latter used a linear formula for extrapolation, although their gas-thermometer experiments appeared to indicate a cubic formula for temperatures below 1200° C.

The temperature of the melting point of platinum on the platinum scale by the resistance method (4) is approximately $pt = 1350°$, and varies but slightly for different specimens of platinum. The result when reduced to the scale of the gas-thermometer by assuming that the rate of increase of resistance diminishes uniformly with rise of temperature (according to the usual formula of platinum thermometry, which has been verified with great care at moderate temperatures) gives a temperature of 1820° C. on the scale of the gas-thermometer. It is not improbable that platinum may deviate slightly from this formula at the extreme limit of the scale in the close neighbourhood of its melting point, but the evidence for this result is at least as good as that obtainable by any of the other methods. The observations are very easy and accurate as compared with the calorimetric method, and it is not necessary to make any arbitrary assumptions with regard to the formula of reduction, as in the case of the thermo-electric method.

As the accuracy of this formula has recently been called in question, on what appears to be insufficient grounds, by certain German and French observers, it is the more interesting at the present time to show that it leads to a result which cannot be regarded as improbable at the extreme limit of the scale. A different formula has recently been employed by Holborn and Wien, and supported by Dickson (*Phil. Mag.*, December 1897). The writer has already given reasons (*Phil. Mag.*, February 1899) for regarding this formula as inferior to the original, of which, however, it is a very close imitation. The above observations on the melting point of platinum, if reduced by Dickson's formula, would give a result $t = 1636°$ C., which appears to be undoubtedly too low as compared with the results of other methods, however great the margin of uncertainty we are prepared to admit in these difficult and debatable regions of temperature measurement.

It should be observed that the results of Violle by method (2) are consistently lower than those given by the resistance method in the case of silver, gold and copper. We should, therefore, expect a difference in the same direction at the F.P. of Pt. as found by method (4), and not a difference in the opposite direction as given by the thermo-electric method, on the arbitrary assumption of a different type of formula for extrapolation at high temperatures. It is a matter of some interest that the assumption of linear formulæ for both the specific heat and the rate of change of resistance should lead to results so nearly consistent over so wide a range of temperature in the case of platinum.

Comparison of the Thermo-couple and the Platinum Thermometer, (3) *and* (4).

The chief difficulty and uncertainty encountered by Paschen in his experiments on radiation, was that of arranging the thermo-couple so as to be at the same temperature as the radiating strip of platinum. It is better for this reason to measure the temperature of the strip itself by means of its electrical resistance, the method adopted by Schleiermacher, Bottomley and Petavel. The same difficulty occurs in the direct comparison of the scales of the thermo-couple and the platinum resistance thermometer. The simplest method of avoiding this objection appears to be that recently adopted by the writer, of enclosing the thermo-couple completely in a thin tube of platinum, which itself forms the resistance thermometer. There can then be no question of difference of temperature between the two, and the same tube may serve simultaneously for the expansion method, and as a radiating source for bolometric investigation of the law of radiation. The uniformity of temperature throughout the length of the tube can be tested at any time by means of potential leads, or by shifting the thermo-couple to different positions along its length. The method of electric heating is employed, and the central portion only of the tube is utilised in the comparison.

(*To be continued.*)

THE ORBIT OF THE LEONID METEOR SWARM.[1]

THE great Leonid swarm of meteors consists of ortho-Leonids which pursue nearly the same path round the sun, and clino-Leonids which move in orbits sensibly differing from the ortho-orbit. The present investigation is concerned with the ortho-Leonids. They form a dense stream extended along a portion of an immense orbit round which they travel in 33¼ years. This orbit has its perihelion a little inside the Earth's orbit, and its aphelion a little outside the orbit of Uranus. It intersects the orbits of these two planets, but lies in a plane inclined to the ecliptic, so that the meteors which traverse it pass under the intervening planets on their outward journey and over them on the homeward journey.

Accordingly, the orbits of the intervening planets—Mars, Jupiter and Saturn—pass through the orbit of the meteors; and they, as well as Uranus and the Earth, whose orbits intersect it, and Venus, which lies but little beyond, are well situated for exercising a perturbating control over the motions of the Leonids. But the influence of Mars and Venus is inconspicuous, and that of the Earth only sensible on the meteors which pass close to it; so that nearly the whole of the perturbating effect upon the greater part of the swarm is due to Jupiter, Saturn and Uranus.

The procession of ortho-Leonids is so long that it takes between two and three years to pass each point of its orbit; and accordingly when it streams across the earth's path, which it does three times in a century, the earth has time to come round to the point of intersection in at least two successive years, and on each such occasion receives one of the greater Leonid showers—a splendid spectacle, but of such brief duration, lasting only a few hours, that it is visible only from the side of the Earth, which happens at the time to be its advancing side.

The first of these great displays recorded in modern times was that witnessed by Humboldt and Bonpland on the morning of November 12, 1799, when travelling in South America. It was quite unexpected. So was the next great shower which visited Europe on the morning of November 13, 1832, and was followed by a still greater display which was seen from numberless stations in America in 1833. This recurrence of the phenomenon after an interval of 33 years led to its being expected in 1866, and diligent preparations were accordingly then made by astronomers to avail themselves of the opportunity of acquiring more information about the mysterious visitants. These meritorious efforts resulted in a great accession to our knowledge. Prof. Hubert A. Newton collected the records of several ancient observations which showed that the swarm returns to the Earth at intervals of 33¼ years, and that the date on which the meteors are seen had advanced by 3½ weeks since A.D. 902. From their periodic recurrence, he found that they must be moving in one or other of five orbits which he described, and from the advance in the date he inferred that the longitude of the node of the orbit has been advancing, an effect which must be due to perturbations. Prof. Adams ascertained which of Newton's five orbits is

[1] "Perturbation of the Leonids." By G. Johnstone Stoney, M.A., D.Sc., F.R.S., and A. M. W. Downing, M.A., D.Sc., F.R.S. (Abstract of a paper read before the Royal Society on March 2.)

the real one. Schiaparelli detected the dynamical explanation of the fact that the swarm is lengthened out like a stream along a portion of Adams's orbit. And Leverrier adduced evidence that the Leonids have been less than eighteen centuries within the solar system : that in fact they were diverted into their present elliptic orbit at the end of February or beginning of March in the year A.D. 126, in consequence of having then passed, while still a compact cluster, close to the planet Uranus. Adams further pointed out that there is a comet moving nearly in their track.

These were great achievements ; of which the most noteworthy is the great discovery made by Prof. Adams when he determined definitely the real orbit in which these bodies move. This he accomplished by computing the perturbations which would be suffered in each of the five possible orbits, and comparing the calculated amount of the shift of the nodes with that which had been obtained by comparing the ancient with recent observations.

The main swarm of Leonids is again returning. A shower of several hundreds of meteors, produced by the extreme front of the ortho-stream, was observed last November in America. Still greater showers may be expected this year and next year, and perhaps a considerable display in the year following; and it is eminently desirable that this opportunity of increasing our knowledge in this entirely new branch of astronomy shall not be lost. It is the second occasion when astronomers have been able to foresee when the opportunity is about to present itself.

In 1866, the great object was to ascertain the orbit. To determine this, what was wanted was the average amount of the perturbations, and it was this average which Adams computed. But to make a further advance—to explore more fully the past history of the Leonids, or their present condition, or to predict the future—a more intimate acquaintance with the perturbations is essential. Now perturbations reach each meteor individually. They differ from one revolution to another, and within each revolution they variously affect the meteors that occupy different stations along the stream.

The present investigation was entered on as a commencement of the more searching inquiry indicated above. The stream is regarded as divided into segments of such moderate length that the perturbations which operate on the meteors occupying any one of them may be regarded as sensibly the same. One of these segments is selected—that through which the Earth passed in 1866—and the actual perturbations to which the elements of its orbit are being subjected throughout an entire revolution, have been computed by the method of mechanical quadratures. The revolution extends from 1866 November 13, when the Earth passed through this segment of the stream, till 1900 January 27, when the same segment will return to the intersection of the meteoric orbit with the Earth's orbit.

The inquiry has already led to remarkable results. During this revolution an entirely abnormal amount of perturbation has acted on the meteors in the selected segment of the stream. This perturbation has been produced chiefly by the attraction exercised by the great planets Jupiter and Saturn, and its unusual amount has been occasioned by a near approach of Saturn when that segment of the stream, for which the calculations were made, was on its outward journey, and a still more close approach of Jupiter, when the meteors were on their homeward journey. These events have resulted in such a perturbation of the orbit, that the shift of its node during this revolution has had more than $3\frac{1}{2}$ times its average amount, and that the periodic time has become augmented by as much as $\frac{1}{4}$ of a year.

This last perturbation will have a remarkable effect on the future history of this segment of the stream, unless it is compensated by what occurs elsewhere or in subsequent revolutions. It indicates, too, that whatever portion of the stream has been most perturbed in this revolution is falling back towards the parts behind and retreating from the portions in front; thus introducing a new inequality of distribution of density along the stream, superadded upon whatever inequalities of a like kind may have existed previously. Thus some parts of the stream are becoming unduly crowded with meteors. Others of the perturbations indicate that in this remarkable revolution a new sinuosity of sensible amount is being set up in the stream. These effects have been made conspicuous by the fortunate circumstance that the revolution for which the calculations have been made has happened to be one in which the perturbing forces have attained an intensity far exceeding the average.

The information supplied by this inquiry in regard to the time when the Leonid shower of next November may be expected is considerable, but far from complete. It may be stated as follows :—At the epoch 1899, November 15, the longitude of the node of the orbit for which the calculations have been made will be $53^\circ\ 41'\!\cdot\!7$, a position which the earth will reach on 1899 November 15d. 18h. It is probable, therefore, that the middle of the shower of the present year (1899) will occur nearly at this time, since the segment of the stream, for which our calculations have been made, is situated in the stream less than three months' journey of the meteors behind the segment which the Earth will encounter next November. This conclusion, however, rests on two assumptions : (1) That the two segments were, in 1866, moving in orbits that did not much differ ; (2) That the perturbations which these segments have since suffered have not much differed. Both assumptions are probable, but unfortunately neither is certain ; so that the prediction can only be offered with reservation. If the shower occurs at the time anticipated, it will be visible from both Europe and America.

A NEW PHOTOGRAPHIC PRINTING PAPER.

WITHIN the last few months several new brands of photographic printing papers have been placed on the market, all of which are characterised by the possibility of all the manipulations involved in the exposure and development of the prints being performed in an ordinarily lighted room. The basis of most of these papers is a very slow bromide emulsion, with varying proportions of chlorides to modify its qualities for particular purposes. The paper issued under the name of "Dekko" by Messrs. Kodak, Ltd. (late the "Eastman Photo. Materials Co."), is one of this class. As stated in the circulars accompanying the paper, its special feature is that it may be exposed, developed and fixed in an ordinary room illuminated by artificial light or weak daylight, thus doing away with the necessity of a special dark room for its treatment.

The paper may be safely handled for placing in the printing frame and developing at a distance of 8 or 10 feet from an ordinary full gas flame, or nearer if the light be turned down. With the Welsbach light or daylight it is advisable to shade the light with one thickness of orange paper.

For exposure the instructions recommend from three to five minutes at a distance of 6 or 8 inches from an ordinary gas burner for a negative of medium density. For daylight from one to two seconds at 2 feet from the shaded window will be sufficient. In this connection, however, we would urge the convenience and certainty with which these contact prints may be made by exposure to the light of burning magnesium. The light given is extremely actinic, as is at once appreciated if its spectrum be examined; it is more portable than any other illuminant, and may consequently be used where others are quite inaccessible, and as the metal in the form of ribbon is fairly pure, the light evolved from the combustion of a given length is practically constant.

The development of the paper is similar to that of ordinary bromide paper, except that the process is much quicker, full density being obtained in at most thirty seconds. The formula recommended for ordinary black tones is a mixture of hydroquinone and metol. The paper, however, lends itself readily to the production of varied tones from brown to bright red, these being obtained by variations both of exposure and developer. A special developer for warm tones is given in the printed instructions.

Fixing is carried out in the usual manner, and the prints should be washed for at least an hour, after which they are ready for mounting.

This paper will prove a useful addition to the printing papers already on the market; its simplicity of working and long range of colours obtainable recommending it for the amateur, while the professional will find it of great service for producing quantities of permanent prints of uniform appearance at any season of the year.

LOCAL AUTHORITIES FOR SCIENCE AND ART INSTRUCTION.

THE Directory issued by the Department of Science and Art in 1897, contained a section which has since become widely known, and will probably take a prominent place in educational politics for some time. The new paragraph—referred to as Clause vii.—reads as follows: "In counties and county boroughs in England which possess an organisation for the promotion of secondary education, such organisation, if recognised by the Department, may notify its willingness to be responsible to the Department for the science and art instruction within its area. In such case grants will in general be made to the managers of new schools and classes, only if they are acting in unison with such organisation. The rights of the managers of existing schools and classes will not be interfered with; and Town Councils and School Boards which are managers of schools receiving Science and Art grants will not be debarred from establishing in their districts additional schools where necessary. In Wales the Intermediate Education Authority is for this purpose regarded as the authority for the promotion of secondary education." Clause vii. was repeated in the Directory for 1898, and has, since its introduction, been the cause of considerable discussion.

The following is a complete list of those local authorities which have up to the present been accepted by the Science and Art Department as responsible for the science and art instruction within their respective areas:—

COUNTIES.

Cambridgeshire	Northumberland
Cumberland	Nottinghamshire
Derbyshire	Oxfordshire
Dorset	Somerset
Durham	Staffordshire
Essex	Suffolk (East)
Hampshire	Surrey
Herefordshire	Sussex (East)
Lancashire	Sussex (West)
Leicestershire	Westmorland
Middlesex	Wiltshire
Norfolk	Yorkshire (West Riding)

COUNTY BOROUGHS.

Bath	Oxford
Bolton	St. Helens
Brighton	West Bromwich
Burnley	Worcester
Devonport	

Just recently the application made by the London County Council to be recognised as responsible within the County of London, for the instruction in subjects sanctioned by the Department of Science and Art, has been granted.

Before referring to the opposition which has been offered by educational organisations (other than those ultimately authorised by the Department to act under Clause vii.) to an acceptance of the claims of the public body applying for recognition, it will be advisable to call attention to certain utterances of the President and Vice-President of the Committee of Council on Education, since their remarks have served to define more clearly the scope of the new clause. His Grace the Duke of Devonshire has said "he was perfectly aware that considerable jealousy had been felt of these organisations (under Clause vii.), because it was supposed that, if largely adopted, they would probably be stereotyped hereafter by legislation as the future educational authority. He did not believe there was any ground for such jealousy or suspicion. The Government was perfectly aware that the creation of strong bodies for the control of secondary education must be the work of Parliament . . . and when the time came the Government had no intention of shrinking from making their own proposals."

Such an utterance as this should go a long way towards dispelling any idea that Clause vii. is an attempt "to carry out the recommendation of the Secondary Education Committee without legislation." At a conference in June last, between the Department of Science and Art and the Organising Secretaries and other representatives of the then recognised authorities, Sir John Gorst explained that "the accepted organisations would (1) receive *en bloc* the grants earned in all schools in their areas; (2) be given power to appoint teachers in science subjects, who would not be required to possess the special qualifications laid down in the Directory; and that the work of examination and inspection would remain in the hands of the Department. It was also decided at the same conference that such local authorities should settle questions relating to the managers of different schools and their duties, and should receive examination results direct from the Department.

The opposition offered by the London School Board to the claim of the London County Council referred to above, led to an inquiry by the Department of Science and Art, and the several points raised by the School Board may be fairly taken as typical of the objections to the clause throughout the country. Amongst other matters the School Board urged that the present policy of the Department was to look upon the managers of elementary schools engaged upon higher work as intruders, and that this was inconsistent with the ideas which led to the establishment of the Department. It was argued that the granting of authority to the London County Council would be an improper prejudicing of the function of Parliament, and would be unconstitutional; and also that Clause vii. in operation might seriously prejudice the rights of volunteers in evening continuation science and art work, inasmuch as the County Council would under the clause have the right of vetoing what they considered to be unnecessary evening continuation work.

Such is briefly the present state of affairs. The Department of Science and Art continues to judge each application received from local educational committees, of one kind or another, upon its own particular merits, and the decision of the Department is final. The extent to which the powers of South Kensington under Clause vii. may be modified by legislation—which appears to be imminent—remains to be seen. Time alone might perchance suffice to reconcile the objectors.

A. T. SIMMONS.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following is the speech delivered by the Public Orator, Dr. Sandys, Fellow and Tutor of St John's, in presenting for the complete degree of M.A. *honoris causâ* Mr. G. Sims Woodhead, Professor of Pathology:—

"Duos deinceps pathologiae professores, fere in medio aetatis cursu morte immaturâ praereptos, non sine dolore nuper amisimus, quorum utriusque egregia in Academiam merita non est quod longius exsequar: vosmet ipsi vobiscum non sine desiderio recordamini. Hodie vero professorem talium virorum in locum nuperrime electum, morâ nullâ interpositâ salutamus, et senatus nostri in ordinem statim cooptamus. Abhinc annos viginti regiae societati medicae inter Edinenses praepositus, postea ibidem uno in quinquennio discipulorum duo milia pathologiae praeceptis imbuisse dicitur. Idem et olim inter Berolinenses et nuper inter Londinenses maximo cum fructu his studiis operam dedisse fertur. Peritis quidem nota sunt volumina illa quae (ne alia commemorem) de pathologiae praesertim scientiâ conscripsit. Ab isdem non sine spe magnâ expectatur opus ingens, in quo de remedio novo contra diphtheriae toxicum nuper feliciter adhibito, aegrotantium numero immenso recensito, accuratissime disputat. Sunt etiam alia professoris nostri in studiis generi humano salutaria, quae memoratu sunt dignissima; sed hodie haec omnia, temporis iniquo exclusus spatio, ut Vergili verbis utar,

"'praetereo, atque aliis post me memoranda relinquo.'

"Duco ad vos Professorem WOODHEAD."

DR. THOMAS BARLOW has been appointed to fill the vacancy in the body of the University of London Commissioners caused by the resignation of Sir William Roberts.

Science announces the following recent gifts to educational institutions in the United States:—Washington University, St. Louis, has just received generous gifts enabling it to remove to its new site facing Forest Park. This site was purchased with a fund of 200,000 dollars, contributed by seventy-five different subscribers. Funds for a library, to cost 100,000 dollars, are in the hands of the directors by the bequest of the late Stephen Ridgley. The additional buildings include an engineering building, costing 150,000 dollars, given by Mr. Samuel Cupples, and a chemistry building, costing 100,000 dollars, given by Mr. Adolphus Busch. Mr. Brookings has also offered 100,000 dollars, on condition that 500,000 dollars be subscribed at once for an endowment.—Mr. Philip D. Armour has given 750,000 dollars to the Armour Institute of Chicago, which he had previously endowed with 1,500,000 dollars.—The will of the late Alexander M. Proudfit, of New York City, gives 30,000 dollars to Columbia University for two fellowships, one in letters, and one for advanced studies in medicine.—Knox College, at Galesburg, Ill., has collected a fund of 100,000 dollars, thus securing the additional gift of 25,000 dollars made by Dr. D. K. Pearsons.—Efforts are being made to persuade President Taylor not to leave Vassar College for Brown University. With this end in view, a meeting of the Alumni decided to try to collect the sum of 2,000,000 dollars for the endowment of Vassar.

An address by Prof. S. W. Holman on "The Function of the Laboratory," published in *The Technology Review*—a quarterly magazine relating to the Massaschusetts Institute of Technology—is of interest in connection with the discussion which has lately taken place in these columns as to the relation between polytechnic institutions and industrial chemistry. Prof. Holman points out that the man whose occupation is exclusively the practice of an art (other than the fine arts) is an artisan, not a member of the technical professions. The work of the technical professions is the direction and extension of the application of the arts, together with a far higher function—the development of the arts, that is, of technology. Prof. Holman's view is that the chief function of the engineer is to bring pure and applied science to the industrial service of mankind. It is for him to analyse the ever new industrial problems, bringing to bear upon them the scientific method of inquiry, and applying to their solution all related scientific as well as technical knowledge. And what is true of the engineer is equally true of the members of the other technical professions. Moreover, modern technical practice is progressing with such acceleration, and every branch of scientific knowledge is so diffusing itself into every line of engineering, that the coming generation of engineers will find the most thorough command of science which they can obtain a none too efficient aid in the keen competition of their future practice. Breadth of view, opportunity, ingenuity, and "common sense" being equal, he who is a master of science will distance competitors. Science, then, and its methods must rank first; applied science, second; artisan skill, last.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, February.—Prof. F. N. Cole gives an account of the fifth annual meeting of the Society, and abstracts several of the papers which were read. It appears that this young Society is in a very flourishing condition. Prof. Cole stated that two factors have contributed powerfully to increase the Society since its reorganisation as a national body (originally it was the New York Mathematical Society). One of these is the institution of summer meetings, held usually in connection with the large general scientific gatherings; and the other is the founding of the Chicago Section, which works in perfect harmony with the general Society.—Prof. Holgate follows with an account of the December meeting of this Chicago branch.—Some thirteen papers were read, and a few of these are given in abstract.—A valuable "report on recent progress in the theory of the groups of a finite order" is a paper by Dr. G. A. Miller, a well-known authority in this field of work. It was read at the meeting of the American Association, held at Boston in August last. The period considered extends over the last ten years, and a full list of works is given. These are considered under the heads of (1) Soluble groups, (2) Simple groups, (3) Substitution groups, (4) Abstract groups, and winds up with a general conclusion. The author's aim has been to call attention to only a few of the important recent advances in the theory.—The same gentleman adds a short note on Burnside's "Theory of Groups."—Prof. F. Morley contributes a short article on a regular configuration of ten line pairs conjugate as to a quadric. This note, which was read before the Society in October, is an addendum to the same author's account of the model laid before the London Mathematical Society in June last (*Proc. L.M.S.*, vol. xxix).—A few short reviews follow: Einleitung in die Theorie der Bessels'chen Funktionen, by Prof. Graf and Dr. Gubler; Leçons de Cosmographie, by MM. F. Tisserand and H. Andoyer; Lectures on Elementary Mathematics, by J. L. Lagrange (McCormack's translation); &c. An account is given of the new publication, *L'enseignement Mathématique*, edited by MM. Laisant and Fehr. Its object is to contribute to the improvement of mathematical instruction by making more widely known its organisation in different countries, by discussing methods of teaching, &c.—Prof. Greenhill contributes a long and excellent review of Prof. Appell's éléments d'analyse mathématique.—Dr. Lovett has a full budget of *Notes*, and there is a good list of new publications.

In the *Journal of Botany* for March is an interesting paper, by Mr. B. Daydon Jackson: on a review of Latin terms used in botany to denote colour. Mr. Jackson enumerates all the terms used by Latin writers, with their different shades of meaning, classifying them under twelve heads, viz. (1) terms implying absence of colour; (2) white; (3) grey (cold neutrals); (4) black; (5) brown (warm neutrals); (6) red; (7) orange; (8) yellow; (9) green; (10) blue; (11) purple; (12) terms implying colour without defining it, and vague terms. A useful bibliography is appended.

Bollettino della Società Sismologica Italiana, vol. iv., 1898, No. 7.—The earthquake of Hayti (West Indies), in the morning of December 29, 1897, by G. Agamennone.—On the form of the slow oscillations in earthquakes. by G. Grablovitz. Argues that the records furnished by pendulums are to be attributed to the composition of the effects produced in them by horizontal motions and tilts of the ground, and not exclusively by either.—List of earthquakes observed in Greece during the year 1895 (July to December), by S. A. Papavasiliou, the total number being about 260 (of which 105 were observed in the island of Zante), *i.e.* about one and a half per day.

SOCIETIES AND ACADEMIES.

London.

Linnean Society, March 2.—Dr. A. Günther, F.R.S., President in the chair.—Mr. H. M. Bernard showed some microscopic sections of the digestive cæca of spiders, which had led him to the conclusion that digestive, assimilatory, and excretory functions are all performed by these.—Mr. J. E. Harting exhibited a male specimen of the rare King Eider (*Somateria spectabilis*) which had recently been forwarded in the flesh from Lerwick, and called attention to the colours of the soft parts, which differed materially from the colours represented by Gould in his folio plate of this species. After referring to the natural haunts of this duck in the Palæarctic and Nearctic regions, he described it as a bird of such rarity in the British Islands that since it was first noticed as a visitor to the coast of Norfolk in 1813, not more than a score of examples had been met with, the last of which was reported in November 1890.—The President referred to the statement of Colonel Montagu, made on the authority of Bullock, that the King Eider had nested in Papa Westra, an observation which had not been confirmed; and Mr. H. Druce made some remarks on the process of bleaching to which the eider-down of commerce is generally, though not always, subjected.—Mr. G. C. Druce exhibited and made remarks on specimens of *Dianthus gallica* from Jersey.—Mr. W. P. Pycraft read a paper on the external nares of the cormorant, intended to supplement a communication on the same subject made some years ago by Prof. J. C. Ewart (*Linn. Soc. Journ.*, *Zool.*, xv., 1881, p. 455). Mr. Pycraft found in every species of cormorant which he had examined that the external nostril lies without and below the rhinothecal groove, and not at its end as had been previously described. He had failed in every case to pass even the finest bristle up this groove into the nasal cavity. In the gannets (*Sulæ*) he had not been able to find any trace of this nasal groove or aperture. Further remarks were made by the President, Prof. Howes, and Mr. Harting, chiefly in regard to the bearings of the facts on correlation of structure with habit.—Mr. G. C. Druce read a paper on the reported occurrence in Ireland of *Carex rhynchophysa*, and gave reasons for believing that *Carex rostrata* var. *latifolia* had been mistaken for it. Typical specimens of both were exhibited, and also a coloured drawing by Mr. N. E. Brown of one of the plants collected by Mr. Lloyd Praeger, near Mullaghmore Lough, Armagh. Some further remarks were made by Mr. C. B. Clarke, more especially with reference to the descriptions of plants believed to be new to British flora.—Mr. Edward Step, read a paper on the fertilisation of *Glaux maritima*. After examining some hundreds of flowers gathered along the coast near Portscatho, Cornwall, he had come to the conclusion that the flower is protogynous. When open, the calyx-lobes at first separate but slightly, affording only a narrow entrance. The curvature of the style is sufficient to bring it within the fold of a calyx-lobe, from which the stigma projects so as to be in the way of any insect that visits the flower for the liquid that exudes from the ovary and base of the style. When the yellow pollen is shed, the style is either quite erect, or retains its original bend sufficiently above the anthers to make self-fertilisation probable. Owing to the lowly habit of the plant and its customary crowding in with sea-sedge and grasses, it is not an easy one to watch. Doubtless it is often fertilised with its own pollen by the agency of flies and other insects; but from the position and precocity of the stigma, Mr. Step considered that cross-fertilisation is quite as frequent. He was consequently unable to agree with Mr. Henslow (*Trans. Linn. Soc.*, n. s. *Bot.* i. 1880. p. 377, pl. 44., fig. 35) as to self-fertilisation in this plant, believing his conclusion to have been drawn from the examination of an abnormal specimen.

Zoological Society, March 7.—Prof. G. B. Howes, F.R.S., Vice-President, in the chair.—Mr. J. E. S. Moore exhibited and made remarks upon specimens of the Medusa (*Limnocnida tanganjicae*) of Lake Tanganyika, which he had obtained during his recent expedition to that lake.—Mr. R. E. Holding exhibited and made remarks upon a large pair of horns belonging to a species of Muntjac (*Cervulus*) received from Singapore.—Mr. W. E. de Winton exhibited and made remarks upon the tail of a Common Fox (*Canis vulpes*), showing the gland on the upper surface covered with straight coarse hair, the existence of which appeared to be little known.—Dr. Arthur Keith read a paper on the relationship of the chimpanzees to the gorilla. He referred to the ape "Johanna," which is on exhibition, under the name of a gorilla, at Messrs. Barnum and Bailey's menagerie, but which was undoubtedly a chimpanzee. "Johanna" showed all the characters of "Mafuka," an ape which, when exhibited in the Zoological Gardens at Dresden, gave rise to a prolonged discussion as to her nature. Both evidently belonged to the variety or species of chimpanzee to which Du Chaillu had given the name of "Kooloo-kamba." "Johanna" was the first chimpanzee, so far as Dr. Keith was aware, that had lived long enough in captivity to complete her dentition, which apparently finished, by the appearance of the canine teeth and last molars, about the twelfth or thirteenth year. She was the second chimpanzee in which the phenomena of menstruation had been observed. In her it occurred every twenty-third or twenty-fourth day, and lasted for three days; the discharge was profuse, and first appeared in about the ninth or tenth year. All the chimpanzees, with the characters of "Johanna," appeared to come from the West Coast of Africa, south of the equator. "Johanna" had the habits and mental temperament of the chimpanzee; her teeth, hands, nose, and ears were also characteristic of that species. Evidence was produced to show that the gorilla, in many of its characters, was the most primitive of the three great Anthropoid apes, and probably retained more of the features of the common anthropoid parent than either the chimpanzee or orang-utan. The chimpanzee was to be looked on as a Gorilline derivative in which the teeth had undergone very marked retrograde changes, accompanied by corresponding changes in the skull and muscles. The various races or species of chimpanzee described differed in the degree to which they had lost their Gorilline characters. Most of the characters which had been ascribed to these species were really only characters of individuals, or were due to age or sex. The skulls of the Central-African chimpanzee certainly showed distinctive features. It was probably a well-marked race. There was not enough material collected as yet to allow a definite statement to be made as to the distinctive features of other races. Du Chaillu was the best guide up to the present time, and the Central-African form might be added to the three species described by him. It was possible, however, that it might be found of the chimpanzees, what Selenka has shown to be true of the orang-utans, that these species were of the nature of local forms.—Mr. W. L. H. Duckworth read a note on the specific differences in the Anthropoid apes, dealing in the first place with a specimen in the Zoological Museum at Jena. The specimen in question was labelled "young female gorilla," but Mr. Duckworth had come to the conclusion that it was not a young animal, and that it was a chimpanzee and not a gorilla. In the second place, the work of Profs. Kukenthal and Ziehen on the "Cerebral Hemispheres of the Primates" was dealt with, and the failure of these authors to recognise the identity of *Gorilla engena* and *Troglodytes savagii* was commented on. Lastly, the reported occurrence of a gorilla at Stanley Falls on the Congo was mentioned, though the specimen in question seemed to be rather a chimpanzee than a gorilla.—Prof. B. C. A. Windle and Mr. F. G. Parsons presented a paper on the muscles of the head, and forelimb of the Edentata. The results were obtained by comparing the already existing scattered literature with a series of recent dissections. In some cases five or six records of the same animal were present, and thus the risk of stating individual variations as the normal arrangement was lessened. This paper was a purely technical record, all generalisations and deductions being reserved for a second part.—Mr. Martin Jacoby contributed a second part of a paper entitled "Additions to the knowledge of the Phytophagous Coleoptera of Africa." It contained descriptions of seventy-two new species of the groups *Halticinae* and *Galerucinae*, six of which had been made the types of new genera.

Mathematical Society, March 9.—Lieut.-Colonel Cunningham, R.E., Vice-President, in the chair.—Dr. Larmor, F.R.S., made some remarks on the phenomenon of Zeeman and its bearing on the problem of the origin of spectra. Dr. Hobson, F.R.S., and Mr. Hargreaves spoke on the subject of the communication.—Dr. Macaulay read a short note by Mr. G. B. Mathews, F.R.S., on involution.—Other papers communicated were: Note on the expansion of tan (sin θ) − sin (tan θ) in powers of θ, Mr. R. H. Pinkerton; note on a property of groups of prime degree, by Prof. Burnside, F.R.S.; and note on the invariant total differential equation in three variables, by Prof. J. M. Page. In the last paper it was pointed out that any number of *types* of invariant total equations can be established; and, in a large number of cases, they can be established very simply. When these equations satisfy the condition of integrability, they can be integrated by a quadrature; and when they do *not* satisfy that condition, the *general* solution of any one of them can be found by a quadrature. Moreover, if the condition of integrability is satisfied by a total differential equation, so that its integral has the form $\phi(x, y, z, c) = 0$, the envelope of these surfaces (that is, the singular solution of the total equation), if one exists, can be found by algebraic operations; and the cuspidal edge of the envelope (if one exists) can be found by algebraic operations, and one differention.

Royal Meteorological Society, March 15.—Mr. F. C. Bayard, President, in the chair.—Mr. F. J. Brodie read a paper on the prolonged deficiency of rain in 1897 and 1898. For several years past there has existed over England, and especially over the central and south-eastern parts of the country, a remarkable tendency in favour of dry weather. The dry weather dealt with in this paper consequently came at a most inopportune time, and its effects, which would in any case have been sufficiently evident, were greatly aggravated by the state of things existing so long previously. Mr. Brodie discussed the rainfall records at eighty stations distributed over the British Isles for the eighteen months, April 1897 to September 1898; these were divided into three periods of six months each. During the period April to September 1897, the rainfall was in excess of the average over practically the whole of Ireland, the greater part of Scotland, and the north-west and south-west of England and Wales; while in the north of Scotland, and the central and the whole of the eastern part of England there was a deficiency of rain, in some parts amounting to between 60 and 70 per cent. During the period October 1897 to March 1898, with the exception of the north-west of Scotland and England, the rainfall was below the average all over the British Isles, the deficiency over the midland and south-eastern parts of England being from 50 to 60 per cent. below the average. During the period April to September 1898, two of the six months were excessively dry, and in the southern parts of England at least two others had a deficiency of rainfall. Taking the period as a whole, the rainfall over the eastern, midland and southern counties amounted to less than 80 per cent. of the average, and in the south-eastern counties to less than 60 per cent., the smallest proportion of all being 51 per cent., in London. From an examination of the Greenwich rainfall records since 1841, it appears evident that for length and severity combined, the recent spell of dry weather was the most remarkable experienced there during that period.—A paper on the climate of Jersey, by the Rev. H. W. Yorke, was read by the Secretary. The situation and geological formation of the island, together with the action of the tides, have a great local effect upon the general character of the weather. The climate as a whole is bright, genial and sunny.

MANCHESTER.

Literary and Philosophical Society, February 21.—Mr. J. Cosmo Melvill, President, in the chair.—Dr. C. H. Lees gave an account of some preliminary experiments on the effect of pressure on the thermal conductivities of rocks and other substances, which he had undertaken with the view of providing data for a recalculation of the age of the earth by Lord Kelvin's method. The experiments showed that there was a slight tendency for the thermal conductivity to increase with pressure, which would render necessary a small lowering of the earth's age given by Lord Kelvin.—On the plague in Uganda, by the Right Rev. Bishop Hanlon (Uganda). The author described the plague, which is known by the natives as "kaumpuli," as being akin to the black plague which once scourged London. It begins suddenly, there is high fever, and a swelling, usually under the armpit. Like many plagues, it has both a mild and virulent form. The first is not attended with much fever; the swelling moves about the body, and, should it get near the heart or into the throat, death may ensue. In the virulent form the swelling seems stationary, either under the armpit or in the fork of the legs, whilst the patient dies if not speedily attended to, this being the case with many sufferers before their condition has become known to a European. This form is considered very infectious; the natives shun the sick person, and will on no account bury those who die; they even remove from the neighbourhood of the hut where the patient died. The natives have a remedy for the disease, but never have it ready to hand when required; the missionaries, therefore, keep it prepared. This remedy consists of a certain insect—a common native fly—many of which are crushed and mixed with vinegar, the preparation thus made being rubbed on the swelling. So great is the terror of the natives when attacked by the disease, that the missionaries' greatest fear is lest death should happen from sheer fright. Buddu has for many years been the centre of this plague in its worst form, and Bishop Hanlon disputes the statement made by Dr. Koch that the disease has travelled from other parts of Uganda to Buddu, and thence south to German territory, he being of opinion that the plague was introduced into Uganda by way of the German East African territory, which has been for many generations the chief Arab route to that part of Africa.

March 7.—Mr. J. Cosmo Melvill, President, in the chair.—A new version of Argand's proof that every algebraic equation has a root, by Prof. H. Lamb, F.R.S.—Prof. Schuster, F.R.S., exhibited some lantern slides illustrating researches made by Mr. G. Hemsalech and himself on the velocity of metallic molecules in the electric spark (see p. 350).

DUBLIN.

Royal Dublin Society, February 22.—Prof. G. F. FitzGerald, F.R.S., in the chair.—Prof. T. Johnson gave an account of the improvement of bog land, illustrating his remarks by an account of the work carried on by Dr. Baumann at the bog experimental station, Bernau, Bavaria, visited by him last year.—Prof. W. F. Barrett read a paper on the remarkable thermo-electric behaviour of certain alloys of nickel steel. In the course of an examination of the physical properties of numerous alloys of steel prepared by Mr. R. A. Hadfield, of the Hecla Steel Works, Sheffield, the author found the thermo-electric behaviour of some of these alloys so remarkable as to be worthy of a separate note. Two alloys of nickel and manganese steel marked 1414 A and 1414 B, which had the enormous electric resistances of 90·6 and 97·5 microhms per cubic cm. respectively (see next paper), were found to give an almost constant electro-motive force through a wide range of temperature, when coupled with iron as the second metal. In the case of 1414 B coupled with the purest commercial iron, the electro-motive force rose rapidly up to a temperature of 300° C., and then remained practically constant up to 800° C., a range of 500° C., that is, from a low black heat up to a bright red heat. Such a couple would form a new standard of electro-motive force, as it is easily made and simply requires heating in any gas flame. Coupled with platinum instead of iron these alloys give an increasing electro-motive force, from about 200° C. to a white heat, the direction of the electro-motive force changing below 200° C. The second part of the paper deals with the curve of electro-motive force on cooling; which is found to be not coincident with that on heating in the case of iron and steel coupled with platinum. At corresponding temperatures a *lower* electro-motive force is noticed in cooling than in heating, the difference being least marked with pure iron, and most with steel, the temperature ranging from 0° to 900° C. The heating and cooling thermo-electric curves thus enclose an area which represents the molecular work done on the iron and steel during the cycle. This may be connected with the phenomena of recalescence. In the case of a couple of 1414 B and platinum the cooling curve, however, shows a higher electro-motive force than the heating curve at corresponding temperatures. The author is continuing his investigations on these and other points.—A paper on the electric conductivity and magnetic permeability of an extensive series of steel alloys (Part i.), by Prof. W. F. Barrett and Mr. W. Brown, was read by Prof. Barrett. This paper gives the main results of four years' work on upwards of a hundred different alloys of steel prepared by Mr. R. A. Hadfield. For the purpose of investigation the alloys were prepared in the form of rods 106 cms. long and about 0·5 cm. diameter. The electric conductivity was determined by the potential method, and referred to Matthiessen's standard of pure copper as 100. Some of the alloys could not be obtained in a homogeneous condition; those which could be were divided into three classes: (1) those with one element added in varying proportions, of which there were eight groups containing about fifty different alloys; (2) those with two elements added, of which there were fourteen groups, also with fifty different alloys; and (3) those with three or more elements added, of which there were five groups with six different alloys. The results were plotted in curves, and show the strikingly different effect which the addition of different elements have on the conductivity of iron. The alloys of tungsten steel diminishing the conductivity *least* and those of aluminium and silicon *most*, manganese having almost as great an effect as the two latter. In all cases the conductivity rapidly falls with small additions of a foreign element up to 2 per cent. in some cases, and 7 to 10 per cent. in others, after which larger additions of the foreign element have but a small effect on the conductivity. In the case of eight different alloys the material was obtained in the form of wire and strip, and the specific resistance and temperature coefficient determined in this condition. The highest resistance was obtained with a nickel-manganese steel alloy marked 1414 B, which gave the enormous resistance of 97·52 microhms per cubic cent. and the remarkably low temperature coefficient of 0·085 per cent. per 1° C. Another similar alloy, marked 1414 A, with somewhat less nickel, had a specific resistance of 90·62 microhms per cubic cent. and a temperature coefficient of 0·1046 per cent. per 1° C.; another gave 89 microhms. These exceed rheostene, also an alloy of nickel and manganese steel, which was found by the authors in 1895 to have a specific resistance of 83·1 microhms per cubic cent. and a temperature coefficient of 0·109 per cent. per 1° C. The second part of the paper deals with the magnetic properties of these alloys. Permeability tests were made, and complete H and B curves obtained for forty-four different alloys. The results are given in the curves and tables attached to the paper. A standard curve was obtained of the purest commercial iron containing less than 0·03 per cent. of carbon. In the case of the tungsten steels, the results are extremely remarkable and of practical importance in the discovery of the best alloy for the construction of permanent magnets. The effect of nickel in the magnetic permeability is also very striking: here, as in other cases, the thermal treatment of the alloy after manufacture was a matter of much consequence. The rods were therefore all submitted to the same thermal treatment, and the permeability taken after annealing. In addition, duplicate sets of many of the alloys were made in the annealed, and unannealed condition, and the electric conductivity and magnetic permeability with complete B and H curves determined in both conditions. The annealing process consisted in heating the rods to a temperature of 1000° C. in a large annealing furnace, and then allowing them to cool very slowly down to the temperature of the air. This took nearly 100 hours, or upwards of four days and four nights.

EDINBURGH.

Royal Society, February 20.—Prof. Chrystal in the chair.—Dr. Buchan, in a communication on the tidal currents of the North Sea, drew attention to the facts which had been established by experiments made by the Scottish Fishery Board. According to Dr. Fulton's summary, the current of surface waters was down the east coast of Scotland and England as far as Spurnhead, then eastwards towards the north of Denmark, and finally northwards along the Norwegian coast. Dr. Buchan pointed out that two important factors contributed to the production of this system of currents. (1) The earth's rotation causing a westward lag of water passing from higher to lower latitudes, and an eastward acceleration of water flowing from lower to higher latitudes; and (2) the westerly and south-westerly direction of the prevailing winds giving the eastward set to the water between the Wash and Denmark. Considerable discussion followed this paper, Sir John Murray expressing doubt as to the sufficiency of the evidence for the particular circulation of currents given on Dr. Fulton's map, while Dr. Knott doubted whether the observed drift of bottles in the North Sea should be ascribed to the *tidal* currents as such, and not rather to the resultant effect of wind over the Atlantic superposed upon the tidal ebb and flow.—Prof. Tait's paper on the experimental bases of Prof. Andrews' paper on the continuity of the gaseous and liquid states of matter (*Phil. Trans.*, 1869), was a communication of data hitherto unpublished, the necessity for which for certain purposes had been pointed out by Mr. Tsuruda, of Tokyo University, in a recent letter to NATURE.—Dr. C. G. Knott, in a note on magnetic twist in nickel tubes, showed how remarkably accordant were the results of experiment with the theory that the twist in a nickel tube, circularly and longitudinally magnetised, was to be explained in terms of the elongations along and perpendicular to the magnetising force. It was necessary, however, to take into account the effects of hysteresis.

Mathematical Society, March 10.—Dr. Morgan, President, in the chair.—The following papers were read:—"Note on attraction," by Prof. Tait (communicated by Dr. C. G. Knott); "On wireless telegraphy and high potential currents," by Mr. J. R. Burgess.

PARIS.

Academy of Sciences, March 13.—M. van Tieghem in the chair.—On the numbers of Betti, by M. H. Poincaré.—On the double cyanides, by M. Berthelot. Thermochemical studies on the replacement of potassium by hydrogen in cyanides by weak acids, such as boric and carbonic acids, sulphuretted hydrogen and phenol.—Does iodine exist in the air, by M. Armand Gautier. The air was carefully filtered over glass wool, and the deposit treated with water, so that iodine was looked for in three places, in those solid substances deposited on the glass soluble in cold water, substances deposited but insoluble in water, and gaseous substances carried on by the filtered air. The minute precautions necessary to guard against the accidental introduction of iodine are carefully described, and results given for air of various localities: town, country, sea and mountain. No iodine could be detected in the filtered air in any case; neither could any soluble iodides be found in the deposit on the glass. Minute traces could, however, be detected in the solid deposit after this had been fused with potash, showing that the iodine was present in the form of complex iodo-compounds, perhaps suspended spores, lichens, or algæ. Sea air contained thirteen times as much iodine as Paris air, the latter containing only ·0013 mgr. per 1000 litres.—An attempt at a new form of the relation $f(p, v, t) = 0$; the case of a state of saturation, by M. E. H. Amagat.—On the interpretation of a limited number of observations, by M. E. Vallier. The author discusses the effect upon the mean of a small number of observations of the same quantity, of rejecting one whose deviation from the mean is large.—M. R. P. Colin was elected a Correspondant for the Section of Geography and Navigation, in the place of M. Manen.—Observation of the Swift comet (1899 *a*), made with the large equatorial of the Observatory of Bordeaux, by M. F. Courty.—On two ancient Bielid showers, by M. D. Eginitis.—On the mechanism of the disintegration of hydraulic cements, by M. H. Le Chatelier. The disintegration of hydraulic cement after some months or years cannot be ascribed to the hydration of free lime or magnesia, as the latter would be a matter of days at most, but would appear to result from two causes: the greater or less solubility of the active constituents of the cement, and the variation of solubility of the solids with the pressure they support.—On the conditions of maximum sensibility of galvanometers, by M. C. Féry.—On a very sensitive coherer, obtained by the simple contact of two pieces of carbon; and on the proof of extra currents induced in the human body by electric waves, by M. Thomas Tommasina. The author has succeeded in making a detector for electric waves, or coherer, out of two electric light carbons, which possesses the property of losing its conductivity with extreme ease with a very slight shock.—Death by alternating electric currents, by MM. J. L. Prevost and F. Battelli.—On methyl-ethane-pyrocatechol, by M. Ch. Moureu. This substance has been prepared from ortho-oxyphenoxyacetone by two methods: one by the action of phosphorus pentoxide in presence of quinoline; the other by treating with acetyl chloride in presence of orthoformic ether.—Double iodates of manganese peroxide, by M. A. Berg.—Researches on *aa*-dimethyl-glutaric acid, by M. E. E. Blaise. Attempts to synthesise *aa*-dimethyl-glutaric acid having failed owing to the production of a pyrrolidine compound, this last substance was also prepared from the natural acid by conversion into the amide and treatment of this with hypobromite. The synthetical pyrrolidine derivative proved to be identical with that obtained from the natural acid, thus proving the constitution of the latter.—On the hæmatin of blood, and its varieties in different species of animals, by MM. P. Cazeneuve and P. Breteau. Pure crystallised hæmatin prepared from the blood of the cow, horse, and sheep showed distinct differences in composition, particularly in the amounts of iron and nitrogen.—On a very sensitive reaction of acetone-dicarboxylic acid, by M. G. Denigès. With acid solution of mercuric sulphate this ketonic acid forms an insoluble compound, even in very dilute solution. The time that the turbidity takes to appear after heating with the reagent is a function of the amount of ketone-acid present, and upon this fact the author bases a method of estimating citric acid.—Oxidation of secondary and tertiary amines, by M. Œchsner de Coninck.—Method of water analysis applicable to water softening on the technical scale, by MM. Léo Vignon and Meunier.—On the use of lime for preparing wool for the Aye-bath, by MM. Ch. E. Guignet and Em. David. The authors have successfully applied on the technical scale an observation of Chevreul on the favourable effect of a lime-water bath upon wool previous to dyeing.—On the reducing power of the tissues: muscle, by M. Henri Hélier.—Synthesis of some vowels, by M. Marage.—On the pathogenic agent in hydrophobia, by M. E. Puscarin.—On an oxydase secreted by the coli-bacillus capable of producing a pigment, by M. Gabriel Roux. The most suitable culture for this purpose was found to be an extract of the head of the artichoke, incorporated with gelatine in the usual proportions. This when sown with the *bacillus Coli communis* gives a copious culture, and acquires a fine emerald-green coloration. Under similar conditions the Eberth bacillus gives rise to no special tint.—On the Algæ which grow upon *Maia squinado*, in the Bay of Biscay.—On the use of colouring matters in investigating the origins of springs, and of waters filtering into these, by M. A. Trillat.

NEW SOUTH WALES.

Royal Society, December 7, 1898.—The President, G. H. Knibbs, in the chair.—The following papers were read:—"The group divisions and initiation ceremonies of the Barkunjee tribes," by R. H. Mathews.—"Native silver accompanying matte and artificial galena," by Prof. Liversidge, F.R.S. The specimens exhibited were obtained from between two courses of brickwork in the arch over the vault of an old reverberatory furnace; the upper course had been raised bodily, but remained intact, and the space between became filled to a thickness of about four inches with a layer of clean matte; the metallic silver occurs on the surfaces in the cracks and crevices of the matte and bricks.—"The blue pigment of corals," by Prof. Liversidge, F.R.S. The coral examined was *Heliopora coerulea*, obtained by Prof. David from Funafuti Atoll when conducting the Coral Reef Exploration in 1897. He states that it is very abundant there in places. The specimens were of a dull, light slate-blue colour externally and a little darker internally (see Moseley's paper in the *Challenger* Report, Zoology ii., p. 109). The pigment has not yet been obtained in a pure condition, as the quantity at disposal was very small. Neither has it yet been obtained in a crystallised condition; its best solvent appears to be glacial acetic acid, to which it imparts a rich blue colour. It appears to be quite distinct from indigo, also from the blue pigment of lobster-shell and other blue substances; the colour of the emu egg-shell seems to be somewhat similar. Its ash contains a good deal of iron, phosphoric oxide, lime, and some magnesia. Rather more than 1 per cent. of the crude pigment was obtained from a freshly collected specimen; an old water-worn dead specimen yielded only ·26 per cent. of pigment. It does not readily lend itself to dyeing either silk, wool, or cotton. On extracting it in a percolator with glacial acetic acid or with absolute alcohol, it after a time changes to a green colour. Dilute solutions of indigo in acetic acid or of sulphindigolic acid fade much more quickly than solutions of the coral blue of equal depths of colour.

AMSTERDAM.

Royal Academy of Sciences, January 28.—Prof. Van de Sande Bakhuyzen in the chair.—Prof. Martin read a paper on brackish-water deposits, occurring in the interior of Borneo, especially in the basin of the Kapooas. They came to the author's knowledge chiefly from the Mĕlawi (a tributary of the Kapooas). In that locality they contain species of *Arca*, *Cyrena*, *Corbula*, *Melania* and *Paludomus*, not one of which is known to have been found in other localities. Among these the occurrence of the genus Paludomus, two species of which have been found, both closely allied to still living Bornean species, is of particular importance. The deposits of the Mĕlawi must be of more recent date than the "intertrappian beds" of India, but still they belong in all probability to the Eocene period. Brackish-water deposits also occur along the Silat (another branch of the Kapooas), containing, however, a different fauna, chiefly characterised by the presence of two species of *Vivipara*. Perhaps these Silat sediments may prove to be older than the Mĕlawi sediments, but they certainly are not older than the Cretaceous formation.—Prof. Van Bemmelen on the isotherms (c, p) at 15° of dehydration, rehydration and re-dehydration of the hydrogel of Fe_2O_3 (c = percentage of water, p = vapour pressure), and presented on behalf of Mr. B de Bruyn a paper on the equilibrium of systems of three substances, two of which are liquids.—Prof. Cardinaal made a communication concerning Sir R. H. Ball's theory of screws, showing the application of Capcrali's method of representation to screws, belonging to a system of the fourth order. Screws in a plane, or passing through a point, were chiefly discussed.—Prof. Lorentz on the vibrations of electrified systems, placed in a magnetic field. A contribution to the theory of the Zeeman-effect.—Prof. Jan de Vries on trinodal quartics. As is well known, the six points in which a trinodal quartic is cut by the lines that touch it in the nodes, lie in a conic, and there is a second conic, containing the points of tangency of the six tangents, that may be drawn from the nodes to the quartic. The author proved that these two conics have two residual points in common. In connection with the theorems, found by Brill (*Math. Ann.*, xii. 106, and xiii. 182), according to which the six points of inflexion are on a conic, which cuts the first-mentioned conic on the quartic, the residual points therefore belong to the three remarkable conics. The author also proved that the quartic contains three systems of inscribed quadrangles, so that in the case of each system the intersections of opposite sides coincide with the intersections of two bitangents.—Prof. Van der Waals presented a paper by Mr. J. J. Van Laar, of Utrecht, entitled, "Calculations of the second correction on the magnitude b of Van der Waals's phase equation."

DIARY OF SOCIETIES.

THURSDAY, MARCH 23.

SOCIETY OF ARTS, at 8.—London Water Supply: Walter Hunter.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Hissing of the Electric Arc: Mrs. Ayrton. (Illustrated by Experiments.)

FRIDAY, MARCH 24.

ROYAL INSTITUTION, at 9.—Transparency and Opacity: Lord Rayleigh, F.R.S.

PHYSICAL SOCIETY, at 5.—On the Criterion for the Oscillatory Discharge of a Condenser: Dr. Barton and Prof. Morton.—The Minor Variations of the Clark Cell: A. P. Trotter.

SATURDAY, MARCH 25.

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

ESSEX FIELD CLUB (at Municipal Technical Institute, Stratford), at 6.30.—Annual Meeting.—Presidential Address: Life Problems in Modern Science: David Howard.—Life-History of the Tiger-Beetle (*Cicindela campestris*): Fred. Enock.

MONDAY, MARCH 27.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Illustrations of Waves: Vaughan Cornish.

INSTITUTE OF ACTUARIES, at 5.30.—Some Notes on Sinking Fund Assurances: J. E. Faulks.

TUESDAY, MARCH 28.

ANTHROPOLOGICAL INSTITUTE, at 8.—Mitla (State of Oaxaca, Mexico): a Study of its Ancient Ruins and Remains: Wm. Corner. (With Lantern Illustrations, Maps, Plans, Drawings, and Antiquities).—Mr. Corner will also exhibit a Collection of Recent Photographs of North American Indians, taken by Rinehaut, Omaha, Neb, U.S.A.

ROYAL HORTICULTURAL SOCIETY.—Prof. Henslow's Demonstration.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Alloys of Iron and Nickel: Robert Abbott Hadfield.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Ozotype with Carbon Tissues, a New Method of Pigment Printing: T. Manly.

WEDNESDAY, MARCH 29.

CHEMICAL SOCIETY, at 3.—Anniversary Meeting.—Election of Officers and Council.—President's Address.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Report of the Seventh Meeting of the Australasian Association held at Sydney, 1898 (Sydney).—Botanische Untersuchungen: S. Schwendener (Berlin, Borntraeger).—In the Guiana Forest: J. Rodway, new edition (Unwin).—Astronomical Observations and Researches made at Dunsink, Part 8 (Dublin, Hodges).—Energy and Heat: J. Roger (Spon).—The Entropy Diagram and its Applications: Prof. J. Boulvin, translated by B. Donkin (Spon).—The Administrative Control of Tuberculosis: Sir R. Thorne Thorne (Baillière).—Haunts and Hobbies of an Indian Official: M. Thornhill (Murray).—Funafuti: Mrs. E. David (Murray).—Queen's College, Galway, Calendar for 1898-99 (Dublin, Ponsonby).—Karl Ernst von Baer und Seine Weltanschauung: Prof. R. Stölzle (Regensburg, National Verlagstanstalt).—Report of the U.S. National Museum, 1896 (Washington).—The Dawn of Reason: Dr. J. Weir, jun. (Macmillan).—Allgemeine Erdkunde, iii. Abteilung (Wien, Tempsky).—The Lepidoptera of the British Islands: C. G. Barrett, Vol. v. (L. Reeve).—Examination of Water: Prof. W. P. Mason (Chapman).—The Microscopy of Drinking-Water: G. C. Whipple (Chapman).—Ichthyologia Ohiensis, or Natural History of the Fishes inhabiting the River Ohio and its Tributary Streams: C. S. Rafinesque and Dr. R. E. Call (Cleveland, Burrows).—Organoterapia: E. Rebuschini (Milan, Hoepli).—On Centenarians and the Duration of the Human Race: T. E. Young (Layton).—Sitzungsberichte der K. V. Gesellschaft der Wissenschaften. Math. Naturw. Classe, 1898 (Prag).

PAMPHLETS.—Address delivered by James Stuart, M.P., on the Occasion of his Installation as Lord Rector of the University of St. Andrews, January 23, 1899 (Macmillan).—The Chinch Bug (Washington).—The Water Supply of Sussex from Underground Sources: W. Whitaker and C. Reid (London).—Royal Geographical Society Year-Book and Record, 1899 (1 Savile Row).—Report of the Meteorological Council for the Year ending March 31, 1898, to the President and Council of the Royal Society (London).

SERIALS.—American Journal of Science, March (New Haven).—Himmel und Erde, March (Berlin).—Bibliography of the more Important Contributions to American Economic Entomology, Pt. 6 (Washington).—Journal of the Institution of Electrical Engineers, March (Spon).—Proceedings of the Royal Society of Edinburgh, Vol. xxii. pp. 249-360 (Edinburgh).—American Naturalist, March (Ginn).—Popular Astronomy, March (Northfield, Minn.).—Zoologist, March (West).

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