THURSDAY, JANUARY 6, 1898.

CAYLEY'S PAPERS.

The Collected Mathematical Papers of Arthur Cayley, Sc.D., F.R.S. Vols. viii., ix. Pp. liv + 570, xvi + 622. (Cambridge: at the University Press, 1895, 1896.)

THESE two volumes form the first of those published after Cayley's death in 1895. The first thirty-eight sheets of Vol. viii. were revised by the author, who added a note on one paper (No. 518); the duty of editing the rest of the papers was entrusted to Prof. Forsyth, who has very faithfully carried out the plan and arrangements which, in the absence of definite instructions, he was able to infer from the previous volumes.

Perhaps the reader's first impression after surveying these 144 papers, mostly published in the years 1871–77, is that they are very miscellaneous, and that comparatively few are of paramount importance. The fact is that Cayley is, as it were, brought into unfavourable comparison with himself; short notes on special problems of geometry and analysis, and solutions of Smith's Prize papers cannot rank with the immortal "Memoirs on Quantics," or some of the earlier geometrical papers, such as that upon plane cubic curves. But it is unreasonable to expect an artist to produce an uninterrupted succession of masterpieces; and it is to be remembered that Cayley seldom, if ever, wrote upon any subject without developing some instructive point or giving an example of his own characteristic elegance.

In trying to give some account of the more important of these memoirs it will be convenient to take the geometry and the analysis separately. Not that the boundary line is very easy to fix: Cayley was never a geometrician in the sense in which the word may be applied to Apollonius or Steiner. But some of the papers have an interest mainly geometrical, although the methods used are almost wholly algebraic; and with them we will begin.

Perhaps the most important are those which deal with transformation, correspondence, and the singularities of algebraical curves and surfaces. With these difficult theories Cayley dealt in a masterly way: he avoided, as if by instinct, the many opportunities of mistake which present themselves in a method which is largely enumerative, and he had the gift of predicting general results from the consideration of special cases.

Coming next to what may be called the metrical geometry of surfaces, which has developed so greatly in recent years, we have papers on curves of curvature, on geodesics on quadrics, and on orthogonal surfaces. To this group may perhaps be added a paper on evolutes and parallel curves, though this is rather meant to illustrate the non-Euclidian geometry.

There are three monographs, on Steiner's surface, on the centro-surface of an ellipsoid, and on the configuration of the twenty-seven lines of a cubic surface, which are in various ways highly characteristic. As models of analytical skill they are admirable; and as helps to the understanding of the geometrical figures with which they deal, they are of great service. But it is curious to see how chary the author is in giving illustrative diagrams. There are, indeed, two figures in the paper on the surface of centres; but why, we ask, did Cayley not give a series of contour lines of the surface? or again, with still more reason, in the case of Steiner's surface? Then the paper on the twenty-seven lines of a cubic surface is so quaint in its topsy-turveydom as almost to suggest Mr. W. S. Gilbert as joint author. Here we have a projective configuration which may be realised with the help of a bundle of sticks and without any measurement whatever. What Cayley did was to take a model by Dr. Wiener, measure approximately the coordinates of a number of points upon it, thence find the approximate equations of the lines, and finally adjust the equations so as to satisfy the geometrical conditions! Of course there is reason in this seeming perversity: by the projective method it is not easy to get a convenient arrangement of the sticks, whereas Cayley's equations make it possible to construct a string model on a cardboard frame without a tiresome series of preliminary experiments.

The poristic polygons of Poncelet appear to have had for Cayley a perennial charm: we have here two papers suggested by Poncelet's results; one "On the porism of the in-and-circumscribed polygon, &c.," which treats of the original problem, and the other "On the problem of the in-and-circumscribed triangle," which really deals with a rather different and more general theory. Cayley, like many others, does not seem to have been aware (at least in 1871) that the complete algebraical solution of the Poncelet problem was published in 1863 in a paper by M. Moutard, which formed part of the appendix to Poncelet's "Applications d'Analyse à la Géométrie." Not only is this so, but, as Halphen pointed out, this paper contains the first fully satisfactory treatment of the multiplication of the argument in elliptic functions.

Before passing on from the geometrical papers, attention should be called to the very interesting series of notes on the mechanical description of curves. This is a promising field of research, and the results could hardly fail to be of interest, especially to those who like to see the deductions of theory embodied in an actual geometrical figure. There is an æsthetic satisfaction in this contemplation: and, moreover, a really correct figure often suggests geometrical truths that would otherwise be overlooked.

Of the analytical papers the one which has been most appreciated in this country is, beyond question, the short paper "On the theory of the singular solutions of differential equations of the first order" (*Messenger*, vol. ii. (1873) pp. 6–12). Here Cayley's power of giving to analysis a geometrical interpretation appears to the best advantage. If we have an algebraical relation $f(x, y, p) = 0$ in which p enters to the degree s, then this associates with any point (x, y) a series of s (real or imaginary) directions corresponding to the different values of p: in other words, the differential equation really expresses that the plane of reference is covered with ∞^2 tiny s-rayed stars. The primitive $\phi(x, y, c) = 0$ gives a family of ∞^1 curves each made up of ∞^1 selected rays. Now if we eliminate p from $f(x, y, p) = 0$, $\partial f/\partial p = 0$, we obtain a locus of points (x, y) at each of which two rays coincide in direction; where this happens either two consecutive curves $\phi(x, y, c) = 0$ touch, or

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two non-consecutive curves touch, or (x, y) is a cusp or point of self-contact of one particular curve $\phi(x, y, c)=0$. Thus we may have the envelope of the family of curves, a tac-locus, or a locus of cusps or of points of self-contact. On the other hand if we eliminate c from $\phi(x, y, c)=0$ and $\partial\phi/\partial c=0$, we get the locus of intersection of consecutive curves ϕ: this may include besides the envelope proper, a locus of nodes, of cusps, or of multiple points of higher order (as, for instance, points of self-contact or triple points). The only outstanding difficulty is the degree of multiplicity in which the singular loci, distinct from the envelope, are involved in the two discriminants.

There are six papers on the transformation of elliptic functions, the most important being No. 578. This contains an exposition of the Jacobian theory, Sohnke's modular equations with additions, and a discussion of the singularities of some of the modular curves. It is remarkable that Cayley, like Kronecker, adhered firmly to Jacobian methods, and never seems to have worked with the Weierstrassian forms. Perhaps just now there is a rather exaggerated tendency in the other direction: as Prof. Klein has pointed out, both theories are self-consistent and form, in a sense, the first and second stages in a complete discussion of periodic functions.

There is not very much about invariants and co-variants; No. 525 is an interesting example of a quadratic transformation, and the papers on "trees," although ostensibly intended for application to chemistry, were suggested by the invariant calculus.

In arithmetic there is a table of reduced binary cubics with their Hessians, which is a development of Arndt's results. Cayley gives the composition tables for the Hessians.

Volume ix. contains eleven papers dealing more or less with astronomy and dynamics; and it may be worth while to notice that this volume also contains a reprint of the British Association "Report on Mathematical Tables."

Many interesting special points suggest themselves to the reader: thus, to mention only three, very different in character, the very simple and pretty proof of Vandermonde's theorem (viii. p. 465) might very well find a place in an elementary text-book of algebra; we are told (*ibid.*, p. 188) how a theoretical error was detected by a numerical calculation; and (*ibid.*, p. 397) there is an unverified conjecture that every surface of negative deficiency may be derived by a rational transformation from a cone whose deficiency is equal to that of the surface with its sign changed. G. B. M.

EXPERIMENTAL PHYSICS.

The Outlines of Physics. By Prof. E. L. Nichols. Pp. xi + 452. (London: Macmillan and Co., Ltd., 1897.)

Lessons in Elementary Practical Physics. Vol. iii. Part i. *Practical Acoustics.* By C. L. Barnes. Pp. x + 214. (London: Macmillan and Co., Ltd., 1897.)

THE first of these books, as the author explains in his preface, is an attempt to "outline a short course in physics which shall be a fair equivalent for the year of advanced mathematics now required for entrance to many colleges"; and he proceeds to point out that if physics is to possess much disciplinary value, it must be taught by laboratory methods. Experimental work thus finds a prominent place in his book, which may, in fact, be roughly described as a series of experiments, mostly suitable for repetition by young students, connected by short discussions of a theoretical character.

With the author's object we imagine that most teachers of physics will cordially sympathise. That experiment is the means whereby a knowledge of physics should be acquired by beginners, is as clear now-a-days as it is that the means itself is open to improvement—at any rate, in its early stages. Whether the author has made the most of his opportunity is, however, less certain. Much of his work is excellent: the experiments are, for the most part, well chosen and clearly described; but after a careful perusal of his book, one's prevailing impression is that he has attempted to include too much.

A book of this kind is, of course, largely taken up with description of experimental procedure; but the space is often further occupied with matter which might, in our opinion, be left until a later stage in the student's career. Such questions as X-rays, tests for and theory of colour-blindness, interference and polarisation of light, are too large for more than the briefest notice, and might therefore just as well have been omitted altogether; especially when, to mention one instance out of many, curved mirrors are dismissed with a far too scanty discussion, and no special experimental illustrations at all. It would, in our opinion, have been better to develop further the experimental treatment of the simpler parts of physics at the expense of these more elaborate phenomena. It is only in places, however, that the work is affected by this fault; and the same may be said of an occasional laxness of expression which will probably lead to mistakes on the part of young readers where it occurs. Taken as a whole, the book forms a useful addition to the elementary text-books on practical physics.

We have noticed a few points that rather need alteration. In the figure of the apparatus for determining the heat of vapourisation of water (p. 172), the long tube connecting flask and calorimeter should be provided with a trap for the steam condensed in it. The statement in italics on p. 213, that "various bodies can be brought by friction (*i.e.* by doing work upon them) into a condition such that they attract and are attracted," is rather misleading. It is, of course, the work done in pulling the rubber and rubbed object apart which should be emphasised. On p. 337, in the figure illustrating the motions of the air in sound waves, the arrows want altering; on pp. 308 and 310, misprints of iron for ion, and ammonium for ammonia, respectively, occur; and on p. 99, in the last column the decimal point has gone astray.

The general get-up of the book is, as one would expect, excellent; and the diagrams, which are mostly by Mrs. Nichols, are very clear and well executed. We may add that the work is almost wholly non-mathematical.

The second of the two books named at the head of this notice, forms the first part of vol. iii. of the "Elementary Practical Physics" series begun in 1885 by Prof. Balfour Stewart and Mr. W. W. Haldane Gee.

With the rapid development of the teaching of physics by laboratory methods, now in progress, has arisen the growing need of a good practical and elementary course on sound. The present work admirably supplies this need, and constitutes a worthy companion to the well-known volumes already published in the Stewart and Gee series. The author is, moreover, thoroughly familiar with the experimental side of his subject; besides being clearly and concisely written, his work is thus rendered very interesting to read.

Starting with chapters on the nature of sound and wave motion, he discusses in the following order the sonometer, resonance, determination of frequency, rods and plates, tuning forks, pipes, harmonic motion, reflection and refraction of sound, velocity of sound, Döppler's principle, musical scale, analysis of sounds, interference, beats, differential and summational tones, &c. The book ends with a useful list of workers in theoretical and experimental acoustics, with dates of birth and death.

Sound is a subject which lends itself to pretty experiments, and there is no lack of such here. To choose one instance out of many, we may refer to Expt. xc., in which the refraction of air waves in the Sondhauss experiment is imitated in water by making ripples pass over a shallow circular patch in a deeper sheet of water, and thus retarding them as the air-waves are retarded by the CO_2.

More might perhaps be made of the india-rubber cord as an illustration of the properties of stretched strings. By causing a metronome to beat at the same rate as a horizontally stretched cord, it is easy to obtain good quantitative results, while the slowness of the vibrations is a great help to unimaginative students in subsequently understanding the behaviour of stretched wires.

There is a mistake in the diagram on p. 22, where, of the two quantities plotted, one should be replaced by its reciprocal if the result is to be a straight line. On p. 105 there is a 2 omitted from the equation for t.

These are, however, trifling slips in a work for which teachers of physics cannot fail to be grateful to the author.

A. P. C.

AMERICAN GAME BIRDS.

The Gallinaceous Game Birds of North America. By D. G. Elliot. 8vo, pp. xviii + 220, illustrated. (London: Suckling and Co., 1897.)

THE author of this little volume is already so well known to naturalists from his splendid illustrated folio monographs of various groups of mammals and birds, that any work from his pen needs but little in the way of commendation. Among his monographs are two respectively devoted to the grouse and pheasants, and it is the American representatives of these groups that he now describes in a less elaborate form, and with the advantage of all the observations recorded since the publication of his larger works. The present volume is indeed the companion to the author's "North American Shore Birds," which has already been well received; and since a large number of British sportsmen now visit the States, the demand for the work ought to be considerable. Although not so good as some we have seen, the photogravures with which the work is illustrated are for the most part of a fair grade of excellence, and afford every facility for the identification of any specimen with which the naturalist or sportsman may meet.

The work commences with a general dissertation on game birds and their affinities, written in such a popular, and at the same time such exact, style, that it should prove acceptable to readers of every class. Following this is a description of the habits and characteristics of the various North American representatives of the group, which, inclusive of subspecies, total up to forty-four. A feature of the work is that the main portion of the text devoted to each form is headed solely by the popular name of the particular species or race; the technical name and detailed description coming at the end of each section. In view of the general shuffling of scientific names now taking place in all classes of animals, their relegation to a subordinate position in a popular work is by no means inadvisable; and those readers who so desire, can easily skip the technical portions altogether.

Apart from these technical descriptions, the work is written in a bright and attractive manner, the habits of the different species being noted in considerable detail, and their geographical distribution most carefully worked out. It will be a matter of satisfaction to many to learn that while certain kinds of game birds are dying out from the effects of persecution in the more settled districts, some others are gradually making their way to the wilder districts of the west, where they will meet with better chances of survival.

As many of our readers are aware, with the exception of the grouse and ptarmigan, which have a circumpolar distribution, the game birds of North America are totally distinct from those of the Old World; the pheasants, quails, and partridges of the latter being quite unknown in the former area, where their place is taken by the so-called American partridges. The author might have explained that this difference is doubtless due to the inability of either of these groups to withstand the cold of high northern latitudes which apparently prevailed at the time of a land bridge *viâ* Bering Strait. A parallel instance is afforded by the absence of hyænas and civets from America.

As regards classification, the author departs considerably from the view usually adopted in Europe. Instead of restricting the *Tetraonidæ* to the grouse and ptarmigan, he includes in that family the Old World *Perdicinæ* and the American *Odontophorinæ*, both of which are usually placed in the *Phasianidæ*. Apart from all other considerations, the circumpolar distribution of the grouse and ptarmigan renders it in the highest degree desirable that they should be kept as the sole representatives of a family differing by its distribution from all the other groups of the order.

A series of coloured papers illustrating the colour-terms employed in the text concludes this well-written and useful compendium of North American game birds.

R. L.

OUR BOOK SHELF.

L'Éclairage à l'Acétylène. Par G. Pellissier. Pp. 237. (Paris: Carré et Naud, 1897.)

IN England the discovery of calcic carbide, and the ease with which acetylene may be prepared from it, has attracted a large amount of attention; but the literature of the subject is practically restricted to a few papers read before various societies and to the returns of the

Patent Office, whereas in France the subject has been considered of sufficient importance to justify the compilation of several fairly bulky works.

Well illustrated and clearly written, M. Pellissier's volume on "L'Éclairage à l'Acétylène" will be found both useful and interesting to the large number of persons who are now taking a lively interest in the future of this new illuminant.

The work opens with a chapter on the physical and chemical properties of acetylene, and a description of the methods by which it has been made since its discovery by Edmund Davy in 1836, a valuable portion of the chapter being devoted to the dangers attributed to its use under low pressures, a consideration of which leads to the conclusion that under these conditions it is no more dangerous than coal-gas.

The question of electric furnaces is then discussed, and illustrations of the forms in use and proposed are given; and this is naturally followed by a chapter on the carbide itself and the various data obtainable as to its cost, the results obtained by the Committee of Investigation appointed by the editor of the *Progressive Age* in America being largely quoted. Such discussions, however, are of but little use, as the cost of the carbide must vary largely with the cost of the power needed to generate the electricity and the facilities for cheap carriage.

It may be taken as proved that under the conditions at present existing the carbide cannot be made at less than from 7*l.* to 10*l.* per ton in France or in England; whilst the selling price is entirely in the hands of the manufacturer, and amounts to from 16*l* to 20*l.* per ton. In treating of the methods by which acetylene can be generated from the carbide and the generators used or suggested for that purpose, the author very conveniently divides the generators into three classes: those in which acetylene is generated by allowing water to drip on carbide, those in which water is brought in contact with carbide by change of level, and finally, those in which the carbide is dropped into water.

There is not the least doubt that the last is by far the best method to employ, as the gas evolved is far purer, and dangerous rise of temperature is avoided.

The question of portable lamps, acetylene in a liquefied and compressed condition, and its solution in acetone are all dealt with, and no attempt is made to gloss over the dangers incurred directly ordinary pressures are far exceeded. The last three chapters of this little work are devoted to the subject of the conditions existing in the acetylene flame, the forms of burners for its consumption, the relative price of acetylene as an illuminant, and practical directions for its use.

The weakest part of this capital work is that in which the author, with true patriotism, attempts to prove the priority of M. Moissan in discovering the possibility of manufacturing calcic carbide in the electric furnace; whilst facts show that the Canadian, Willson, had made crystalline calcic carbide in the electric furnace, and had privately sent specimens of it to scientific friends, several months before Moissan first mentioned its accidental formation.

Atlas der Himmelskunde auf Grundlage der Ergebnisse der coelestischen Photographie. By A. v. Schweiger-Lerchenfeld. (Vienna: A. Hartleben, 1897.)

HERR VON SCHWEIGER-LERCHENFELD set himself no light task when he undertook the work of selecting and publishing the material gathered together in this beautiful atlas. A glance through the first few parts shows that no pains have been spared, either in the selection and reproduction of the photographs or in the text, to make the volume, when completed, of most absorbing interest to any one who wishes to know something outside this little earth of ours.

The aim of the compiler has been to fully illustrate by the best processes available, and to explain by accompanying appropriate text, the wonders of the universe as they have been revealed to us by means of that most valuable aid to science—photography. Herr v. Lerchenfeld has been fortunate enough, not only in obtaintaining the aid of most of the chief astronomers connected with observatories in which photography is employed, but in receiving valuable information from the most skilled instrument-makers of to-day. The result is that the atlas is full of beautiful reproductions of many of the finest photographs ever taken of celestial bodies, and the instrumental equipment of modern observatories is fully included.

It would be impossible to enumerate the many and various subjects which are here dealt with, so it must suffice to give a brief summary of the more prominent features. It may, however, be first remarked that the atlas in a completed state will contain over 50 large plates and about 135 single reproductions, the text being accompanied by no less than 500 additional illustrations. Nearly one third of the latter is devoted to a description of the various astronomical instruments now at work in the chief observatories of the world. This section is of great interest, and will be found useful, as a great amount of information is here brought together. The fine reproductions of the best lunar landscapes will be found invaluable to selenographers, as particular care has been bestowed on these to render them accurate. Stellar photography is richly and beautifully illustrated, and one really revels among the best illustrations that have yet been brought together in one volume. The plates illustrate the results of employing lenses varying from one to thirty-six inches, with periods of exposures varying from minutes to several hours.

Cometary, solar, spectroscopic and planetary photography all fall within the compiler's reach, so that a reader's desire for a good astronomical picture book is here fully satisfied.

In conclusion we may say that this atlas is well worth obtaining, if only for the illustrations themselves, and it will be found serviceable not only in observatories, but in schools and teaching centres. W. J. S. L.

Knowledge. Vol. xx. January to December 1897. Pp. xii + 304. (London: *Knowledge* Office.)

THIS well-known popular magazine of science is as good to-day as ever it was. The illustrations, especially the full-page plates, are excellent, and the articles cover a variety of scientific subjects. Special characteristics of the volume are a series of articles on the science of the Queen's Reign, and the prominence given to ornithological notes.

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.*]

Physiology and the Royal Institution.

ALL interested in physiology must notice with regret the retirement of the late Fullerian Professor of Physiology from his appointment at the Royal Institution, after expiration of only one year's tenure. His resignation leaves a valuable and notable course of lectures incomplete, to the disappointment of many whom they keenly interested. His withdrawal removes in mid-career a teacher of recognised ability from a chair to which he was devoting himself with conspicuous success. Matter for regret this it seems cannot, however, be taken as matter for surprise, if I judge rightly in connecting with his resignation a letter appearing last July in your columns; there the Fullerian Professor pointed out that the practical circumstances attaching to the chair almost preclude possibility to treat its subject as a province of experimental science. Physiology, inseparable from chemistry and physics, could, one might have imagined, at an Institution so famous for the character of its lectures on those subjects, have been advantageously placed. That, from Prof. Waller's letter, is evidently the reverse of its present case at the Royal Institution. Not a workroom, even of the smallest size, could he obtain for conduction or preparation of his experiments. This must be a revelation to many who know the Institution as connected with the names of men, such as Davy and Faraday, who contributed by research to physiology—who, in other words, considered the chemistry and physics of living material as well as that of dead to lie within the scope of study and inquiry supported by the Institution. It is true that the Fullerian chair of Chemistry has proved fruitful in measure exceeding the productiveness of the Fullerian chair of Physiology. The latter has been declared comparatively sterile. This is regrettable; but its reason does not seem far to seek Both chairs have been held by men of high distinction; but the former has rested upon a laboratory, while the latter—so far from resting upon a laboratory—"does not possess even one small room in which to keep itself alive." Is this condition irremediable? I ask although by circumstance outside the Institution; and ask simply as one interested in the welfare of physiological science, and as a unit of a public who esteem the Institution as a place of instruction for the educated masses of a great city where at present such opportunities as the Institution offers are lamentably few.

Liverpool, December 31, 1897. CH. S. SHERRINGTON.

A Mechanical Theory of the Divining Rod.

THE review in NATURE (October 14, 1897, pp. 568, 569) of a publication relating to the "divining rod," recalls to my mind a purely mechanical theory of that rod, which was given me years ago by a friend.

This theory has been repeatedly tested by me and shown to be correct in the presence of my classes. The process is exceedingly simple. Take any forked twig of a reasonably tough fibre in the clenched hands with the palms upward. The ends of the limbs forming the twig fork should enter the closed fists on the exterior side of each fist, *i.e.* on the two sides of the clenched hands furthest from each other.

When a twig is grasped in this position it will remain stationary if held loosely, or with only a moderately firm grasp; but the moment the grasp is tightened, the pressure on the branches will force the end of the twig to bend downwards. The harder the grip the more it must curve.

The curvature of the twig is mechanically caused by the pressure of the hands forcing the limbs to assume a bent and twisted position; or the force that causes the forked limb to turn downwards is furnished by muscles of the hands, and not from any other cause.

The whole secret of the "divining rod" seems to reside in its position in the hands of the operator, and in his voluntarily or involuntarily increasing the closeness of his grasp on the two ends of the branches forming the fork.

If the above conditions are fulfilled the twig will always bend downwards—water or no water, mineral or no mineral; any one can be an operator, and any material can be used for the instrument, provided the limbs forming the fork are sufficiently tough and flexible.

It can be easily understood how an ignorant operator may deceive himself, and be perfectly honest in supposing that some occult force, and not his hands, causes the fork to curve downwards. M. E. WADSWORTH.

Michigan College of Mines, Houghton,
Michigan, December 8, 1897.

Growth of the Tubercle Bacillus at a Low Temperature.

A BROTH culture of the tubercle bacillus a month old was filtered through a sterilised Berkfeld filter; the filtrate was ascertained to be sterile; it was then sown with a trace of *B. tuberculosis* and incubated at a temperature varying slightly between 18°-20° C., but never higher than 20°.

The bacillus developed well, but not so rapidly as at the customary temperature, *i.e.* 37·8° C.; the growth had not the usual flocculent appearance, but was granular.

Microscopically the organism was unchanged.

London, December 20, 1897. F. J. REID.

THE STORY OF GLOUCESTER.

1979 cases of small-pox, 434 deaths; or a mortality of 21·9 per cent. during a period of thirteen months.

	Cases.	Deaths.	Percentage mortality.
Previously vaccinated ...	1211	120	9·8
Unvaccinated	768	314	40·8
	1979	434	

SUCH, in brief, is the story told by Dr. Sidney Coupland in his Report to the Royal Commission on Vaccination on the outbreak of small-pox in the city of Gloucester in 1895-96.

These figures, in all their baldness, convey a lesson such as no long garnished account can accentuate or emphasise; but in Dr. Coupland's Report a number of most interesting facts and statistics have been brought together, which will form the basis of many future reports and arguments.

One of the most interesting points brought out, apart from the mortality, was the proportion of severe and mild cases in vaccinated and unvaccinated patients. Of those vaccinated in infancy, there suffered from—

	Per cent.	
Malignant small pox	2·4	of the whole of those attacked.
Confluent ,,	19·1	,, ,,
Coherent ,,	9·6	,, ,,
Discrete ,,	28·7	,, ,,
Mild ,,	40·0	,, ,,

When we come to those who are said to have been vaccinated, but of which there is no very strong evidence, we find:—

	Per cent.	
Malignant small-pox	17·5	of the whole of those attacked.
Confluent ,,	52·5	,, ,,
Coherent ,,	10·0	,, ,,
Discrete ,,	12·5	,, ,,
Mild ,,	7 5	,, ,,

Being a marked rise in malignant and a great fall in mild cases.

Amongst the unvaccinated the proportion of severity of attacks at all ages was:—

	Per cent.
Malignant small-pox	5·0
Confluent ,, ...	72·3
Coherent ,, ...	10·3
Discrete ,, ...	8·7
Mild ,, ...	3·6

Showing a very high percentage, indeed, of the severe type of case.

These figures are given in full because they afford evidence, quite apart from the mortality, of the enormous influence that vaccination exerts on the course of an attack of small-pox.

The Gloucester epidemic appears to have differed from almost every other recent outbreak of small-pox in the fact that its incidence was especially heavy on infants and young children. Below one year the proportion of deaths was no fewer than 14 per cent. of the whole, whilst at ages from 1 to 10 years it was exceedingly heavy—50·4 per cent. This, of course, was accompanied by a corresponding diminution in the proportion of deaths at later years; and from 10 to 30 years the proportion had fallen to 12·6 per cent., though from 30 years and upwards (the effect of early vaccination having worn off to some extent) it had again risen to 22·7. When these figures are compared with the earlier outbreak of 1873-75 in Gloucester and with the Dewsbury and Leicester outbreaks, it is found that the proportion of deaths amongst children is exceptionally high. It was noticed, too, that the disease spread amongst these children with enormous rapidity, and that it occurred amongst them in an exceptionally severe type, both as regards the proportion of malignant cases and the height of the mortality.

It is certainly not going beyond the facts of the case to state that the above-mentioned characteristics of this epidemic must in great measure be attributed to the large number of unvaccinated children who were in attendance at school, and who were thus not only extremely susceptible to the attacks of small-pox, but were in a position to disseminate the disease, though in a milder form, amongst those who had been vaccinated. That is, the neglect to have the children vaccinated left them in a condition in which they would readily take small-pox just at the time when their surroundings were of such a nature that everything was favourable to their taking the disease from one another, and in turn passing it on to those with whom they daily came in contact; with the result, as Dr. Coupland points out, that one in twenty of the whole population of Gloucester were struck down with small-pox. Indeed, he goes so far as to say that, "viewing the subject with as impartial a mind as I can, the conviction is forced upon me that Gloucester would not have suffered as it did had its child population been vaccinated." It was this want of vaccination, and the impossibility of maintaining effective isolation of the attacked, that allowed of the abnormally rapid spread of the disease after it has once obtained a firm hold in the city.

If there was one more important feature than the rapidity of the outbreak, it was that the epidemic faded away—for that is the only term that can be applied—so abruptly. Numerous explanations have been put forward to account for this, but the only factor that appears to have had any real determining influence in bringing about this abrupt cessation of the disease, was the universal adoption of re-vaccination after small-pox had already obtained its firm foothold in the city.

That Dr. Coupland is not going beyond his brief when he holds that this high child mortality was due to the unvaccinated condition of many of the children, is evident from certain statistics which he gives concerning 3546 cases. Of these only 85, or 2·5 per cent., were in vaccinated children below the age of ten years; and amongst these 85 cases there was only a single death.

These were all cases recorded in papers and reports which had come directly under Dr. Coupland's personal observation during his investigations into the outbreaks of small-pox in Dewsbury, Manchester, Oldham, Leeds, Halifax, Bradford and Leicester. In the Dewsbury, Leicester, and Gloucester outbreaks the number of children that had not been vaccinated was very high indeed. Now, taking Dewsbury, where the proportion was lowest, the number of deaths to attacks was as one to nine; in Leicester, as one to seventeen; and in Gloucester—where the proportion of unvaccinated was highest of all—the proportion of deaths to attacks was as one to four and a half, although the attacks in Gloucester were nearly 2000 (1979), in Leicester 357, and in Dewsbury 1029.

Comparing these three outbreaks, and bearing in mind the proportion of unvaccinated as above, we find that the proportion of the whole number attacked under ten years was in Dewsbury 21·7 per cent., in Leicester 30·5 per cent., and in Gloucester 35·6 per cent.; the fatality of this class in the three cases being Dewsbury 25·4 per cent., Leicester 13·7 per cent., and Gloucester 39·6 per cent.

As affording evidence of the disproportionate incidence of the disease upon young children, to which reference has already been made, it may be stated that 706 of the whole number attacked, or 35·7 per cent., were under ten years of age; whilst of the 434 fatal cases 280, or 64·5 per cent., occurred in this age period. Of these 706 only 26 had been vaccinated before the epidemic broke out, whilst of the remainder, 80 were undergoing vaccination when attacked with small-pox, the operation having been performed within fourteen days of the onset of the disease. It will thus be seen that only 4 per cent. of those attacked at this age period had been vaccinated, although a much larger proportion of vaccinated had been exposed to infection. It is found that of those exposed to infection, in households invaded by small-pox, of the vaccinated class 3386, and of the unvaccinated class 1475, there were attacked with small-pox—of the vaccinated class 1028, or 30·3 per cent.; whilst of the unvaccinated class 689, or 46·6 per cent., became infected.

It has already been indicated that amongst the unvaccinated at Gloucester the type of the disease was much more severe than in the vaccinated class. For purposes of comparison it may be shown that in Gloucester, where, as we have already seen, the number of unvaccinated children was very high—much higher than in Dewsbury or Leicester—the type of the disease over all was much more severe than at either Dewsbury or Leicester, and still more so than in many of the other recent outbreaks. Taking the severe type as including malignant and confluent cases, and the milder type as including coherent, discrete and mild cases, we find that in Dewsbury 26·5 per cent. of all attacks were of a more severe type, in Leicester 26·8 per cent., and in Gloucester 43·1 per cent.; whilst the mild type accounted for 27·5 per cent. in Dewsbury, 35·5 in Leicester, and only 25·5 in Gloucester.

If we now take out Dr. Coupland's figures as regards attacks of small-pox affecting vaccinated and unvaccinated patients, we find that in Dewsbury 64·3 per cent. of the whole number, with a mortality of 2·7 per cent., were vaccinated; in Leicester 55·8 per cent., with a mortality of 1 per cent.; in Gloucester 61·2 per cent., with a mortality of 9·8 per cent. These figures compare very favourably with the cases of deaths in the unvaccinated class. There were 35·7 per cent. of the whole cases that had not been vaccinated in the Dewsbury Union, and amongst these there was a fatality of 25 per cent.; in Leicester 44·3 per cent. of the cases were unvaccinated, with a death-rate of 12 per cent; whilst in Gloucester 38·8 per cent. of the cases had not been vaccinated, and amongst these there was a death-rate of 40·8 per cent. It will thus be seen that the lowest death-rate in the unvaccinated class (12 per cent. at Leicester) was considerably higher than the highest death-rate in the vaccinated class (Gloucester, 9·8 per cent). It must be borne in mind, of course, that even in the worst vaccinated districts the proportion of unvaccinated to vaccinated persons is very much lower than the proportion of vaccinated small-pox cases to non-vaccinated cases, so that we not only have an enormously greater mortality amongst those attacked, but the percentage of attacks is also considerably higher.

Any one who goes carefully and with unbiassed mind into the statistics collected by Dr. Coupland must inevitably come to the conclusion that, although the disease was spread in schools owing to the simultaneous infection of school children from cases unrecognised by, or unknown to, the authorities until the area of infection had been considerably widened; although after the sudden outbreak of small-pox it became, first, a difficult—and eventually an impossible—task to isolate the patients attacked, and to treat even a small proportion in hospital; and although insanitary surroundings and a certain amount of overcrowding may have played some part in spreading the disease, we must ultimately fall back upon the neglect of a large number of parents to see to the vaccination of their children for an adequate explanation of the extent of the epidemic and the rapidity of its extension. The utter futility of all ordinary measures recommended for the limitation of the spread of small-pox, apart from vaccination, is only too clearly brought out.

Hospital accommodation and isolation are usually insisted upon, by those who do not believe in vaccination, as being sufficient to prevent any outbreak of small-pox assuming serious epidemic proportions. Now, what did Dr. Coupland find at Gloucester? That a few slight or mild cases in 1895 were followed by a severe epidemic extending from February to April 1896, in which not only was there an increase in the numbers attacked, but there w s also an undue proportion of cases of a severe type accompanied by a high rate of mortality. As showing how in a community with a large proportion of unvaccinated children the disease may spread rapidly, we have the fact that there was an "almost simultaneous invasion of many homes through children who were infected whilst attending certain of the public elementary schools." As a result of this sudden outbreak it became impossible to provide hospital accommodation, and, ultimately, all attempts at isolation, of even a modified form, had to be abandoned as utterly impracticable. As a result of the crowding of the hospitals, and of the removal of the most severe cases to them, the hospital mortality was comparatively high, and the friends of the patients would soon not permit of the removal of these patients to hospitals; this, of course, resulting in an utter break-down of the system of isolation.

Dr. Coupland sums up in the following exceedingly striking passages. He says: "There is no escape from the conclusion that the heightened mortality and the severity of the epidemic were greatly due to so large a proportion of unvaccinated children being attacked; for (*a*) the case mortality under ten years of age was 39·6 per cent., whilst amongst the vaccinated it was only 3·9 per cent., leaving a mortality amongst the unvaccinated of 41 per cent. . . . (*b*) The disparity is quite as marked when the type of the attack is contrasted, for of 507 cases of *severe* attacks [malignant, confluent, indeterminate] there actually occur only three amongst the vaccinated." From these and other considerations it follows that in the Gloucester epidemic "the severity of the disease, its high mortality, and its propagation were influenced and promoted by the unduly large proportion of unvaccinated children who were exposed to infection and who were infected."

To whatever figures or tables we turn, the effect of them is always the same. They tell the same story — vaccination protects; unvaccinated children are left susceptible to the attacks of the disease, and they not only take the disease more readily, but they take it in a more dangerous and fatal form, and, in most cases at any rate, are a source of greater danger to those with whom they may come, directly or indirectly, in contact. Isolation, good hospital accommodation, and favourable sanitary conditions are useful in the treatment of small-pox in a vaccinated community; but once let small-pox find its way into an unvaccinated community, the inefficiency of these "accessory" measures, when used alone, are demonstrated with the most absolute clearness; and if Gloucester has one lesson more than another to teach, it is that Jenner, by his advocacy of vaccination, did more to limit the spread of small-pox than have all the sanitarians of the century. Small-pox undoubtedly does not come under the class of diseases that can be held in check by ordinary sanitary measures; these, no doubt, are contributory, but without vaccination they can never be depended upon as being fully effective.

CANADIAN GEOGRAPHY.

THE reissue of "Stanford's Compendium" now includes Australia and the Pacific Islands in two volumes by separate authors, Asia in two volumes and Africa in two volumes by the same author, and vol. i. of North America.[1] The new issue is in many ways vastly superior to the old; the cramping influence of the foreign original has disappeared, the illustrations have greatly improved, and, linked by the general title, each of the volumes forms a separate and original work of distinct value. So good, indeed, has "Stanford's Compendium" become, that it may now be allowable to subject one of its volumes to criticism of a more searching kind than would have been justified formerly. Then any attempt to form a library of solid geographical works in the English language was worthy of commendation; now it is possible to set up a higher standard, and it is reasonable to look for those excellencies of grasp and arrangement which one naturally expects in, let us say, a German work of similar scope.

The morphological unity of the continent is one of the fundamental facts of modern geography. The continent is the natural unit which must be considered in its entirety, with parts subordinated to the whole, and with functional activities of a distinctive kind. It is capable of subdivision, either naturally into regions or artificially into countries, and of aggregation with other continents to form the whole land-surface. The dominant lines of the continent—its axial mountain systems—determine

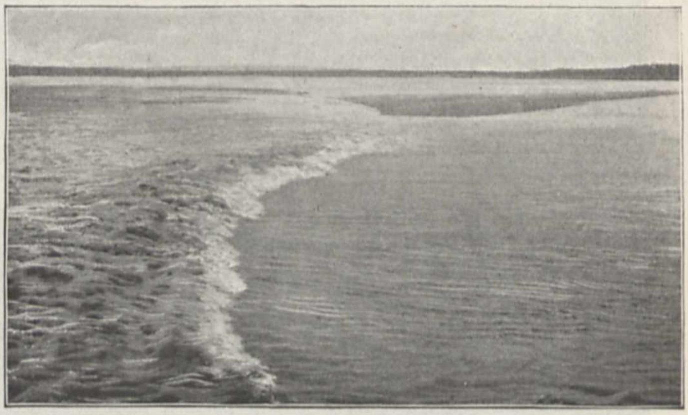

FIG. 1.—The Bore, Petitcodiak River, Moncton, New Brunswick, August 8, 1892. Height, 5 feet 4 inches.

the primitive slopes of the land, and the development of the river systems, subject to the continuous workings of secular uplift or depression and the accumulation of sediment. The resulting configuration modifies the climate as dependent on latitude, and leads to the formation of areas of moderate and of extreme temperature, of high rainfall and of aridity. Climate reacts on vegetation, and vegetation and climate together influence the distribution of animals; and all these varieties of feature and function are framed in the continent. Thus up to the appearance of man a geographical description must be based on the continent as a unit if it is to be really simple and comprehensible. With the advent of man complications arise, but the guiding influence of the main features of continental relief and surface-covering is still to be traced. The deep inlets tempt the adventurous stranger to penetrate the continent, the easy waterways lure him into the interior, where products of forest and plain supply an adequate inducement to remain or to return. In time groups of people settle down in habitats more or less distinctly defined by natural features—different tribes frequent the river, the lake, the forest, the plain, the mountain valley, the indented ocean shore.

[1] "Stanford's Compendium of Geography and Travel" (new issue). North America. By S. E. Dawson. Vol. i. Canada and Newfoundland. Maps and illustrations. (London: Edward Stanford, 1897.)

Consequent pressure of population or change in the availability of resources sets up migratory movements along natural lines dictated by land-form, water-flow, and soil-covering; conquest and delimitation ensue, and the straight boundary lines of the map, which come last, are, after all, natural relations to geographical facts associated with the whole body of the earth itself and its rotation. The grouping of dwelling-places around certain centres leading to the origin of towns may also, as a rule, be explained by geographical considerations.

Of the six continents which are usually recognised two stand out from the rest, distinguished by the simplicity of their great features and the clearness of the interdependence of the various relationships. These are North and South America, either of which forms an ideal subject for a geographical monograph.

We have mentioned the superiority of the new issue of "Stanford's Compendium" over the old; but there is one point of distinct inferiority. The old issue retained some traces of the original design, giving it a certain unity; the new is not so much a compendium as a series of separate works. Dr. S. E. Dawson's "North America, Vol. i.," is not, strictly speaking, the first part of a geographical description of North America. It is the description of the Dominion of Canada and Newfoundland, written not from the standpoint of a geographer, but from that of an imperialist British subject and patriotic Canadian. The author infuses warm colour into his narrative, which, gratifying as it must be to the sentiments of the people of the British Empire, does not enhance the value of the work as a scientific treatise. Dr. S. E. Dawson is obviously not himself a geographer—his strength lies in his treatment of history. Having expressed our view as to what a geographical treatise on a continent should be, we need only add that "North America, Vol. i.," is written without regard to the guiding principles of geographical science.

We have seldom, if ever, read more satisfying or more graceful renderings of history than the chapters of this book dealing with the discovery, exploration and occupying of the provinces of the Dominion. Unexpected comparisons and contrasts of the aptest kind with the course of history in other lands and other times continually delight the reader's mind and illuminate the story. But when from history the author enters geography the wheels seem to drop from his chariot, and he drives heavily. One could imagine that he wrote with effort, perhaps even with distaste. His comparisons lose point, and are sometimes inaccurate. Canada is not, as stated on p. 29, "above all others the land of abundance of waters." Finland or Sweden would, we believe. correspond better—certainly as well—to the definition, If any great river is to be celebrated for the length of its tributaries it should surely be the Amazon, the Congo, the Mississippi, rather than the St. Lawrence (p. 34). As to climate, we dispute the suggestion that tobacco cannot be grown in England (p. 47), and we must remember the success of Lord Bute's wine-making from grapes grown in the open air at Cardiff. The treatment of climate is otherwise not fully satisfactory. While no attempt is made to deny that the Canadian winter is cold, the author seems more concerned to combat what he believes to be the average Englishman's exaggerated ideas on the subject than to describe the actual conditions. With regard to the French of Quebec (p. 295), which some people seem to have called a *patois*, the author observes: "English is not spoken in the same way over all the United Kingdom, but no one speaks of a Dublin or an Aberdeen *patois*, or for that matter of a London *patois*." We can assure him that some people do speak of the *dialect* (a word as displeasing as *patois*) of these parts, and many authors, with an eye to popularity, delight to exaggerate rather than minimise such differences. The tunnel at Sarnia, 6025 feet long (p. 391), cannot be termed "one of the greatest in the world," unless the standard of greatness is put very low, and the number of great tunnels made very large.

FIG. 2.—The Prairie, Manitoba.

These are instances which do not seriously detract from the value of the book to the general reader; but Canada is so great, and its natural resources are so vast, that comparisons of the kind would be quite unnecessary even if they were sound. A somewhat serious defect is the occasional imperfect revision, giving rise in the non-historical sections to repetition and to vague or even inaccurate phrases, such as the description of a boundary as a "perpendicular line" (p. 453) when a meridian is meant. We note a few omissions: nothing appears to be said of the extreme danger of the Magdalen Islands, in the Gulf of St. Lawrence, to shipping; of the devastation of the forests in many parts of the country by fire; or of the high "benches" or river-terraces of British Columbia, which to a geographer form, perhaps, the most striking feature of that wonderful province.

We must, however, make it perfectly distinct that so far as the matter in this book is concerned the omissions are trifling, and the selection of facts most judicious. Dr. S. E. Dawson handles themes regarding which a Canadian might justly be excused if he were to indulge in a little exaggeration; and if the writer of this notice had never seen Canada, he would have supposed that there was some exaggeration here. But a journey from Quebec to Nanaimo, with visits to various points in the Kootenay and on the shores of the Great Lakes, has convinced the critic that in every estimate of natural wealth, and in every appreciation of the law-abiding enterprise of the Canadian people, the author has under-stated rather than over-stated the facts. If a passing tourist of no very imperialistic tendencies felt the pride of a citizen of the British Empire rising within him with each mile of the magnificent railway which is the benefactor of every province in the Dominion, he cannot but be surprised at the moderation of tone adopted by an heir of that fair heritage in writing an account of its actual and potential greatness.

Yet the book is not planned in harmony with the principles of geography, and that, after all, is the aspect to which attention must be called in the pages of a scientific journal. The illustrations are good, and characteristic, as the specimens here reproduced show, and the maps very fair, although not so numerous or so well selected as we could wish. There are practically no physical maps, for the sketch of the Archæan nucleus on p. 24 is a mere diagram, and the "Meteorological Map" shows only mean annual isotherms, which give no clue to the climate, and rainfall areas, which are difficult to grasp as a whole. There is certainly no lack of cartographic material in Ottawa, as the beautiful physical maps in the "Handbook of Canada," issued in connection with the recent meeting of the British Association, prove.

HUGH ROBERT MILL.

THOMAS JEFFERY PARKER, F.R.S.

THOMAS JEFFERY PARKER, whose death on November 7 last we chronicled on December 23, was the eldest son of the late William Kitchen Parker, F.R.S., the world-renowned comparative osteologist. He was born at 124 Tachbrook Street, London, S.W., on October 17, 1850, and received his elementary education at Clarendon House School in the Kennington Road, under Dr. C. H. Pinches. In 1868 he entered the Royal School of Mines as a student, taking the Associateship in Geology in 1871, together with the Edward Forbes medal and prize of books for distinction in biology. Thus qualified, he became for a short period science master at Bramham College, Yorkshire; but in 1872, on a special invitation by Huxley, he returned to London to fill the office of demonstrator under him at South Kensington, and that he held until his appointment in 1880 to the chair of Biology in the University of Otago, Dunedin, N.Z. During his period of demonstratorship he also held the office of Lecturer in Biology in Bedford College, London, and officiated as examiner in Zoology and Botany to the University of Aberdeen and as an assistant examiner in Physiology to the Science and Art Department. Parker was of a distinctly artistic temperament, æsthetic, musical, well-read, and possessed of marked literary ability, which asserted itself to a conspicuous degree in his little book upon his father, published in 1893, an altogether ideal filial biography—a good work by a good man. He early cultivated the critical faculty, as a direct result of the study of Matthew Arnold, whose writings he knew by heart; and with the great power of application and strength of character which he displayed during active work, there can be little doubt that he would have succeeded in any of the higher walks of life. He would have made a mark in literature, and as a caricaturist draughtsman would have achieved renown; and there is little doubt that his choice of biology for his life's calling was largely due to the charm and influence of his father's career and to his early association with Huxley, who knew him from childhood and became the object of his veneration. Both as a teacher and investigator Parker was untiring and thoroughly trustworthy. Though easily roused to enthusiasm he rarely became excited, and his cool deliberation came welcomely to the aid of the troubled student, to whom if in earnest his attention knew no bounds. His published papers exceed forty in number, and though mostly zoological they embody important work and observations in botany. Parker was the first appointed of the little band of biological professors sent out from home in the '80's, who now fill the Australian and Novozelandian chairs, and his second paper published in New Zealand dealt with a new species of Holothurian (*Chirodota Dunediensis*), as it were in anticipation of the later determination by himself and his contemporaries at the Antipodes to devote their attention to the indigenous fauna, rather than to refinements in histology and the like which could be better studied at home. The work already achieved by this body of investigators, with Parker at their head, is now monumental, and none of it more so than Parker's monographs "On the Structure and Development of Apteryx" and "On the Cranial Osteology, Classification, and Phylogeny of the Dinornithidæ," in themselves sufficient to have established his reputation. His lesser writings, although they deal with a wide range of subjects, show interesting signs of continuity of ideas, as for example in the association of his early observations on the stridulating organ of *Palinurus*, made in London in 1878, with those upon the structure of the head in certain species of the genus (one of the most charming of his shorter papers), made on the voyage to New Zealand, and upon the myology of *P. Edwardsii*, which, in co-operation with his pupil Miss Josephine Gordon Rich (now Mrs. W. A. Haswell), he in 1893 contributed to the Macleay Memorial volume. And the same may be said of his work on the blood-vascular system of the Plagiostomi. Soon after his arrival at the Antipodes, Parker instituted a series of "Studies in Biology for New Zealand Students," and chiefly with the aid of his pupils, these have been continued, either in their original form or in that of theses for the higher degrees of the University of New Zealand, as contributions to the publications of the Museum and Geological Survey Department of that colony. Botanical as well as zoological topics were thus taken in hand, the series, like that of a companion set of "Notes from the Otago University Museum," which he from time to time contributed to the pages of NATURE, containing important observations of general biological interest. Of Parker's books, it is sufficient to recall his "Lessons in Elementary Biology," now in its third edition and recently translated into German, undoubtedly the most important and trustworthy work for the elementary student which has appeared since Huxley and Martin's epoch-marking "Practical Instruction in Elementary Biology," published in 1875. Parker's book, in sharp contrast to his previous "Zootomy," which is a severely didactic and somewhat uneven laboratory treatise, is a book for the study, beautifully balanced and poetic in idea. It has a charm peculiarly its own, and to ponder over it is to appreciate to the full the honest, loving, sympathetic temperament of its author, and the conviction which he was prone to express that in the progress of scientific education there lies the panacea for most human ills, mental and corporeal. Great though the merits of these books, Parker five years ago essayed a more formidable task, in the resolve to prepare in conjunction with his friend Prof. W. A. Haswell, F.R.S., of the Sydney University, a general text-book of zoology. This work of 1400 pages, in two volumes, as recently announced in NATURE, will be noteworthy for the large number and excellence of its original illustrations; and from a passing knowledge of its contents, I am of opinion that it will do much towards relieving English text-book writers of the opprobrium begotten of a too frequent content with mere translation and continental methods. And when we consider that Parker was not spared to see this great work in circulation, it is heartrending to relate that, though ailing and weak, he had since arranged with his co-author and publishers for the production of a shorter text-book to be based upon it, and had prepared the preliminary pages of yet another elementary treatise to have been entitled "Biology for Beginners," while as a next subject of research he had begun to work out, in conjunction with Mr. J. P. Hill, Demonstrator of Biology in the Sydney University, a series of Emeu chicks, including those collected by Prof. R. Semon during his expedition into the Australian Bush. The thoroughness of Parker's best work was its most distinctive character, and when tempted to generalise he always did so with extreme caution and consideration for others, fairly presenting all sides of an argument. As he remarked of himself with characteristic modesty, in a letter written in 1894 commenting upon his chances of securing a chair of Zoology at home then vacant, "I don't profess to be brilliant, but I am vain enough to think that I have the gift of exposition and can do a straightforward research so long as it does not involve anything about the inheritance of acquired characters." Far-reaching generalisation and random rhetoric had no charm for him, nor was he tempted into over-ambition and haste so oft productive of slip-shod and ill-conditioned results. As a writer and lecturer he was always logical, cautious, temperate, content could he but spread, extend, and help systematise our knowledge of observed facts, convinced that if this be done properly their ultimate teachings become self-evident. His work is of that order which marks the growth of real knowledge and the consequent bettering of mankind; and the thought that there has thus early passed from the ranks one so good and earnest, so well fitted by nature for the responsible task of training the young and susceptible, fills us with sorrow.

Parker matriculated at the London University in June 1868, and passed the Intermediate Science Examination in 1877 and the final B.Sc. in 1878, while the D.Sc. was but a matter of formal application *in absentia* in 1892. He was in 1888 elected a Fellow of the Royal Society, and in 1880 an Associate of the Linnean Society of London, resigning the Associateship for the Fellowship of the latter but a short time before his death. He was an active member of the New Zealand Institute, to which he communicated several papers, and he became in turn Secretary and President of its Otago branch. Before these bodies and elsewhere in New Zealand he delivered addresses which will linger in the memory of his hearers and those who have read them. There may be especially mentioned an address delivered before the Otago University Debating Society on September 17, 1892, upon "the weak point in our university system," in reality an eloquent appeal for post-graduate study. Proceeding to classify an average assemblage of students into "the able, the mediocre, and the stupid," he remarked that "the only duty of members of the university towards the third class appeared to be that of imposing a sufficiently severe entrance examination to keep them from wasting their own time and their parents' money, in the vain attempt to train to purely intellectual pursuits an organism which nature intended to make its way by virtue of muscle and mother wit." A more ingenious defence of an examination system could hardly be imagined. It is preceded by the shrewd remark that "the republic of science and letters is an aristocratic, not a democratic republic." Parker was evidently of opinion that what the world terms breeding and feeding count for a great deal in the end, and the whole context of his address is apposite to the share he took in the work of organisation of the University of New Zealand, which led at least to a humanising of its syllabus in biology. And for any one desirous of a knowledge of Parker at his best in a popular function, a speech delivered on the occasion of the prize-giving at the Otago Boys High School on December 13, 1894, may be recommended, as a perfect example of the kind of thing appropriate to such an occasion, so oft provocative of the mere "airy nothing." Parker was, further, a Corresponding Member of the Zoological Society of London and of the Linnean Society of New South Wales, a Member of the Imperial Society of Naturalists of Moscow, and we believe he was President-elect of the Biological Section of the Australasian Association for the Advancement of Science for the present year. He was also a Fellow of the Royal Microscopical Society; and, ever ready to help in a good work, he became one of the original assistant editors who, under the generous leadership of Frank Crisp, in 1879 elevated the Society's Journal to its present important status.

The key-note of Parker's life-work is his connection with Huxley, and in testimony to his devotion to his great chief ("the General," as he loved to call him) there remains the delightful dedication of his "Lessons in Elementary Biology." Parker entered Huxley's service as Demonstrator in Biology at South Kensington in 1872, immediately after the conclusion of the memorable course of instruction there given, now historical as having marked the introduction of rational methods into the teaching of natural science. In the conduct of that course Huxley, as is well known, secured the aid of leading British biologists of the time. It was, however, reserved for Parker to fill the more important *rôle* of lieutenant in the development of the Huxleian system and to assist in carrying it beyond the experimental stage. At the time of his appointment laboratory appliances were lacking, and a practical teaching museum based on the type-system was a desideratum. Under instructions to supply these needs, Parker in due course entered upon the task with a will, his only materials a free-hand and an early set of proofs of Huxley and Martin's "Elementary Biology" (with the final revision of which he was largely entrusted, since the junior author was leaving for Baltimore), and in carrying the task to a successful issue he founded the first practical biological museum or teaching-collection on the now generally adopted type-system, the prototype of all those subsequently established at home and abroad, in some cases even to the measurements of the furniture. The Huxleian method of laboratory instruction in the course of its development at headquarters has witnessed no change on the zoological side at all comparable to the inversion in the order of the work originally prescribed—*i.e.* the substitution of the anatomy of a vertebrate for the microscopic examination of a unicellular organism as the opening study, and this we owe entirely to Parker. As one privileged at the time to play a minor part, I well recall the determination in Parker's mind that the change was desirable, and in Huxley's that it was not. Again and again did Parker appeal in vain, until at last, on the morning of October 2, 1878, he triumphed. Dyer and Vines were Parker's more immediate associates in the early work of development of the Huxleian laboratory-system; and among the persons who studied under him as it progressed now occupying prominent positions in the biological world, may be named F. E. Beddard, A. G. Bourne, G. C. Crick, J. J. Fletcher, Patrick Geddes, Angelo Heilprin, C. H. Hurst, C. Lloyd-Morgan, Daniel Morris, R. D. Oldham, H. F. Osborn, W. B. Scott, T. W. Shore, Oldfield Thomas, and H. Marshall Ward. Parker's first paper ("On the Stomach of the Fresh-Water Crayfish") and his first book ("Zootomy") were alike a direct outcome of the undertaking, and the scheme for his "Lessons in Elementary Biology," formulated while still he was in London, was similarly begotten of his experience during its development, which oft formed the topic of conversation as he and I in the late '70's sat working side by side. Nor must it be forgotten that Parker rendered Huxley commendable aid in the production of his wonderful book on "The Crayfish." I venture to think that in recognition of all this Parker has established a claim to distinction in connection with the educational work of his great master second to that of none other; and when it is remembered that the unparalleled activity among botanists and zoologists during the last two decades has rendered it impossible for one man to efficiently teach the two subjects from a professorial chair, in the manner originally laid down under the Huxleian dispensation, Parker's name will occupy a unique position in the history of this, as that of the only man prominently associated with its inception who taught both subjects to the end of his career.

To the task of founding the Huxleian teaching-collection, moreover, is due Parker's interest in the work of the preparator, which led to his being the first person to successfully prepare and mount in a condition fit for prolonged display cartilaginous skeletons in a dry state. Under Parker's curatorship the Otago University Museum advanced by leaps and bounds, and while to his reputation as a teacher and investigator he thus added distinction as a conservator and administrator in zoology, he attained also a reputation in botany both as a manipulator and discoverer. He came upon the botanical platform at the time when Alfred Bennett and Dyer were at work upon the English translation of the third edition of Sachs's monumental "Lehrbuch der Botanik," and when the methods of that great man, already introduced into Britain by McNab, were by these botanists and their associates becoming established. For Parker, however, carrot-drill had little charm, while to his æsthetic nature glycerine and gold-size were messy and distasteful. He was at the time repeating the work of Nicholas Kleinenberg on *Hydra*, busy with osmic acid and cocoa-butter, and the well-known results of his labours led him to apply the method to the treatment of plant tissues, with the result that through a short paper communicated to the Royal Microscopical Society in March 1879, he ranks as one of the first to apply the modern dry methods of micro-chemical technique to vegetable histology. As a discoverer in botany he will remain memorable for having first directed attention to the existence of sieve-tubes in the marine algæ (*Macrocystis*) in a short communication to the *Transactions* of the New Zealand Institute for 1881.

Truly is his a great record, worthy his noble character and his association with a Huxley! but while the world will cherish his memory for that which he achieved, those who knew him feel that by his death something more than a link with the historic past has gone, and that they have lost a true friend, a noble man, an example. In the autumn of 1892 Parker came home on a visit. Soon after his return his wife died, and this event probably helped to bring on an illness which showed itself formidably about two years ago. Recurrent attacks of influenza, the last of which rendered him prostrate for three months, told severely upon his health and strength; but despite all, following the example of his beloved father, he worked on whenever he could, patient under suffering and affliction the like of which has killed many a man, beautiful in his unselfishness and lack of ostentation, loving, and sympathetic. On October 26 last, he had recovered sufficiently to start on a journey of some forty miles to visit a friend at Shag Valley, in company with his eldest sister, who for several years had lovingly shared his anxieties and administered to the needs of his three boys. While half-way onwards he became so prostrate that a halt was necessary, his friends deeming it advisable to take him towards home again. He reached only as far as Warrington, where he became weaker and comatose, and passed peaceable away on Sunday, November 7, at one a.m. He was buried there two days later, in the presence of sorrowing friends, a few among the many by whom he was universally beloved.

G. B. HOWES.

NOTES.

FEW men of science appear in the list of New Year honours. The honour of Knighthood has been conferred upon Prof. George Brown, C.B., Consulting Veterinary Surgeon to the Board of Agriculture; Mr. Ernest Clarke, Secretary to the Royal Agricultural Society; Dr. John Struthers, late President of the Royal College of Surgeons of Edinburgh; and Dr. John Hatty Tuke, President of the Royal College of Physicians of Edinburgh. Prof. Gardiner, Dean of the Faculty of Medicine, Glasgow University, has been promoted to be Knight Commander of the Order of the Bath (K.C.B.), and Prof. D'Arcy Thompson, British delegate at the recent Conference on the Bering Sea Fisheries, has been appointed a Companion of the same Order (C.B.). Mr. James Dredge, one of the editors of *Engineering*, has been made a Companion of the Order of St. Michael and St. George (C.M.G.), for services in connection with the Brussels Exhibition; and Major R. H. Brown, of the Egyptian Irrigation Department, has been given the same honour.

MR. ALEXANDER AGASSIZ, as we learn from his recently issued report on the Museum of Comparative Zoology at Harvard College, U.S.A., for the past year, has planned to pass the greater part of the present winter in studying the coral reefs of the Fiji Islands. He will be accompanied by Dr. Woodworth and Dr. Mayer as assistants. The steamer *Yaralla* has been chartered in Sydney for the expedition. In addition to the usual apparatus, for photographic purposes, for sounding and dredging, and for pelagic work, Prof. Agassiz takes with him a complete diamond-drill outfit, and hopes to find a suitable locality for boring on the rim of one of the atolls of the Fijis. The boring machinery will be in charge of an expert sent by the Sullivan Machine Company, from whom the machinery is obtained. The Directors of the Bache Fund have made a large grant towards the expenses of this boring experiment.

THE Sydney meeting of the Australasian Association for the Advancement of Science opens to day, under the presidency of Prof. A. Liversidge, F.R.S. A large number of papers are down for reading before the various sections, and we hope to give some account of them later. The evening lectures are by Prof. W. Baldwin Spencer, on "The Centre of Australia"; Sir James Hector, K.C.M.G., F.R.S., on "Antarctica and the Islands of the Far South"; and Prof. R. Threlfall and Mr. J. A. Pollock, on "Electric Signalling without Wires."

WE regret to announce the death of Major-General Edward Mounier Boxer, F.R.S., for many years Superintendent of the

Royal Laboratory at Woolwich. General Boxer was elected a Fellow of the Royal Society so long ago as 1858.

THE deaths are announced of Mr. Arthur Kammermann, astronomer at the Geneva Observatory; Dr. Eugen Zintgraff, African explorer; and Dr. Max Graf von Zeppelin, zoologist at Stuttgart.

A LIFE of Pasteur, written by Prof. and Mrs. Percy Frankland, will very shortly be published by Messrs. Cassell and Co. The volume will form the latest addition to the Century Science Series.

PRINCE ROLAND BONAPARTE has been elected a Correspondant of the Lisbon Academy of Sciences and of the Bologna Academy of Sciences.

THE new number of the invaluable *Minerva Jahrbuch der gelehrten Welt* has for the frontispiece a fine reproduction of a portrait of Dr. Nansen.

THE Paris correspondent of the *Times* states that the statue of Jules Simon, to be executed by M. Fremiet, will probably be erected in the Place de la Madeleine, near which he lived, and will supersede the fountain now standing there.

WE learn from *Science* that a resolution has been introduced in the House of Representatives appropriating 20,000 dollars for the representation of the United States at the International Fisheries Exposition to be held at Bergen, Norway, from May to September of next year.

THE British Institute of Public Health will be styled in future the Royal Institute of Public Health, and Her Majesty the Queen has accepted the office of patron. The Council of the Institute has conferred the Harben Gold Medal for 1898 upon Lord Playfair, and has appointed Prof. W. R. Smith the Harben Lecturer for the year 1899.

INVITATIONS are being sent out for the forthcoming International Congress of Zoology. A Committee of Reception has been formed in Cambridge, where the Congress will meet on August 23, 1898. An International Congress of Physiologists will be held at the same time in Cambridge. It is proposed at a later date to distribute further information on the more important subjects which will be brought forward for the consideration of the Congress.

THE personal estate of the late Mr. Alfred Nobel has been valued at 434,093*l.*, of which amount 216,901*l.* is in England. After a number of personal bequests have been made, Mr. Nobel's will stipulates that the capital of the whole of the remaining realisable property is to form a fund, the interest from which is to be annually divided in five prizes to those who during the preceding year have done most for the benefit of humanity. The interest is to be divided into five equal parts, which are to be awarded in prizes as follows: (1) To him who within the department of natural philosophy has made the most important discovery or invention; (2) to him who has made the most important discovery or improvement in chemistry; (3) to him who has made the most important discovery within the department of physiology or medicine; (4) to him who in literature has produced the most excellent work in an idealistic direction; and (5) to him who has worked most or best for the fraternisation of the nations and for the abolition or diminution of standing armies, as also for the promotion and propagation of peace. The prizes in physics and chemistry are to be awarded by the Swedish Academy of Sciences, for physiological or chemical work by the Carolinian Institution in Stockholm, for literature by the Academy in Stockholm, and for the propagation of peace by a committee of five persons to be elected by the Norwegian Parliament. The will continues:—

"It is my express will that at the distribution of prizes no regard is to be paid to any kind of nationality, so that the most worthy competitor may receive the prize whether he is a Scandinavian or not."

THE Russian Institute of Experimental Medicine, at St. Petersburg, held its seventh annual meeting on December 20, 1897. The Institute consists of six scientific sections and one practical section, and during the past year no less than 120 persons took part in its regular work, which is carried on in the departments of biological chemistry, physiology, bacteriology, pathological anatomy, general pathology, and epizootic diseases. Sixty-five papers—some of them of high scientific value—were published by the scientific staff of the Institute. In addition to this, no less than 25,000 bottles of diphtheria serum, 800 bottles of anti-streptococcus serum, and 300 bottles of anti-staphylococcus serum were sent out from the Institute during 1897—making a total of 138,000 bottles of anti-diphtheria serum, and 15,000 bottles of malleine and tuberculine that were distributed within the last three years. Of persons bitten by rabid animals, 277 were under treatment, the percentage of deaths having been only 0·7. The serum treatment of the bubonic plague, the prophylactic measures against it, and the preparation of anti-plague serum were the subject of special work during the year, and its results were summed up in a paper which was read at the annual meeting by Prof. A. A. Vladimiroff.

THE following are the arrangements for lectures during January at the Imperial Institute. These lectures will be open free to the public, without tickets, seats being reserved for Fellows of the Imperial Institute and persons introduced by them. Monday, January 10, "Western Australia: its growth and possibilities," by Mr. H. C. Richards, M.P.; Monday, January 17, "South Africa, from the Cape to Ngamiland," by Mr. H. A. Bryden; Monday, January 24, "New Brunswick—Past and Present," by Mr. C. A. Duff-Miller; Monday, January 31, "Through the Gold Fields of Alaska to Bering Straits," by Mr. Harry de Windt.

AT the recent annual meeting of the Paris Academy of Medicine (says the *Lancet*) a report was presented upon the prizes awarded in 1897. The François Joseph Audiffred prize, which consists of 24,000 francs to be awarded to him who shall have, in the opinion of the Academy, discovered a really curative or preventive remedy against tuberculosis, has not been awarded. The offer holds good for twenty-five years, starting from April 2, 1896. Another prize not awarded was the Chevillon prize of 1500 francs offered to the writer of the best work upon cancerous affections—but a consolation prize of 500 francs was given to Dr. Livet for his work on the subject.

MR. JOHN W. BARBOUR, writing from Bangor, Co. Down, Ireland, informs us that an albino lark—believed to be a skylark—was shot in that district on December 27, 1897.

MR. B. WOODD-SMITH calls our attention to the following paragraph, which appeared in the *Whitby Gazette* of December 17:—"A splendid meteoric display was witnessed in the eastern heavens on Sunday night [December 12], shortly before eight o'clock. The meteors, which appeared of various colours, were of great brilliance, and illumined the sky with an effulgence greatly surpassing that of the clear and almost full moon shining at the time. About the time of the display, a sound like that of thunder was heard." Further information with reference to these observations would be of interest.

DR. R. F. SCHARFF records, in the *Irish Naturalist*, the discovery of some remains of the wild horse (*Equus caballus*) in Ireland. The remains consist of the occipital part of a skull and the posterior part of another. Both of these were forwarded to Dr. Scharff, who decided that they evidently belonged to horses, but to specimens of very small dimensions—certainly not larger than an ass. The skulls were discovered, when making a drain in Major Moore's property near Naas (Co. Kildare), resting on the gravel beneath the bog. The remains therefore probably belong to wild horses, which are known to have inhabited Ireland as contemporaries of the Irish Elk. Dr. Scharff points out that all the remains of the wild horse hitherto discovered in Ireland, viz. in Shandon Cave and many Pleistocene deposits, point to the fact that it was of small stature.

AN interesting glimpse of Huxley's home-life is given in the *Century Magazine*, by his son Mr. Leonard Huxley, and it reveals another aspect of his gentle and loving character. After his retirement in 1885, the extra leisure permitted his affection for children to have full play. Of one of his grandsons, Julian, he was very fond, and the following incident shows how he would give rein to his humour and wisdom to please a child. Julian had been reading the "Water Babies," wherein fun is poked at his grandfather's name among the authorities upon water babies and water beasts of every description. The book is illustrated by a picture showing Huxley and Owen examining a bottled water baby under big magnifying glasses, so Julian thought he would consult his grandfather upon the matter. He therefore wrote: "Dear Grandpater—Have you seen a water baby? Did you put it in a bottle? Did it wonder if it could get out? Can I see it some day?" Julian's interrogations are worthy of a Huxley, and this is the reply they received: "My dear Julian, I never could make sure about that water baby. I have seen babies in water and babies in bottles; but the baby in the water was not in a bottle, and the baby in the bottle was not in water." Other stories are told to illustrate Huxley's sympathies with, and tenderness to, the little ones. As is well known, cats were great favourites with him. Like Mahommed who, rather than disturb his cat, cut off the sleeve of his robe on which it had gone to sleep, Huxley would not turn a cat out of his study chair, but would himself sit in a less comfortable seat and leave the cat in peace. At Eastbourne he gave most of his time to gardening, and all through the last years of his life the garden and the flowers were his greatest source of pleasure.

WE learn from the Annual Report of the Director of the Royal Alfred Observatory at Mauritius, for the year 1896, that a new series of publications has been commenced; a separate volume, entitled "Mauritius Magnetical and Meteorological Observations," will contain the daily, monthly and annual values of the principal elements, and will be substituted for the various tables which have hitherto appeared in the Mauritius Blue Book. The rainfall was 18·58 inches above the average for the last twenty-two years. After heavy floods in February (25·94 inches in four days), followed by excessive rain during a severe thunderstorm on May 7, severe droughts were experienced between September and December. An examination of the diurnal variation of rainfall for 1888–96 shows a double oscillation, the maxima occurring at 4h. a.m. and 3h. p.m., and the minima at 10h. a.m. and 8h. p.m., these hours corresponding nearly to the epochs of minimum and maximum barometric pressure. The mean temperature was nearly normal, being only 0°·3 below the average. As usual the logs of ships arriving at the island were copied, so far as the observations related to the Indian Ocean. Photographs of the sun were also taken daily, when the weather permitted, and these have been forwarded to the Solar Physics Committee.

A USEFUL series of records of the Hereford earthquake of December 17, 1896, as it affected the county of Hertford, is contained in a paper by Mr. H. G. Fordham (*Hertfordshire Nat. Hist. Soc. Trans.*, vol. ix., 1897, pp. 183–208). In his summary of the observations, Mr. Fordham notes that the earthquake was felt more or less distinctly over the whole county, though it was naturally more marked on the west side than on the east. There is no clear difference in its recorded effects at places situated at different altitudes and on different rock-formations. While there is a general agreement as to the swaying or rolling character of the movement, there is a conflict of evidence as to accompanying sound. In a large number of cases, a rumbling sound is recorded; but, on the other hand, some very competent observers speak positively as to the absence of noise. There is the usual diversity in the personal impressions with regard to the direction of the movement, with a balance of numbers, however, in favour of a movement along a west and east line.

THE lately issued sixteenth volume of the *Bulletin* of the United States Fish Commission contains an excellent report on the Russian Fur Seal Islands, prepared by Mr. Leonhard Stejneger, of the U.S. National Museum, which should be studied by every one interested in the question. Mr. Stejneger, who has visited the Commander Islands twice—first in 1882–83 in the palmy days of the fur seal industry, and again in 1895 during its decline and fall, and who is a well-known expert on the subject, comes to the conclusion that the only measures likely to stop the ultimate destruction of the fur seals of these islands is the "total and absolute prohibition" of pelagic sealing in the North Pacific for at least six years, and, after that period, the total prohibition of pelagic sealing within a zone of 150 miles from the islands. These measures would, no doubt, be effectual if they could be carried out, and would be much for the benefit of the Russian Seal-skin Company, which holds the lease of the islands; but Mr. Stejneger does not explain how it is proposed to stop seal-catching in the free and open ocean, nor whether the Russian Company, to which the benefit would accrue, is prepared to pay for it.

MR. J. COSMO MELVILL has reprinted from the *Journal of Conchology* his presidential address upon the principles of nomenclature and their application to the genera of recent Mollusca. It contains an historical sketch of the subject as regards pre-Linnæan authors which will be useful, if, as we understand, nomenclature is to be one of the subjects for discussion at the meeting of the International Zoological Congress at Cambridge in August next. Mr. Melvill gives also a useful list of genera of marine Gastropods about the names of which some differences of opinion have existed, and indicates those which he thinks ought to be adopted.

IT is well known to psychologists that some persons experience a sensation of colour in association with certain sounds, the colour seen being definite and invariable for the same sound. Dr. W. S. Colman describes a number of these cases of colour-hearing in the *Lancet* (January 1). Cases of this kind usually fall into two groups. In the first there is a crude colour sensation, often very beautiful, associated with certain sounds such as each of the vowel sounds, musical notes, or particular musical instruments. The appearance is usually that of a transparent coloured film similar to a rainbow in front of the observer, but not obscuring objects. In the second group there are colour sensations whenever letters or written words (symbols of sound) were spoken or thought of, so that when a word is uttered the subject visualises the letters, each having a distinctive tint. A study of the subject leads Dr. Colman to regard the phenomena as "associated sensations" analogous to the cutaneous sensation of shivering in certain parts of the body, varying in different individuals, which is experienced at the sight or thought of an accident, or at the sound of the squeak of a slate-pencil. The tints excited are very definite and characteristic, each for its own sound. They do not vary as time goes on. The colours are scarcely ever the same in two individuals. This is very clearly shown in two coloured diagrams which accompany Dr. Colman's paper. The first diagram shows the tint excited by the spoken vowel sounds in twenty-one individuals, while the second shows the tints of the colour sensations excited by the letters of the alphabet in seven individuals. Dr. Colman does not, however, give the colour sensations excited by numbers. The writer has tested a boy at intervals within the past four years, and has found that each numeral is associated with a colour as follows:—1, black; 2, white; 3, yellow; 4, red; 5, green; 6, grey; 7, mauve; 8, light grey; 9, brown; 0, black. These associated colours have remained the same throughout the period.

A NEW monthly journal of mechanics and electricity for amateurs and students has just made its appearance under the title of *The Model Engineer*. The periodical is intended particularly for amateurs who take up mechanical or electrical work as a hobby.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*) from West Africa, presented by Mrs. R. H. Padbury; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Mrs. Soames; a Spectacled Bear (*Ursus ornatus*, ♂) from Colombia, a Spotted Cavy (*Cœlogenys paca*) from South America, presented by Mr. William Crosley; three Brown Capuchins (*Cebus fatuellus*), a Blue and Yellow Macaw (*Ara ararauna*), a Red and Yellow Macaw (*Ara chloroptera*) from South America, deposited; a Naked-throated Bell-Bird (*Chasmorhynchus nudicollis*) from Brazil, two Noisy Pittas (*Pitta strepitans*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

WINNECKE'S COMET.—As announced in this column a fortnight ago, Winnecke's periodic comet is shortly due at perihelion, and therefore might be expected to be picked up at any time. Such has been the case, for Prof. Perrine telegraphs from the Lick Observatory that it was found on January 1, being only feebly visible. Its position then was R.A. 15h. 19m. 42·5s., Decl. $-3° 58' 34''$ S.

ARRIVAL OF ECLIPSE PARTIES AT BOMBAY.—Reuter's correspondent at Bombay states that Mr. E. W. Maunder, Mr. C. Thwaites, and the Rev. J. M. Bacon, with the parties under their direction sent by the British Astronomical Association for the observation of the total solar eclipse on the 22nd inst., have arrived there. The different observing stations will be as follows:—Mr. Maunder and Mr. Thwaites will be stationed at Talni, on the Great Indian Peninsula Railway, between Amraoti and Nagpur; the Rev. J. M. Bacon at Baxar. The Astronomer Royal and Prof. H. H. Turner, forming one of the official parties sent out by the joint committee of the Royal Society and the Royal Astronomical Society, will be stationed at Sahdol, between Katni and Bilaspur. The observing party from the Government Observatory at Madras, under the direction of Prof. Michie Smith, will be at Indapur.

MONT BLANC OBSERVATORY.—The closing of the year brings to hand the reports from many observatories, and not the least interesting is that by M. J. Janssen, in *Comptes rendus* No. 24, "On the work done in 1897 at the Mont Blanc Observatory."

During 1897 the principal work has been the determination of the quantity of heat received by the earth from the sun, or the *solar-constant*, as it is called.

The meteorological conditions have not been very favourable, and M. Janssen was compelled to direct observations and expeditions from Chamonix, only reaching there with difficulty, having seriously injured his left leg, which made an ascent of Mont Blanc quite impossible for him. The observations were, therefore, made by M. Hansky—first at Brévent, again at the Grands Mulets, and finally at the summit of Mont Blanc, at the observatory.

From these observations a *solar-constant* of nearly 3·4 calories has been deduced; that is to say, a value notably higher than that obtained before. This, M. Janssen thinks, will be still further increased, for the more deeply the question is studied the more one ascertains the complexity of the elements which enter into it. For instance, of the radiations which strike the earth, it is those having wave-lengths of large and small periods that undergo the greatest absorption in the atmosphere; those with a mean wave-length corresponding to the most luminous part of the spectrum are propagated with the least relative loss. As a result of this, if the transmission of heat in a zenithal direction be deduced from observations made through a great thickness of the atmosphere, it will give a value much too high, and hence one much too small for the solar radiations outside the limits of our atmosphere, which value is the solar-constant. Again, the presence of water vapour and dust particles, whether of snow or other matter, all give rise to disturbing effects which influence the results. To obtain precise indications of water vapour the spectroscope has been used, and for the dust particles and snow clouds M. Cornu's form of polariscope has been employed with success.

From these results it can be seen that it is desirable the observations should be made with as little atmosphere intervening as possible; that is, at high altitudes—in balloons even, if sufficiently precise instruments could be used in these regions of the atmosphere. Nevertheless, if stations such as that of Mont Blanc do not offer comparable altitudes with those which balloons can reach, in return they permit the use of instruments more delicate and precise, giving trustworthy results.

PHOTOGRAPHY OF UNSEEN MOVING CELESTIAL BODIES.—Quite recently Prof. Barnard showed in *Astr. Nach.*, 3453, how it might be possible to photograph an "unseen moving but known celestial body," as, for example, unseen comets, or the swarm of meteorites giving rise to the November shower. The method, it may be remembered, was to watch with a guiding telescope and keep an adjacent star on cross wires moving in the correct position angle at the proper rate, the movement to be produced by an arrangement of watch-work. In *Astr. Nach.*, 3467, Herr Josef Jan Fric, of Prague, gives an account of a somewhat similar method in which the photographic plate or object glass is moved in the requisite direction. The holder is driven by a fine screw, which derives its motion from the intermittent action of a ratchet wheel moved by a "powel," which in turn is actuated at will by an electro-magnet. The length of stroke can easily be altered so as to give any varying motion which may be necessary, but of course, in consequence of the discontinuity of the movement produced in this way, the change in the position of the plate must be so small as not to interfere with the perfectness of the image photographed.

ASTRONOMICAL ANNUALS.—Perhaps the most useful annuals for use, either in a well-established observatory or by amateurs, are: the *Companion to the Observatory* and the *Annuaire Astronomique et Météorologique;* and if these two could be compounded together, they would form a most desirable and complete compendium of astronomical data. The former confines itself chiefly to tabular matter giving data for finding the planets and their satellites with their respective phenomena, occultations, and eclipses. In addition to these, and perhaps the most important section, as it is not readily found elsewhere, is the ephemeris for physical observations of the sun, mean places, and maxima and minima of variable stars of all periods, and also the radiant points of the principal meteor showers of the year.

The latter publication, by M. Camille Flammarion, is in its thirty-fourth year, and while treating of astronomical events in a popular way, it gives numerous diagrams, and has many interesting features. The calendar, detailing observations to be made for each day, has proved itself most useful, as also have the charts of the positions of the planets.

PHOTOGRAPHIC MEASUREMENT OF HORSES AND OTHER ANIMALS.

VALUABLE horses are habitually photographed by professionals and amateurs, and beautiful portraits of them appear in newspapers; notably in *Racing*, in the *Horseman* of the U.S.A., in *Le Sport Illustré*, and in other similar periodicals. I am informed that in shows of pedigree stock it is frequently required that the prize-winners should be photographed, it being of obvious importance that the appearance of the progenitors of animals should be known before selections are made for pairing. It seems, then, that if photographs of horses and other pedigree stock could be rendered available for strict scientific studies in heredity, the material is copious, and as it would in time extend through many generations, should far exceed in value anything that is now procurable for those purposes. But all depends on that "if." The basis of science is exact measurement, for which the existing photographs are unsuitable. My present object is to show that by paying strict regard to conditions of a simple kind, an ordinary photograph will be transformed from a mere picture into a record of real scientific value; so that if photographs should hereafter be habitually made of pedigree stock (not only of horses) under those conditions, and be afterwards published, a mass of material would quickly accumulate, sufficient to advance the science of breeding far beyond the point at which it now stands. Artistic photographs

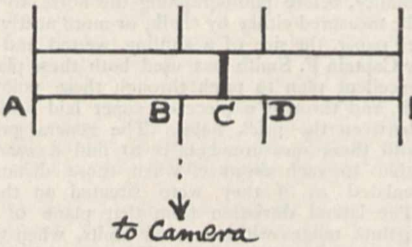

FIG. 1.

are not to be discouraged. Their object is to exhibit animals in their more attractive positions, as by inclining the fore part of their bodies to the camera when it is desired to make the shoulders look larger than they are. What I desire is that other and inexpensive photographs should be procurable, which shall be suitable for exact measurement.

All that is asked for is a strip of hard level ground, on which a rectangle is laid out of some 8 or 9 feet (say 100 inches) long and 20 inches wide, and otherwise marked, and that the camera shall be directed squarely towards a certain point in it, as shown by the diagram (Fig. 1). The horse is to be led to the rectangle, and kept in it, taking care that all his feet stand within its margins, that the cross-line at C lies clear of his front and

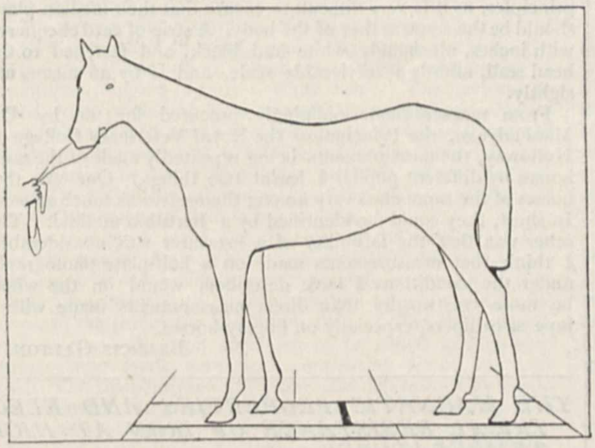

FIG. 2.

hind legs, and that the tip of every hoof and each corner of the rectangle is visible from the camera. The appearance of the horse standing upon the rectangle, as seen in the photograph, would be this (Fig. 2), but the lines should be much more delicate. The camera should be placed on a line strictly at right angles to the side A E of the rectangle. When the horse's head, as in Fig. 2, is on the side of A, the perpendicular in question should be drawn from B, a point about a foot distant from C, and on the same side as A. Then the image of the horse fits, laterally, well into the field of the camera. When the horse's head is intended to be on the side of B, a symmetrically situated point D must be selected for the foot of the perpendicular on which the camera is to stand. The distance of the latter from the rectangle should be fully 20 feet.

The camera having an adjustable back, must be slightly tilted downwards in order to get a good view of the feet, but its back must be kept *strictly vertical*. It would be a decided gain if the installation were so arranged, that the photograph should contain means of judging whether the plate in the camera had really been adjusted aright—that is, parallel to the vertical planes passing through the long sides of the rectangle. This can be accomplished by laying out the rectangle near the base of a wall, with its long sides parallel to it; then, driving two nails into the wall in the same horizontal line, hang a long string with weighted ends over them, the ends nearly touching the ground. If the two nails are well placed, the line will appear in the photograph, as running along the top and down the two sides of it, close to the margin. Then, if the plate has been rightly adjusted, the upper line in the picture will remain parallel to the long sides of the rectangle, and the two weighted ends will remain parallel to one another. Otherwise there will be convergence in one or both respects. The camera must be high, in order to show well the position of the horse's feet; 5 feet is perhaps the best height for it at a distance of 20 feet, then the perspective foreshortening of the width of the rectangle is such that its scale is one-quarter of that of its length.

Relative measurements can be made with accuracy on photographs taken under these conditions, between any visible points that are situated on the median plane, such as between the withers and the lower part of the chest below them, between the front and the back of the profile, and so on, but absolute measurements cannot be made because the distance between the camera and the median plane is not yet accurately determined. Much less can heights above the ground be measured, for in order to do so it is necessary first to determine the line at which the median plane of the horse intersects the ground, because it is to this line that the vertical measurements must be made. What is meant by "median plane," is the imaginary plane which passes lengthways and vertically through the spine of the animal, and which serves generally as a plane of reference. It cuts the ground half-way between the two pairs of hoofs, so that if the half-way position between the tips of the fore hoofs be called S, and that between those of the hind hoofs be T, then the intersection of the median plane with the ground lies along the line S T. For its accurate determination the animal should stand on hard ground, and the hoofs be so disposed that at least the tips of all four shall be visible from the camera, which must be well elevated so as to look down on them, as already described.

Beginning with the simplest case, namely that in which the median plane of the horse is parallel to the long sides of the rectangle, and also parallel to the plate in the camera, we are at once in a position to measure the height of the horse, its depth of body wherever desired, and its length. For by prolonging S T in the photograph until it cuts the ends of the rectangle in S' and T', a length equal to that of the line S' T' drawn on the median plane in any direction will correspond to the length of 100 inches objectively. We begin by measuring the lengths of S' T', and those of any other, say two, dimensions on the photograph. Call their several measurements s', a, and b, reckoning them according to the scale used throughout for that purpose, whatever the value of the units of that scale may be. Let x and y be the objective values of a and b, which have to be found;

$$\text{then } s' : 100 :: a : x \text{ and } :: b : y$$

$$x = \frac{100}{s'}a \qquad y = \frac{100}{s'}b,$$

so the coefficient $\frac{100}{s'}$ being determined, serves to convert these and all other measurements in this same median plane into their objective values. Those persons who possess Crelle's Multiplication Tables, can perform these little sums without effort and with great rapidity. In Fig. 2 the real length of the rectangle there represented happens to be only 80 inches. The measurements on the diagram are as follow:—(1) S' = 21·6 mm.; (2) height of withers, 15·7; (3) height of lower side of chest, vertically below, 8·9; (4) height of rump, 16·2; (5) extreme length of body, 15·5. Whence the coefficient $= \frac{80}{21 \cdot 6} = 3 \cdot 7$, and the objective values are (2), 58·1 inch, (2–3) 25·1; (4) 59·9.

Before considering the effect of obliquity the following objec tion must be disposed of. It may be said that the protuberan sides of the animal will prevent its true outline being visible from the camera, for the reasons indicated by Fig. 3, which is an extreme case in which the camera, or eye, R is supposed to be very near to the side of an animal, so fat that his cross section has to be represented by a circle.

The summit of the outline as seen from R is H, giving the idea that the spine of the animal is as high as L, whereas it is really at K. The ratio of LO to KO is of course the same as that of LO/OR to KO/OR, that is to HO/OR; in other words as the tangent of L R O to the sine of the same angle. The values to be dealt with in reality, are very different from those in the diagram. OR is 240 inches and KO may be taken as 15 inches. It results that L R O is only 3° 35′. Now the tangent and sine of such a small angle are so nearly alike that LO : KO :: 100·00 : 99·85, which corresponds to a difference of less than 1/8th inch in a horse of 15 hands high, and is quite negligeable.

In some fat stock, however, the backs are flat like tables. Here some artifice would be necessary to obtain the true height, such as by fixing a stud of say 2 inches in height to a surcingle. The top of the stud would then be the point of measurement, and 2 inches would be subtracted from the result.

We now come to the effect of obliquity of the median plane of the horse to the long sides of the rectangle. The hoofs of a thoroughbred horse are some 4 inches wide, and 4 inches apart, so that the closest distance between either S or T, and the nearest side of the rectangle, is 6 inches; therefore the utmost cross distance between S and T is (20 − 12) or 8 inches, and the length of ST in a horse of 15 hands in height may be taken as 60 inches. Therefore the maximum obliquity within the strip is as 8 to 60, or 0·1333, which corresponds to an angle of 7° 39′.

The foreshortening of the length ST (= 60 inches) is such that its foreshortened value must be multiplied by the secant of 7° 39′

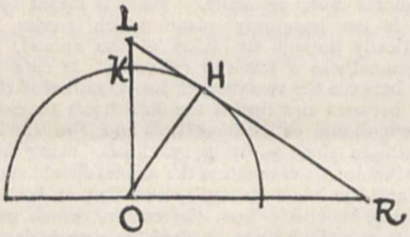

FIG. 3.

to obtain the unforeshortened value, that is by 1·009, which makes it nearly 1 per cent. longer. This is the greatest error to be feared under the conditions, and it is further much diminished by determining the actual obliquity. We can do this easily by measuring the distance lengthways between the points where ST produced cuts the opposite sides (not ends) of the rectangle. The further side of the rectangle affords the scale for reckoning distances from C along that line when produced; similarly the nearer side affords the scale for distances from C measured along and beyond itself. The cross distance between those points is known to be 20 inches, so the obliquity is easily found. The accompanying table may be found convenient. It applies with strictness only to objects viewed from a great distance, but is practically correct for much smaller ones.

Obliquity.		Multiplier to convert fore-shortened values.	Corrections to be added to foreshortened measurements of			
			10 ins.	30 ins.	50 ins.	70 ins.
	° ′		in.	in.	in.	in.
1 in 7	8 12	1·0103	0·100	0·20	0·50	0·70
,, 10	5 43	1·0050	·050	·15	·25	·35
,, 15	3 49	1·0022	·022	·07	·11	·15
,, 20	2 52	1·0012	·012	·04	·06	·09
,, 25	2 18	1·0008	·008	·02	·04	·06
,, 30	1 55	1·0006	·006	·02	·03	·04

The mean scale for the slightly oblique median plane is the perspective length of the rectangle at the point where a line drawn through the middle of ST cuts the perspectively viewed ends of the strip. It is unnecessary to attempt greater minuteness, as by determining the vanishing point (the position of which is given by prolonging two or more of the cross-lines upon the ground to their points of common intersection in the photograph), and then employing the further methods known to draughtsmen in perspective. Much could be written of which it is unnecessary to speak here, because it is a condition that the obliquity shall never be great. A strict attention to the elementary requirements laid down above, makes the problem of measurement extremely simple; otherwise it becomes complex and troublesome.

The next point to be considered is the method of measuring between points situated on the side of the horse, such as from the haunch bone to the shoulder. I shall speak of these in general terms only, because the most suitable points for measurement have yet to be determined. Whatever they be, it is a great assistance, before photographing the horse, to mark the points to be measured either by chalk, or more neatly by a disc of gummed paper, the size of a shilling, wetted and stuck on. Veterinary-Captain F. Smith has used both these plans. It is also an excellent plan to prick through these points in the photograph, and through a piece of paper laid below, and to measure between the prick holes. The general principle of dealing with these measurements is to find a *mean* correction suitable to each distance, when those distances have been calculated as if they were situated on the median plane. The lateral deviation from that plane of each one of these points, ranges within narrow limits, when the height of the horse is taken as unity. The mean deviation even of either protuberant haunch bone from the median plane between them, is much under 20 inches in a horse of 60 inches (15 hands in height). The mean range of this deviation in different horses of that height, judging from what occurs in anthropometric measurements, is probably very much under an inch, and its extreme range in ordinary cases would be under 2 inches. Extraordinary cases of massive or slender build would be betrayed by the photograph itself, and could be allowed for. It seems, then, that after the desirable points had been determined, between which measurements might be wanted, it would be a straightforward piece of work to make numerous measurements between them in different horses, and to draw up the suggested table of corrections for 2 or 3 different positions in the rectangle.

The head and neck can hardly be measured on the above principles, as it is very difficult to ensure that their median plane should be the same as that of the body. A strip of card chequered with inches, alternately white and black, and fastened to the head stall, affords a serviceable scale, and is by no means unsightly.

From measurements obligingly procured for me by Dr. MacFadyean, the Principal of the Royal Veterinary College at Holloway, the measurements being repeatedly made of the same horses by different pupils, I learnt two things. One was that horses of the same class vary among themselves as much as men. In short, they could be identified by a Bertillon method. The other was that the fallibility of a measurer was considerable. I think that measurements made on a half-plate photograph, under the conditions I have described, would on the whole be more trustworthy than direct measurements made with a tape or callipers, especially on fidgety horses.

FRANCIS GALTON.

THE MAGNETIC PROPERTIES AND ELECTRICAL RESISTANCE OF IRON AT HIGH TEMPERATURES.

THE magnetic properties of iron and, to a lesser extent, of the associated metals, nickel and cobalt, have always been a fascinating subject of study. Possessed by these three metals alone, these properties, so peculiar and so different from any of the other known properties of matter, have imparted to the study of these so-called magnetic metals a special charm and interest, apart from that excited by the vast industrial importance of at least one of them.

Among the very early inquiries into the nature of magnetism there were not neglected experiments on the effect produced by change of temperature. Three centuries ago, Gilbert recorded the observation that a piece of iron or steel, if heated more strongly than up to a full red heat, ceased to be attracted by a magnet, though it regained its previous magnetic qualities on cooling below that temperature.

Until comparatively recently, however, accurate magnetic measurements, even at ordinary temperatures, could alone be made on *permanent* magnets and the forces acting on their poles. The capability of acquiring *temporary* or induced magnetism when near a magnet, which is the characteristic property of soft iron, could not be subject to strict measurement until it was shown, firstly, how a given specimen of iron could be uniformly magnetised in a uniform magnetic field; and secondly, how both the magnetising force of that field, and the consequent magnetisation of the iron could be measured. We know of only one way of completely satisfying the first condition: namely, by covering a ring-formed specimen (whose outer diameter but slightly exceeds the inner) with a uniform layer of insulated wire carrying an electric current, thus forming a ring-magnet with no disturbing poles. And Faraday's researches on electro-magnetic induction have furnished us with a method, at once accurate and convenient, of determining the magnetisation of the apparently unmagnetised ring magnet, *i.e.* by the use of a "secondary winding" or outer layer of insulated wire, connected with a "ballistic" galvanometer. Knowing then the intensity of magnetisation called up by a given magnetising force, we can, from their ratio, express the facility with which the iron takes up magnetic induction, or, in other words, its magnetic *permeability*.

To apply this method to the measurement of permeability at high temperatures, both the magnetising and the secondary winding must be so insulated as to be uninjured by the heating; and further, the thermometer or pyrometer, which measures the temperature, must be placed inside the ring, so as to measure the actual temperature of the iron.

Among the earlier important researches on magnetic properties at high temperatures, that of Baur of Zürich, in 1879, should be mentioned. He experimented simply on an iron bar heated in a furnace, and thence rapidly transferred to the interior of a straight magnetising coil. Not, however, till 1889 was it shown by Dr. Hopkinson, in his classical researches, that the ring-magnet method could be successfully applied to the measurement of permeability at high temperatures. The windings of the ring-magnets were in this case of copper wire insulated with asbestos; the heating was carried out in a gas furnace; and the rise of temperature of the iron core was deduced from the increase of the electrical resistance of the secondary winding.

Of the more recent researches, the most remarkable is that of M. Curie, published in 1895, describing experiments on the magnetic behaviour of a great variety of substances, at temperatures ranging up to a white heat. The method he adopted—that of finding how strongly the specimens were attracted, when placed near a powerful magnet, was well adapted to determine permeability in intense magnetic fields, but it is much inferior to the ring-magnet method, where the permeability varies much with the magnetising force, as is the case whenever the magnetic field is not intense.

In the course of some experiments on the subject of this article, the results of which have been recently published, I have endeavoured to approximate, where possible, more closely than previous experimenters to the ideal method which would be the outcome of the principles laid down above. The ring-magnet, whose core was the iron specimen to be tested at high temperatures, was made very small, measuring about one inch across. The temperature of this core was determined by means of an electrical thermometer *embedded in it*, consisting of a wire of pure platinum whose electrical resistance at any temperature had been previously determined, and whose resistance, therefore, if subsequently measured, gave its temperature, and hence also that of the iron core in which it was laid. Asbestos paper insulation, as had been used by former experimenters, was found to be very imperfect at high temperatures, owing largely to carbon deposited from the materials used in its manufacture. This difficulty was, after some trouble, overcome; but wherever a high degree of insulation was wanted, as in the case of the thermometer wire and secondary winding, it was found necessary to employ *mica*, though, as may well be imagined, the use of such an untractable material for such a purpose is beset with considerable mechanical difficulties.

Now, to find the magnetic condition of a sample of iron at a given temperature with any completeness, it is not sufficient merely to measure its permeability in various magnetic fields; the behaviour of the iron when subjected to what is called a "cyclic" process of magnetisation must be studied—the "hysteresis," or energy, absorbed in one double reversal of the magnetisation of each cubic centimetre of the iron, must be measured.

But the taking of so many observations requires time; and if, during this time, the temperature of the iron be not perfectly constant, all efforts at refinement in the magnetic measurements are thrown away. The heating of the ring must, then, be thoroughly under control. The method I adopted was an electrical one. The ring-magnet was furnished with an extra winding of asbestos-insulated platinum wire, so wound as to have no magnetising influence; and by passing through this wire a suitable electric current, heat could be generated in the ring at any desired rate. This method, however (the principle of which was adopted as long ago as 1888 by M. Ledeboer) is not used to full advantage unless combined with an effort to thermally isolate the body to be heated. Each ring-magnet was therefore thickly wrapped with asbestos, and supported in the centre of a closed and partially exhausted glass vessel (oxidation of the iron core was also in this way avoided).

This method of heating proved most satisfactory. The loss of heat by radiation and conduction being slight, the ring-magnet could not rapidly alter its temperature; and there is probably no way in which we can supply heat-energy to a body, which can compete with the electrical resistance method, either as regards constancy or control. For obtaining temperatures up to 1300° or 1400° C.—a white heat—this method, combined as far as possible with "thermal isolation," and an electrical method of measuring the temperature, should in the future prove of the greatest value in all cases where the physical properties of bodies at high temperatures require careful investigation.

The original intention of my experiments was to ascertain exactly in what way the specific electrical resistance of iron changes at and about the "critical temperature" at which the magnetic properties of iron so nearly disappear, so as to throw light if possible on the molecular state which we characterise by the term "magnetic." With this object the iron core of the ring-magnet was formed of a long insulated iron strip, among the turns of which the platinum thermometer wire was buried; and with this piece of apparatus simultaneous measurements of the magnetic qualities and electrical resistance of a sample of iron could be made with accuracy alike at low and high temperatures.

Let us now consider the magnetic changes which occur in soft iron when heated. At ordinary temperatures iron shows a kind of unwillingness, so to speak, to become *slightly* magnetised—its permeability under small forces is not great. Beyond a certain limit, however, it exhibits the greatest readiness to become further magnetised, and continues to have a high permeability until magnetised very strongly. But from this point it begins to show signs of magnetic *saturation*, and ultimately refuses to be further magnetised without the application of very great force.

Now, as the temperature of the iron is gradually raised, it is found that practical magnetic saturation takes place sooner and sooner. Iron refuses to become so strongly magnetised at higher temperatures. Thus the permeability in strong magnetic fields falls off as the temperature rises—very slowly at first, then more rapidly, till, near the "critical temperature," the permeability rapidly drops to quite a low value.

On the other hand, in weak magnetic fields, the behaviour of iron up to within a few degrees of the "critical temperature" is precisely opposite. The permeability *rises* with the temperature—at first slowly, then above 500° C. with ever increasing rapidity, until at last that lack of susceptibility to small forces disappears, and iron shows itself just as amenable to magnetic influence in small magnetic fields, as in the larger ones, where the maximum permeability occurs.

At this temperature—say 15° below the critical temperature (about 750° C.—a red heat), iron possesses all those qualities at once which are sought after by the transformer maker:—Practical absence both of hysteresis and of eddy currents (the latter owing to the greatly increased electrical resistance), and a permeability nearly four times as great as that attainable in commercial transformer iron. So magnetic, indeed, is the iron, that even the earth's magnetic field, in the direction of its greatest intensity, is enough to induce strong magnetisation ($B = 5000$), in fact almost saturate the iron (for which at this temperature a relatively low induction suffices). The behaviour of a compass needle near a slowly cooling ingot of cast steel, should be rather interesting, for just below the critical temperature the vertical ingot must behave as a very powerful magnet indeed.

For all the lesser magnetic fields, there is a temperature of maximum permeability which is nearer to the critical temperature the smaller the magnetic field. But *at* that temperature the magnetic qualities in almost all fields practically vanish. Hence, when the magnetising force is very small, the change from enormously magnetic to almost non-magnetic takes place with extreme suddenness.

Above the critical temperature, iron is but feebly magnetic; yet it is still much more readily affected by a magnet than most other feebly magnetic bodies. Not till a white heat is reached, do the magnetic qualities of iron become imperceptible.

It is not easy in an article like the present to deal with the changes which occur in the electrical resistance of iron, but the following remarks may be of interest:—

The experiments of Dewar and Fleming have shown that at a temperature of − 200° C. the specific electrical resistance of iron is extremely low. Throughout the range of temperature included between that extreme of cold and the critical temperature, about + 780° C., the resistance rises at a steadily increasing *rate*, so that at the latter temperature it is over 150 *times* as great as at the former: far in excess of that of any known alloy at ordinary temperatures (crystalline metals and their alloys excepted), and about equalling liquid mercury for high specific resistance. On still further raising the temperature of the iron, it is found that the *rate* of rise of resistance, instead of further increasing, very rapidly falls off till, at a white heat, the resistance of iron increases only slowly with the temperature.

It has long been known that this *increasing rate of rise* of resistance with temperature is a characteristic possessed by the magnetic metals alone. Here now we see that no sooner does the iron cease to be strongly magnetic than this quality disappears, and becomes exchanged for an opposite one, namely, a *decreasing* rate of rise of resistance with temperature. In some hitherto unpublished experiments on Hadfield's manganese steel (a non-magnetic steel which can be rendered magnetic by annealing), I have observed a precisely similar change of the resistance-temperature function to take place during the annealing of this steel, thus furnishing a second case of this obscure resistance-change accompanying the change from magnetic to non-magnetic, in one and the same sample.

The connection between magnetic and electrical properties is evidently not a very simple one, but in the face of these facts it is hard to deny that there is one; and it is only by trying to find out how the various physical properties depend upon magnetism that we may hope to arrive at a comprehensive explanation of that obscure but most interesting condition of matter.

DAVID K. MORRIS.

EARLY MAN IN SCOTLAND.[1]

IN Scotland, as in other countries, man existed before the time of written history. The conditions under which his remains are found, and the works which he has left behind him, provide the data for determining their age, not absolutely or capable of being expressed in numbers of years, but relatively to each other.

Marked differences existed in the physical conditions of Scotland, and indeed in the northern parts of England also, as compared with the southern districts of England and the adjoining parts of France and Belgium at the first appearance of primeval man in those countries. It is the more necessary, therefore, that the conditions then prevailing in Scotland should not be overlooked.

No evidence sufficient to satisfy geologists has been advanced to prove that man existed in Britain during the period called Tertiary. So far, indeed, as Scotland is concerned, even if it were admitted that in other parts of the globe man had been on the earth during Tertiary times, there is little likelihood that his remains could have been preserved; for in that country the Tertiary is represented chiefly by volcanic rocks, and a few patches of sand and gravel with rolled sea shells belonging to the closing stages of that period.

From the careful study which geologists have given to the surface of Scotland, it is evident that at the commencement of the period termed Quaternary or Pleistocene, immediately succeeding the Tertiary, the whole of the country was covered with ice which formed a great sheet 3000 or 4000 feet thick in the low grounds, of which the lower boulder clay, or Till, as it is termed, was the ground-moraine.

[1] A discourse delivered at the Royal Institution, London, by Sir William Turner, F.R.S.

As an upper boulder clay also occurs, which is often separated from the lower boulder clay by stratified deposits, some of which contained marine, and others fresh water and terrestrial organic remains, it is obvious that the Ice Age was not one uninterrupted period of continuous cold.[1] The lower and upper tills are the ground-moraines of independent ice sheets, each indicating a distinct epoch, separated by an interglacial period. The earlier epoch was that of maximum glaciation, and the ice sheet extended over the north and middle of England, as far south as the Thames Valley and the foot of the Cotswold Hills; but the high moors in Derbyshire and Yorkshire and the tops of the highest mountains in Wales and Scotland rose above its surface. The great Mer de Glace stretched westward over Ireland into the Atlantic, whilst on the east it was continuous across the North Sea with a similar ice sheet which covered Scandinavia and the region of the Baltic, and extended south to the foot of the hills of central Europe, and overspread much of the great central plain. In the extreme south of England, therefore, the conditions differed from those that obtained in the country further north. Although not actually covered with a sheet of ice, yet the more southern counties had been of necessity under the influence of cold, and must have been subjected to the effects produced by rain and snow, by freezing and thawing.

During the succeeding interglacial epoch the climate eventually became temperate and genial, and vegetable and animal life abounded. It is to this stage that most of the Pleistocene river alluvia and cave deposits of England and the adjacent parts of the continent are assigned. The British Islands appear at that time to have been joined to the continent, and the same mammalian fauna then occupied Britain, France and Belgium, which implied similar climatic conditions. As examples of these, it may be sufficient to name the larger mammals, as the cave and grizzly bear, the hyæna, lion, Irish deer, reindeer, hippopotamus, woolly rhinoceros, straight-tusked elephant and mammoth, all of which are now either locally or wholly extinct.

Abundant evidence exists that man was contemporaneous with these mammals in western Europe, as is shown by the presence of his bones alongside of theirs, and of numerous works of his hands, more especially the implements and tools which he had manufactured and employed. To a large extent these consisted of flint, rudely chipped and fashioned. To these implements, and to the men who made them, the well-known term "Palæolithic" is applied. But along with these, other implements have been discovered, made from the bones, horns and teeth of the larger mammals, on some of which animal forms and incidents of the chase have been sculptured both with taste and skill. Up to now, however, no trace of pottery which can without question be referred to Palæolithic men has been found, and no habitations, except the caves and rock shelters which nature provided for them.

One may now consider how far northwards in Britain Palæolithic man and the large mammals, with which he was contemporaneous, have been traced. The exploration of caverns, made by Prof. Boyd Dawkins and other geologists associated with him, has proved that bones of certain of the mammals of this epoch were present in caves in Derbyshire, Yorkshire and North Wales, and that human remains and implements of Palæolithic type have been found along with them in the Robin Hood cave in the Cresswell Crags, and in caverns in North and South Wales.

When Scotland is considered, evidence of the existence of the mammals of this epoch is not so abundant, yet the interglacial beds of that country have yielded remains of mammoth, reindeer, Irish elk, urus, and horse. But notwithstanding the keen scrutiny to which the superficial deposits in Scotland have been subjected by the members of the Geological Survey and others, no traces either of the bones of Palæolithic man or of the work of his hands have been discovered in North Britain. This, indeed, is not much a matter of surprise, for it must be remembered that, subsequent to the genial interglacial epoch, another ice sheet, that of the upper boulder clay, made its appearance, grinding over the surface of the land, wearing away alluvia, and largely obliterating the relics of interglacial times. Hence inter-

[1] For the evidence on which these statements are based, consult the "Great Ice Age," by Prof. James Geikie, edition 1894, also his "Classification of European Glacial Deposits," in *Journal of Geology*, vol. iii., A May 1895.

glacial beds occur only at intervals and are very fragmentary. Nor in Scotland are there any caves similar in dimensions to those which in England and elsewhere have yielded such abundant traces of Palæolithic man and his mammalian congeners. If Palæolithic man ever did exist in Scotland, and there is no reason why he might not have migrated northward from Yorkshire and Wales, yet one could hardly expect to discover traces of his former presence. In Scotland there are no massive limestones, with extensive caverns, in which man could have sheltered, and in which his relics and remains could have been secure from destruction during the advance of the second ice sheet. It is only in the alluvial deposits of interglacial times that such traces have been preserved, but these deposits, as we have seen, were ploughed out and to a great extent demolished by the later sheet of ice. The shreds that remain, however, are of extreme interest, from the fact that they contain relics of the Pleistocene mammals, with which Palæolithic man was contemporaneous; and there is a bare chance that some day traces of man himself may be encountered in the same deposits.

Geologists have shown that in the regions which were overflowed by the second or minor ice sheet no traces of Palæolithic man, or of the southern mammals with which he was associated, have ever been met with in British superficial alluvia. When found in those regions out of Scotland, they occurred in caves chiefly, and sometimes in the stratified deposits which here and there underlie the upper boulder clay and its accompanying gravels.

So far as Scotland is concerned, one must look for a period subsequent to the melting of the second great ice sheet for evidence of the existence of early man. After its disappearance important fluctuations in temperature and in the relative level of land and sea took place from time to time, so that the climate and the area of land in Scotland differed in some measure from what is known at the present day. Eventually a period of cold again occurred, not so severe, undoubtedly, as in the two preceding glacial epochs, but sufficient to bring into existence considerable district ice sheets and extensive valley-glaciers in the Highlands and Southern Uplands. Scotland at this stage was partially submerged, and many of the Highland glaciers reached the sea and gave origin to icebergs. The submergence slightly exceeded 100 feet, and the marine deposits formed at the time are charged with arctic shells and many erratic blocks and débris of rocks. On a subsequent elevation of the land, the beach formed at this level constituted a terrace, well marked on the coast line in many districts, and now known as the 100-foot beach.

There is good reason to believe that the elevation referred to was of sufficient extent to join Britain again to the continent. It is to this stage that the great timber trees which underlie the old peat bogs of Scotland are referred. The peat with its underlying forest bed passes out to sea, and is overlaid in the Carse lands of the Tay and the Forth by marine deposits, which form another well-marked terrace, the 45 to 50 foot raised beach of geologists.

Thus the elevation of the land that followed after the formation of the 100-foot beach coincided with an amelioration of climate and with the presence of an abundant vegetation, and large mammals, such as the red-deer, the elk, and the *Bos primigenus* roamed through the woods. While these conditions obtained partial submergence again ensued, and the sea rose to fifty feet, or thereabouts, above its present level. Within recent years it has been shown that during this period of partial submergence glaciers reached the sea in certain Highland firths, which would seem to show that the climate was hardly so genial as during the preceding continental condition of the British area, when that region was clothed with great forests. Ere long, however, elevation once more supervened, and the sea retreated to a lower level. Here it paused for some time, and so another well-marked terrace was formed, which is known as the 25 to 30 foot beach.

There is not any evidence of the presence of man in Scotland during the formation of the 100-foot beach or terrace, but one can speak with certainty of his presence there during the period of formation of the later beaches. If one could put oneself into the position of an observer who, at the time of the 40-50 foot submergence, had stood on the rock on which Stirling Castle is now built, instead of the present carse lands growing abundant grass and grain, and studded with towns, villages, and farmhouses, one would have seen a great arm of the sea extending almost if not quite across the country from east to west, and separating the land south of the Forth from that to the north. In this sea great whales and other marine animals disported themselves, and sought for their food. Abundant evidence, that this was the condition at that time in the Carse of Stirling, is furnished by the discovery during the present century of no fewer than twelve skeletons of whalebone whales belonging to the genus Balænoptera or Finner whales, imbedded in the deposit of mud, blue silt and clay which formed the bed of the estuary.[1] This Carse clay, as it is called, is now in places from 45 to 50 feet above the present high-water mark, and is extensively used for the manufacture of bricks and tiles. At a still lower level lies the carse clay of the 25-30 foot terrace. Until the beginning of the present century the clay had been covered by an extensive peat moss, which the proprietors of the land have removed. The question which has now to be considered is—Did man exist in Scotland at the period of the formation of the carse clays and of the two lower sea beaches? There is undoubted evidence that he did.

Along the margin of the 45-50 foot terrace in the neighbourhood of Falkirk one comes upon the shell-mounds and kitchen-middens of Neolithic man. All these occur on or at the base of the bluffs which overlook the carse lands—or, in other words, upon the old sea-coast. Again, in the Carse of Gowrie, a dug-out canoe was seen at the very base of the deposits, and immediately above the buried forest-bed of the Tay Valley. The 25-30 foot beach has been excavated out of the 40-50 foot terrace; it is largely a plain of erosion rather than of accumulation. It is probable, therefore, that many of the relics of man and his contemporaries which have been obtained at certain depths in the 25-30 foot beach may really belong to the period of the 40-50 foot beach. Some of these finds will now be referred to.

In 1819 the bones of a great Fin-whale, estimated about 72 feet long, were exposed in the carse land adjoining the gate leading into the grounds of Airthrey Castle, near Bridge of Allan, about 25 feet above the level of high water of spring tides. Two pieces of stag's horn, through one of which a hole about an inch in diameter had been bored, were found close to the skeleton. In 1824, on the estate of Blair Drummond, in the district of Menteith, a whale's skeleton was exposed, and along with it a fragment of a stag's horn which was said to have a hole in it and to have been like that found along with the Airthrey whale. Mr. Home Drummond also states that a small piece of wood was present in the hole, which fitted it, but on drying, shrunk considerably. Unfortunately these specimens have been lost, and no drawings or more detailed descriptions were ever apparently published, though in some geological and archæological works they have been stated, without any authority, to have been lances or harpoons. Twenty years ago the skeleton of another whale was exposed at Meiklewood, Gargunnock, a few miles to the west of Stirling, and resting upon the front of its skull was a portion of the beam of the antler of a red deer, fashioned into an implement eleven inches long, and six and a half inches in greatest girth; a hole had been bored through the beam, in which was a piece of wood one inch and three-quarters long, apparently the remains of a handle. The implement was truncated at one end, and shaped so that it could have been used as a hammer, whilst the opposite end was smooth and bevelled to a chisel or axe-shaped edge formed by the hard external part of the antler.[2] There can be no doubt that this implement resembled those found alongside of the Airthrey and Blair Drummond whales earlier in the century, and it effectually disposes of the statement that they were lances or harpoons. Dug-out canoes have indeed been found imbedded in the Carse clays at a similar level, so that the people of that day had discovered a means of chasing the whale in the water; one can, however, scarcely conceive it possible to manufacture a horn implement sufficent to penetrate the tough skin and blubber of one of these huge animals, and to hold it in its efforts to escape. It is much more probable that the whale had been stranded at the ebb of the tide in the shallower water near the shore, and that the people had descended from the neighbouring heights, and had used their horn implements, with their chisel-like edges, to flense the carcass of its load of flesh and blubber, and had carried the spoil to their respective habitations. There can

1 See more particularly Mr. Milne Home's "Ancient Water Lines" (Edinburgh, 1882), and "The Raised Beaches of the Forth Valley," by D. B. Morris (Stirling, 1892).

2 I described this implement in Reports of British Association, 1889, p. 790. It has subsequently been figured in a Report by Dr. Munro in the *Proceedings of the Society of Antiquaries*, 1896.

be little doubt that these implements rank, along with the dug-out canoes, as the oldest relics made with human hands which have up to this time been found in Scotland, and that they belong to the earliest period of occupation by Neolithic man.

After the oscillations in the relative level of land and sea had ceased, and the beach found at the present day had been formed, evidence of the presence of Neolithic man and of mammals, both wild and domesticated, such as now exist in Scotland, becomes greatly multiplied.

Shallow caves or rock shelters situated in the cliff which bounds the esplanade at Oban Bay, which, after being closed for centuries by a landslide from the adjacent height, had recently been quarried into in obtaining stone for building purposes, were described by the lecturer.[1] The caves were as a rule 100 yards inland, and about 30 feet or more above the present high-water mark. They had, no doubt, been formed by the action of the waves at the period of formation of the 25-30 foot beach, for the floor of one of the caves was covered by a layer of gravel and pebbles, which had obviously been washed there when the sea had had access to it.

In these caves, bones representing fifteen human skeletons, men, women, and children were found; also bones of the *Bos longifrons*, red and roe deer, pig, dog, goat, badger, and otter, shells of edible molluscs, bones of fish, and claws of crabs; flint scrapers, hammer stones, implements of bone and horn fashioned into the form of pins, borers and chisel-shaped instruments. In one cave several harpoons or fish spears made of the horns of deer were obtained; similar in form to those found in the Victoria Cave, Settle, in Kent's Cavern, and in the grotto of La Madelaine, France, which in some of these instances have been associated with Palæolithic objects.

An account was then given of the construction and contents of the chambered horned cairns in Caithness and the north-west of Scotland, which have been so carefully investigated and described by Dr. Joseph Anderson ("Scotland in Pagan Times," Edinburgh, 1886). The presence of incinerated bones and of unburnt skeletons showed the cairns to have been places of interment, whilst flint flakes and scrapers, bone and polished stone implements, and shallow vessels of coarse clay, associated them with Neolithic man, obviously the same race as the builders of the English long barrows.

Stone abounds in Scotland, and the polished stone implements which have been found in every county, in the soil and near the surface of the ground, are often of large size, and beautifully ground and polished. Flint, on the other hand, is confined to a few localities, as the island of Mull and limited areas in the counties of Banff and Aberdeen. The nodules are as a rule small in size, and though adapted for the manufacture of arrow-heads and scrapers, flint does not seem to have attained the same importance in Scotland as the raw material provided by nature for the manufacture of articles used by Neolithic man, as was the case in England and Ireland.

Although there is ample evidence of the nature of the implements and weapons manufactured by Neolithic man, and of his methods of interment in rock shelters and chambered cairns, no traces of built dwellings which can be ascribed to the people of this period have been discovered. Doubtless their habitations were constructed of loose stones and turf, and sun-dried clay, or of the skins of animals killed in the chase spread over the branches of trees, which, from their fragile and destructible character, have not been preserved.

In the course of time stone and bone, readily procurable, and which are directly provided by nature for the use of man, gave place to materials which require for their manufacture considerable skill and knowledge. The introduction of bronze as a substance out of which useful articles could be made, marked an important step in human development, and could only take place after men had learnt by observation the ores of copper and tin, and by experiment the methods of extracting the metals from them, and the proportions in which they should be combined in the alloy in order to secure the necessary hardness. So far as Scotland is concerned, bronze must have been introduced from without; its manufacture could not have been of indigenous development, as the ores of tin and copper do not occur in North Britain. Doubtless it came from the southern part of our island, and was extensively employed in South Britain long before it became substituted in the north for the more primitive materials.

[1] For a detailed description, see papers by Dr. Joseph Anderson and the author in *Proc. Scot. Soc. Antiquaries*, 1895.

There is abundant information that Scotland had a Bronze Age. Swords, spears, bucklers, bracelets, rings, fish hooks, axes, chisels, sickles and other implements made of this metal have been found in considerable numbers. These objects occur sometimes singly, at others in collections or hoards in peat mosses, or even at the bottom of lochs and rivers, or buried in the soil as if they had been placed there with a view to concealment, and then, through the death or removal of their owners, had been lost sight of. In many instances these weapons and implements are elegant in design, show great mechanical ability in their construction, and are ornamented with much taste and skill. Instances also are not uncommon in which objects of bronze are found in the sepulchres of the period.

In the study of the Bronze Age in Scotland a want is experienced similar to that felt in a review of the Neolithic period. There are no buildings which can be distinctly regarded as dwelling-places for the men of this time. With them, however, as in the Polished Stone Age, there is evidence of the mode in which they disposed of their dead friends and relatives. Interments which there are good grounds for associating with these people, have been exposed in the formation of roads and railways, and in agricultural operations. Where the surface of the ground has not been cultivated or otherwise disturbed, in almost every county tumuli, mounds, hillocks and cairns occur, the exploration of which has in many cases yielded interesting results. In no instance, however, have chambered cairns, divided into compartments, and possessing an entrance passage, been found associated with articles made of bronze. The sepulchral arrangements of the period possessed a greater simplicity than is shown in the chambered cairn.

The interments in the Bronze Age were sometimes that of a single individual in a knoll or mound, or under a cairn artificially constructed, and now overgrown with grass, heather and whin bushes, or, as is not uncommon, in a collection of sand or gravel near the sea shore, or on a river bank, or in the moraine of some long-vanished glacier. At other times, in similar localities, two to six interments had been made as if in a family burying ground. At others the interments were much more numerous, and represented doubtless the cemetery of a tribe or clan; one of the best known of these was observed some years ago at Law Park, near St. Andrews, in which about twenty interments were recognised. In another at Alloa, twenty-two separate interments were exposed. Quite recently, immediately to the east of Edinburgh, in the districts now known as Inveresk and Musselburgh, not less than fifty interments of this period have been brought to light, in connection with building operations, which implies that then, as now, this part of the country was settled and had a considerable population.

Two very distinct types of interment prevailed, viz. Cremation, with or without cinerary urns; and Inhumation, the unburnt body being enclosed in a stone cist or coffin. From an analysis of 144 localities in Scotland of burials which may be associated with the Bronze Age,[1] and which included about 400 distinct interments, it would appear that in fifty-one of these localities the bodies had all been cremated; in sixty they had been buried in stone cists; in fifteen the same mound or cemetery furnished examples of both kinds of sepulchre, and in the rest the kind of interment was not precisely recorded. These diversities did not express tribal differences, but seemed to have prevailed generally throughout Scotland. Both cremation and inhumation are found in counties so remote from each other as Sutherland in the north and Wigton in the south, in Fife and the Lothians on the east, and in Argyll and the distant Hebrides in the west, as well as in the intermediate districts.

The cremation had been effected by wood fires, for in many localities charcoal has been found in considerable quantity at the place of interment. The heat generated was sufficient to reduce the body to ashes, and to burn the organic matter out of the bones, which fell into greyish-white fragments, often curiously cracked and contorted, which were not very friable. They were then collected and usually placed in an urn of a form and size which we now call Cinerary. When a bank of sand or gravel was convenient, a hole three or four feet deep was made and the urn lodged in it Sometimes the urn stood erect, and a flat stone was placed across the mouth before the hole was filled in with sand and earth; at others a bed of compacted earth, or of

[1] Most of these are recorded in the "Archæologica Scotica," the *Proceedings* of the Scottish Society of Antiquaries, and Dr. Joseph Anderson's "Scotland in Pagan Times"; whilst others, in the author's note books, have not yet been published.

small stones, or of a flat stone, was made at the bottom of the hole, and the urn, with its contents, was inverted. In some cases the urn was protected by loose stones arranged around it. In obviously exceptional instances, it may be perhaps of a tribal chieftain, a small stone cist was built to enclose the urn, and even a cairn of stones was piled above and around to protect it and to mark the spot.

Cremated interments not contained in urns have been recorded in a few instances, and in them the surrounding sand or gravel has usually been discoloured, from the blackened remains and charcoal having to some extent become diffused through it.

The largest examples of cinerary urns were from 12 to 16 inches in height, with a flat narrow bottom, and 10 to 12 inches wide at the mouth. About one-third the distance below the mouth the urn swelled out to its widest diameter, and was surrounded by one or two mouldings, between which and the mouth the outer surface was often decorated with lines which ran horizontally, or vertically, or obliquely; sometimes they intersected, and formed a chevron or a diamond-shaped pattern. Below the mouldings, the surface was without pattern, though sometimes raised into an additional simple circular moulding.

When the inhumation of an unburnt body was decided on, a rude cist or coffin, formed of undressed flattened stones, was built for its reception. As a rule, the sides and ends of the cist were formed each of a single slab of sandstone, schist, gneiss, granite or other stones provided by the rock in the neighbourhood; but in some instances of a stone of a different character from the adjoining rocks, and obviously brought from a distance. The stones were set on edge and supported a great slab, which, being laid horizontally, formed the lid or cover of the cist, and which was much thicker and heavier than the side and end stones; sometimes, as if for additional protection, a second massive slab was placed on the top of the proper cover. The floor of the cist was formed, when the earth was shallow, of the native rock, and at other times of compacted earth, or a layer of pebbles, or of flat stones. Usually the stone walls and the cover of the cist were simply in apposition, but sometimes they were cemented together with clay. In some cists, exposed a few years ago on the farm of Cousland, near Dalkeith, the peculiarity was observed of the cist being divided in its long direction into two compartments by a stone slab down the middle.

The cists were oblong, the length exceeding the breadth, and although they varied in size, those for adults being larger than for children, they were always shorter than would have been required for a body to be extended at full length. As the end stones were usually set within the extremities of the side stones, the internal measurement of length was some inches less than the external. The average dimensions may be given for the interior about 4 feet in length, 2 feet in breadth, and 2 feet in depth. The cover slab was much larger both in length and breadth, as it overlapped both the sides and ends.

These cists remind one, in their general form and plan, but on a much smaller scale, both as regards the size of the enclosed space and the magnitude of the stones, of the dolmens so frequent in Brittany. As survivals in modern times, we may point to the empty stone boxes, on the cover stone of which an inscription is incised, to be seen in so many country churchyards, built on the ground superficial to the pit in which the body in its wooden coffin has been inhumed.

Owing to the shortness of the cist the body could not be extended at full length, but was laid upon its side, with the elbows bent, so that the hands were close to the face; the hips and knee joints were also bent so that the knees were in front of the body.

Usually only a single skeleton has been found in a cist, either a man or a woman as the case may be. Sometimes two skeletons have been seen, at times a man's and a woman's, doubtless husband and wife; in others the second skeleton has been that of a child. Sometimes the cist was below the average in size, and contained only the skeleton of a child or young person. Such examples throw light upon the family relations of the people of this period. They show that they desired to preserve the associations of kinsfolk even after death; and when the cist contained the remains only of a child it was constructed with the same care as if it had been the tomb of a chief.

When cremated bodies are found associated with stone cists in the same cemetery, the cinerary urns in which the ashes were customarily deposited lie outside the cists, and in quite independent excavations in the soil, but in such close proximity as to show that they belonged to the same period. In two instances short cists have been opened, in which, alongside of the skeleton of an unburnt body, were cremated human bones, not contained in a cinerary urn, but scattered on the floor of the cist, which conclusively prove that both cremation and inhumation were sometimes in practice at the same interment.

(To be continued.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. CHARLES E. GREEN, President of the Board of Trustees of Princeton University, died suddenly on December 24.

LAFAYETTE COLLEGE, at Easton, Pennsylvania, suffered serious loss by fire a few days ago for the second time in its history. Pardee Hall, with its valuable collections, was nearly destroyed, and the library was much injured.

Science states that bills have been again introduced into both Houses of Congress to establish the University of the United States. Such a bill was introduced by Senator Edmunds in 1890 and referred to a select committee, which reported unanimously in its favour. The standing committee since appointed has also reported unanimously in its favour, and it is said that the bill will probably be passed during the present session.

AMONG recent appointments are:—Dr. S. Fuchs to be associate professor of physiology at the University at Jena; Prof. Waldemar Lindgren, of the U.S. Geological Survey, to be professor of metallurgy and mining engineering in Stanford University; Mr. Edgar R. Cumings, of Cornell University, to be instructor in geology in the University of Indiana; Dr. W. Ophüls to be professor of pathological anatomy in the University of Missouri.

AN additional chair of Chemistry has been founded and endowed in the McGill University, Montreal, by Mr. W. C. McDonald, who recently erected a new chemical building at a cost of 240,000 dols. The same donor has provided an additional endowment of 50,000 dols. for the faculty of Law, to the deanship of which faculty, with the chair of Roman Law, Mr. F. P. Walton, of the Scotch Bar, was recently appointed. Mr. McDonald has, moreover, supplemented the existing endowments associated with his name by a further gift of 200,000 dols. to provide for any deficiency in income that may result from the fall in the rate of interest on investments.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, December, 1897. —A wet day in a wet district. A remarkably heavy rainfall occurred in the Lake district on November 12. At Skelwith Fold (Lancashire) it amounted to 6·03 inches, or 7·5 per cent. of the annual mean; at Skelwith Bridge (Westmoreland) 6·35 inches were measured, or 7·8 per cent., and at Leathwaite (Cumberland) 8·03 inches, or 6·1 per cent. of the annual mean. There was no thunderstorm, but a continuous pelting rain nearly throughout the twenty-four hours. Naturally, much damage was caused by floods.—Temperature variations in November. An observer at Cheltenham draws attention to some remarkable changes during November 14 to 20, the greatest of which was a fall of 21°·4 between the 18th and 19th. In the neighbourhood of London the greatest difference between any two consecutive readings during November was 19°·6. Mr. Symons points out that nearly similar differences also occurred in 1866 and 1893.—The same number also contains some useful particulars, with illustrations, respecting Richard's instruments for use with kites or balloons. Pressure, humidity, and temperature are simultaneously recorded on a single sheet of paper; the total weight of the instrument is only 36 ounces.

Wiedemann's Annalen der Physik und Chemie, No. 12.—Origin of contact electricity, by C. Christiansen. The gas surrounding a jet of zinc, lead, or tin, amalgam has a marked influence upon its uninterrupted length. Air, oxygen, and sulphurous acid have the effect of retarding the breaking up of the jet, owing to contact electrification. The author measures the length of the continuous jet by making it part of a circuit containing a galvanometer, the steadiness of the needle denoting the continuity of the jet. He finds that air or oxygen have no effect when quite dry.—Temperature of the electrodes of mercury arc lamps, by L. Arons. In the arc lamp with mercury electrodes, devised by Arons, the anode is the hotter, and gradually distils over into the kathode, which is flickering and turbulent. Mercury is condensed on the walls of the vacuum tube, which are easily obscured.—Deflection of kathode rays, by W. Kaufmann and E. Aschkinass. The authors determined the deflection produced in kathode rays by a narrow field due to condenser plates mounted in a tube crossing the vacuum tube at right angles. They found that the amount of deflection observed is strictly in accordance with the projection hypothesis of kathode rays as against the German wave hypothesis.—Magnetic deflection of kathode rays, by W. Kaufmann. The above result led the author to redetermine the ratio e/m of the charge of the projected particles to its mass, by a close study of the magnetic field deflecting the ray. It was found to be $1{\cdot}77 \times 10^7$ instead of 10^7.—Kathode rays, by E. Wiedemann and G. C. Schmidt. There are two distinct kinds of kathode rays, which proceed from a point in the form of a solid cone and of a hollow cone respectively, producing on the wall of the tube a patch or a ring. The authors studied these two species under the simplest conditions. They placed a knob, forming the terminal of a Lecher secondary wire, against an exhausted glass sphere without electrodes. A hollow cone proceeded from a point in the sphere next to the knob, whose angle varied with the exhaustion, the size of the sphere, and the curvature of the electrode, increasing as they increased.—Electric observations by balloon, by R. Börnstein. The balloon offers the best means of determining the true potential at any point in the atmosphere, but the charge of the balloon itself is a source of error. This may be eliminated by employing three collectors for three successive points below the balloon, and only about 2 m. distant from each other. If the decrease of potential is uniform, the charge of the balloon is zero. Otherwise, the charge is easily calculated from the observed decrements.—Thermodynamics of luminescence, by K. Wesendonck. A luminescent body is capable of imparting heat to a body warmer than itself. This does not contradict the second law of thermodynamics, as luminescence is not ordinary thermal radiation.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 16, 1897.—"The Comparative Chemistry of the Suprarenal Capsules." By B. Moore, M.A., and Swale Vincent, M.B.

In this paper it is shown that the "paired bodies" of Elasmobranch fishes contain the same chromogen as the medulla of the suprarenal capsules of mammals. In previous papers Vincent had shown not only that the "paired bodies" bear a close resemblance histologically to mammalian medulla, but that they contain a substance which constricts arterioles and raises blood pressure in a similar manner to mammalian medulla.

From the chemical point of view Moore had further shown that this active substance is closely associated with a chromogen also found only in the suprarenal medulla. The active material and chromogen are not, however, identical, for the activity may be destroyed without destroying the chromogen by allowing the material to stand for seven to ten days in strong alcohol. Moore hence supposes that the active material has a complex molecule which is decomposed by the alcohol, and that the chromogenic properties are attached to a group in this molecule which is unattacked in the decomposition.

The colour reactions of the chromogen show that it contains an ortho-dihydroxy-benzene nucleus; thus, it gives a deep green coloration with ferric chloride, and reduces silver nitrate in the cold. Besides these tests, it gives a rose-red colour with alkalis and free halogens and other reactions, which show that it is a strong reducing agent.

Using these colour reactions as tests the chromogen was sought for in extracts of the paired bodies of Elasmobranchs (*Scyllium canicula*), and was found to be present in abundance.

It was also shown that no chromogen is present in the inter-renal of Elasmobranchs, which, according to Vincent, corresponds to the cortex of the suprarenal of mammals.

Thus, additional evidence is furnished that the paired bodies correspond to mammalian medulla, while the inter-renal does not resemble medulla and is probably cortex, as suggested by Vincent.

"On a Method of determining the Reactions at the Points of Support of Continuous Beams." By George Wilson, M.Sc., Demonstrator in Engineering in the Whitworth Laboratory of the Owens College, Manchester.

The solution given in this paper differs from those of Bresse, Clapeyron, and Heppel, insomuch that the reactions at the points of support are considered as the unknown quantities to be determined, instead of the bending moments over the piers.

It is shown that by considering the continuous beam as a beam supported at each end and under the action of the given loading acting downwards, and the intermediate supports considered as unknown concentrated loads acting upwards, and equating the deflection at any intermediate point of support caused by the former loading to that caused by the several intermediate reactions treated as concentrated loads, the following series of equations is obtained, viz.:—

$$N_1 = R_1 n_1' + R_2 n_1'' + R_3 n_1''' + \ldots$$
$$N_2 = R_1 n_2' + R_2 n_2'' + R_3 n_2''' + \ldots$$
&c. &c.

Where R with the correct suffix is the reaction at any intermediate point of support, and N and n with their suffixes are quantities depending on the dimensions of the beam and the loading.

The quantities n are constant and need only be determined once, whilst the value of N changes with the position and magnitude of the live load. A method of determining these constants when the cross section of the beam is variable, is given; when the cross section is uniform, the equations can be written down at once.

The elevation or depression of the supports from any cause affects the values of R, the alterations in which can be determined by means of the above equations when the amount of the elevation or depression is known.

An example is appended to show the application of the method.

Geological Society, December 15, 1897.—Dr. Henry Hicks, F.R.S., President, in the chair.—On the Pyromerides of Boulay Bay, Jersey, by John Parkinson. After briefly noticing the literature of the subject, the author described the altered rhyolites of Boulay Bay. One variety, the commonest, is of a dark red colour, showing flow-structure; another is porphyritic; a third, near the centre of the Bay, has a pale greenish matrix enclosing fragments, which, however, are due to flow-brecciation. Large pyromerides occur in two localities: in the more interesting, that north of the jetty, the structure of the rock indicates either a very peculiar magmatic differentiation *in situ* or (more probably) the mixture of two magmas differing in their stage of consolidation. From study of a series of specimens of the pyromeridal rock, the author arrived at the following conclusions: (1) The rock shows marked flow-structure and at times bands which indicate a slight difference in its composition, the latter tending to assume a moniliform outline. In such the microscopic structure corresponds with that of the pyromerides, and exhibits traces of radial crystallisation. (2) These afford a passage into somewhat oval pyromerides, with rather tapering ends and irregularly mammillated surfaces. (3) From these sometimes a single one seems to be thrown off, while lines of pyromerides or little lumps of similar material are scattered about the matrix. (4) Many of the pyromerides are solid throughout; others have a central cavity filled with quartz.—On the exploration of Ty Newydd Cave near Tremeirchion, North Wales, by the Rev. G. C. H. Pollen. In November 1896 a Committee was formed, consisting of Dr. H. Hicks, Dr. H. Woodward, and the author, for the purpose of exploring this cavern, which is situated in the same ravine on the east side of the Vale of Clwyd as the well-known caverns of Ffynnon Beuno and Cae Gwyn, explored about twelve years ago by Dr. H. Hicks and Mr. E. B. Luxmoore. Grants have been made by the Royal Society and by the Government Grant Committee for the purpose of carrying on the explorations; and though a considerable time must elapse before the work is completed, the results already obtained are of importance. The cavern had been in part broken into by quarrying operations, but the chambers and tunnels were completely filled up with more or less stratified deposits, and had remained entirely untouched. Although the ground above the cavern is strewn over with drift and erratics from the north and from the central areas of Wales, not a fragment of anything but immediately local material has been discovered in the cavern itself, showing clearly that the deposits in the cavern had been carried in by water before the northern and western ice had reached this area. The work has been carried on almost continuously throughout the year, and most of the material has been removed for a distance of over 60 feet from the entrance. The height of the cavern above sea-level is 420 feet, or about 20 feet above the floor of the Cae Gwyn Cave. The following points appear to the author to be now fully established: (1) The material in the Ty Newydd Cave, as in the lower parts of those of Ffynnon Beuno and Cae Gwyn, is of purely local origin. Of this he can speak with confidence, as the question was before him from the beginning and the gravels were examined with minute care for erratics. (2) This local deposit is of earlier date than the boulder clay with western and northern drift. This was proved by the finding of granite- and felsite-boulders abundantly at higher levels and over the cave, and in one case filling the upper part of one of the fissures communicating from above with the cavern. (3) The occurrence of the tooth of a large mammal (*Rhinoceros*) in the lower part of the cave shows that the animal was contemporary with, or of earlier date than the infilling of the cavern by the local drift.

Chemical Society, December 15, 1897.—Prof. Dewar, President, in the chair.—Prof. F. R. Japp delivered the Kekulé Memorial Lecture (see p. 180)—December 16, 1897.—Prof. Dewar, President, in the chair.—The following papers were read:—Stereochemistry of unsaturated compounds. Part i. Esterification of substituted acrylic acids, by J. J. Sudborough and L. L. Lloyd. The authors have made experiments on the esterification of many cinnamic acids and other derivatives of acrylic acid; the acids were boiled under fixed conditions with methylic alcohol solutions of hydrogen chloride, and the quantity of methylic salt formed was subsequently determined. Several rules governing the speed and course of esterification are formulated.—Formation and hydrolysis of esters, by J. J. Sudborough and M. E. Feilmann. The authors conclude that in the conversion of an acid into its ester by the action of an alcohol, either with or without hydrogen chloride, the rate of esterification is determined by two factors, namely (1) the configuration of the acid or the close proximity of substituting groups to the carboxyl group, and (2) the strength of the acid as determined by its affinity constant. The same two factors operate in determining the rate of hydrolysis of the ester.—A new method of determining freezing points in very dilute solution, by M. Wildermann.—A possible basis of generalisation of isomeric changes in organic compounds, by A. Lapworth. The author points out that many isomeric changes, hitherto regarded as of dissimilar types, may be formulated as special cases of a general form, expressible by the reversible equation $R_{\alpha}M . R_{\beta} : R_{\gamma} \rightleftarrows R_{\alpha} : R_{\beta} . R_{\gamma}M$; a labile group M moves from an α to a γ position, the necessary rearrangement of single and double bindings taking place between the three atoms, R_{α}, R_{β} and R_{γ}. By the aid of this general formula and its extended forms the author is able to explain a large number of cases of desmotropy, tautomerism and isomeric change.

DUBLIN.

Royal Dublin Society, December 22, 1897.—Prof. G. F. Fitzgerald, F.R.S., in the chair.—Prof. Thomas Preston read a paper on the radiation of light in a magnetic field. The author described how he had been led to apply photography to the study of the effect (recently discovered by Prof. Zeeman) produced by a strong magnetic field on the radiation from a source of light placed in it. The photographs were projected on a screen, and they rendered all the effects described by Prof. Zeeman clearly visible to a large audience (see p. 173).—Prof. J. Joly, F.R.S., then read a note on a theory of sun-spots. If at some level in the photosphere the temperature falls below the critical temperature of the elements present, and the pressure is sufficient, a precipitation of liquid will result; and it is suggested such a precipitated flood of liquid matter, supported on gaseous matter of higher density, would give rise to the appearances presented by a sun-spot. If the liquid is opaque, it will look darker than the surrounding photosphere. The reflection of the photosphere at the edge and the inrush of gaseous matter over the cooler area will, it is believed, explain the appearance of the penumbra. The re-evaporation of the liquid constitutes the disappearance of the spot. On this view the sun-spot constitutes the first beginning of a change of state in the sun visible to us.

PARIS.

Academy of Sciences, December 20, 1897.—M. A. Chatin in the chair.—The Secretary informed the Academy of the loss it had sustained through the recent death of M. Brioschi, of Milan.—Observations relative to the coffins of Voltaire and of Rousseau, opened December 18, 1897, by M. Berthelot.—Determination of the absolute coordinates of the stars, and also of the latitude, by means of meridian instruments. General method for the solution of these problems, by M. Lœwy.—On the periods of double integrals of algebraic functions, by M. Emile Picard.—Comparison of the thermogenetic or dynamogenetic power of simple food-stuffs with their nutritive value, by M. A. Chauveau. A considerable difference exists between the isoenergetic and isotrophic weights of sugar and fat in the case of a working subject. The isoglycogenetic and isotrophic powers are practically identical.—On those cases of the problem of three bodies (and of *n* bodies) in which two of them collide at the end of a finite time, by M. Painlevé.—On a special method of circumzenithal observations, by M. Ch. Rouget. A further study of the method described in a previous note.—On a particular conjugate net of certain surfaces derived from surfaces of the second order, by M. S. Mangeot.—On Taylor's series, by M. Eug. Fabry.—On the isothermal and adiabatic transformations of true gases; determination of the ratio of the two specific heats, by M. A. Leduc.—On an apparatus permitting of the separation of simple radiations in close proximity, by M. Maurice Hamy. The method is based upon the principle of interference.—Ebullioscopy of some salts in ethereal solution, by M. R. Lespieau. Results are given for uranyl nitrate and the chlorides of mercury, iron, zinc, and antimony.—On cerium, by M. Boudouard. A reply to criticisms on a former paper by the author.—On the duration of the phosphorescent power of sulphide of strontium, by M. José Rodriguez Mourelo. Experiments on sulphide of strontium prepared by different methods show that those specimens which exhibit the greatest intensity of phosphorescence are also those in which the property is most quickly developed and is preserved for the longest time.—Volumetric estimation of antimony, by M. H. Causse. The new method proposed is an iodometric one, depending upon the liberation of iodine from iodic acid by antimonious oxide.—Difference between nitroso-substitution derivatives according as the NO group is directly connected with carbon or with nitrogen, by MM. Camille Matignon and Deligny. A thermochemical paper.—A colour reaction of ordinary aldehyde, by M. Louis Simon. A blue colour is produced on the addition of solutions of trimethylamine and of nitro-prussiate of sodium. The reaction is not given by other aldehydes.—Action of piperidine upon carbonic ethers of phenols; formation of aromatic urethanes, by MM. Cazeneuve and Moreau.—On two Lepidoptera destructive to the sugar-cane in the Mascarene Isles, by M. Edmond Bordage. The author endeavours to clear up the confusion which has arisen as to the history and nomenclature of two species, the larvæ of which are known as "borers."—On the nuclear value of the *central body* of bacteria, by MM. J. Kunstler and P. Busquet.—On extra-liberian cribriform tissue and extra-ligneous vascular tissue, by M. E. Perrot.—On potato rot, by M. E. Roze. An account of the nature and causes of the various changes to which the tubers are liable after gathering.—The composition of oat, wheat, and rye straw, by M. Balland. The results of analyses show no difference between the three varieties of straw, which contain only trifling quantities of nutritive material. Short and leafy straw is to be preferred for the food of horses, and long straw for their litter.—On the presence of beds containing *Planorbis pseudo-ammonius* and *Bulimus Hopei* in the neighbourhood of Sabarrat and Mirepoix (Ariège), by M. G. Vasseur.—Influence of sub-nitrate of bismuth upon the "hardening" of cider, by MM. Leon Dufour and Daniel. The presence of the salt greatly retards the development of acidity. Its addition is recommended in the proportion of 10 grams per hectolitre (0·01 per cent.).—On the estimation of the acidity of urine, by M. H. Joulie. Advantages are claimed for the use of a standard solution of saccharate of lime. No indicator is required, the end-point being shown by the production of a precipitate of phosphate of calcium when the free acid and acid phosphate of sodium have been neutralised.—On the fermentation of cellulose, by M. V. Omelianski. A quantitative study of the action of the ferment described in a previous communication. The products of the decompositions are hydrogen, carbon dioxide, and a large proportion of fatty acids.—Muscular atrophy experimentally produced by pyocyanic intoxination, by MM. Charrin and H. Claude.—On tubercular sclerosis of the pancreas, by M. Paul Carnot.

December 27.—M. A. Chatin in the chair.—In an obituary notice of M. F. Brioschi, whose recent death was announced at the previous meeting, M. Hermite gave a brief account of the work of that distinguished mathematician.—A special method for the absolute determination of declinations and of latitude, by M. Lœwy. A further development of the subject of the author's previous communication.—The centrosomes in vegetable cells, by M. L. Guignard.—On phthalic green. Constitution, by MM. A. Haller and A. Guyot. The colouring matter previously described is to be considered as a substitution derivative of malachite green. The results obtained by Fischer are explained by the presence of impurities in the materials used by him.—Observation of the shower of Orionids, December 12–14, at Athens, by M. D. Eginitis.—On the existence of integrals in orthoic systems, by M. Riquier.—On surfaces applicable to a surface of revolution, by M. A. Pellet.—On linear functional equations, by M. Lémeray.—On a spring ergograph, by MM. A. Binet and N. Vaschilde. Several advantages are claimed for the use of a spring, instead of a weight, in this instrument.—Conductivity of radio-conductors or discontinued electrical conductivity. Resemblance to nervous conductivity, by M. Edouard Branly.—Magnetic properties of tempered steels, by Mme. Sklodowska Curie.—On the polarisation of the light emitted by a sodium flame placed in a magnetic field, by M. A. Cotton.—On the preparation of alloys of beryllium. Alloys of beryllium and copper, by M. P. Lebeau. The alloys are obtained by heating, in an electric furnace, an intimate mixture of oxide of beryllium, oxide of copper, and charcoal.—On the impurities of aluminium and of its alloys, by M. Ed. Defacoz. The author seeks to determine the form in which the foreign elements (silicon, iron, and copper) exist in the metal.—On a double carbonate of sodium and protoxide of chromium, by M. G. Baugé. The new salt results from the action of a solution of sodium carbonate upon chromous acetate in an atmosphere of carbon dioxide. It crystallises with either one or ten molecules of water and is a powerful reducing agent, decomposing water at 100° C. with evolution of hydrogen.—On the atomic weight of cerium, by MM. Wyrouboff and A. Verneuil. A rejoinder to M. Boudouard's criticism.—On the use of carbide of calcium in the preparation of absolute alcohol, by M. P. Yvon. Pure alcohol is without action upon calcium carbide, but the presence of even traces of water leads to the evolution of acetylene and formation of calcium hydrate. It is therefore possible by one, or at most two, distillations to prepare absolute alcohol from spirit of 90 per cent. strength.—On the aromatic diurethanes of piperazine, by MM. P. Cazeneuve and Moreau.—On α-acetylfurfurane and its presence in wood-tar, by M. L. Bouveault.—On the behaviour, on distillation, of a mixture of pyridine with propionic, acetic, and formic acids. The author has studied the progress of fractionation in the case of mixtures of a volatile acid with a feeble base. In the case of pyridine and formic acid the former begins to distil over in a nearly pure state, although its boiling point is 14° higher than that of formic acid.—On crystalline minerals formed under the influence of volatile agents at the expense of the andesites of the island of Thera (Santorin), by M. A. Lacroix.—The theory of the sense of orientation in animals, by M. G. Reynaud.—On the generation of leucocytes in the peritoneum, by M. J. J. Andeer.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 6.

ROYAL INSTITUTION, at 3.—The Principles of the Electric Telegraph: Prof. Oliver Lodge, F.R.S.

FRIDAY, JANUARY 7.

GEOLOGISTS' ASSOCIATION, at 8.—A Brief Account of the Excursions in the Urals, down the Volga, in the Caucasus, &c., made in connection with the International Geological Congress held in Russia, August-September, 1897: L. L. Belinfante.

SATURDAY, JANUARY 8.

ROYAL INSTITUTION, at 3.—The Principles of the Electric Telegraph: Prof. Oliver Lodge, F.R.S.

TUESDAY, JANUARY 11.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Machinery used in the Manufacture of Cordite: E. W. Anderson.
ANTHROPOLOGICAL INSTITUTE, at 8.30.
RÖNTGEN SOCIETY, at 8.30.—Practical Work with the X-Rays: W. Webster.
ROYAL VICTORIA HALL, at 8.30.—Diamonds: Prof H. A. Miers, F.R.S.

THURSDAY, JANUARY 13.

MATHEMATICAL SOCIETY, at 8.—Note on a Property of Pfaffians: H. F. Baker.—On the Stationary Motion of a System of Equal Elastic Spheres of Finite Diameter (continuation): S. H. Burbury, F.R.S.—On Discontinuous Fluid Motion: B. Hopkinson.—On the Intersections of Two Conics of a given Type, and on the Intersections of Two Cubics: H. M. Taylor.—On the Continuous Group defined by any given Group of Finite Order: Prof. W. Burnside, F.R.S.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Presentation of Premiums.—Inaugural Address of the President, Joseph W. Swan, F.R.S.

FRIDAY, JANUARY 14.

ROYAL ASTRONOMICAL SOCIETY, at 8.
INSTITUTION OF CIVIL ENGINEERS, at 8.—Mechanical Draught: R. Gordon Mackay.
MALACOLOGICAL SOCIETY, at 8.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Span of Gestation and the Cause of Birth: Dr. J. Beard (Jena, Fischer).—Die Farnkräuter der Erde: Dr. H. Christ (Jena, Fischer).—Lehrbuch der Vergleichenden Mikroskopischen Anatomie der Wirbeltiere: Dr. A. Oppel, Zweiter Teil, Schlund und Darm (Jena, Fischer).—Annuaire de l'Observatoire Municipal de Montsouris, 1898 (Paris, Gauthier-Villars).—Alembic Club Reprints, Nos. 13 and 14 (Edinburgh, Clay).—Imperial University of Japan, Calendar for 1896–97 (Tōkyō).—Sixteenth Annual Report of the Bureau of American Ethnology (Washington).—Knowledge, Vol. xx. (Witherby).—Tables of Parabolic Curves: G. T. Allen (Spon).—Gesammelte Kleine Schriften: L. Rütimeyer, 2 Vols. (Basel, Georg).

PAMPHLETS.—National Association for the Promotion of Technical and Secondary Education, Tenth Annual Report (London).—A New Theory of the Stars: Prof. A. W. Bickerton (Christchurch, N.Z., Whitcombe).—La Planète Vénus: C. Flammarion (Paris, Gauthier-Villars).—Periodic Orbits: Prof. G. H. Darwin.

SERIALS.—Bulletin of the Illinois State Laboratory of Natural History, Vol. 5, Article 3 (Urbana, Ill.).—Humanitarian, January (Hutchinson).—Contemporary Review, January (Isbister).—Maori Art, Part 2: A. Hamilton (Wellington, N.Z.).—Proceedings of the Academy of Natural Sciences of Philadelphia, 1897, Part 2 (Philadelphia).—Fortnightly Review, January (Chapman).—Journal of the Royal Horticultural Society, December (117 Victoria Street).—Journal of the Royal Agricultural Society, Vol. 8, Part 4 (Murray).—Plankton Studies on Lake Mendota, II.: Prof. E. A. Birge (Wisconsin).—National Review, January (Arnold).—Reliquary and Illustrated Archæologist, January (Bemrose).—American Journal of Mathematics, January (Baltimore).

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