THURSDAY, MAY 19, 1904.

THE STRUCTURE OF AUSTRIA-HUNGARY.

Bau und Bild Österreichs. By Carl Diener, Rudolf Hoernes, Franz E. Suess, and Victor Uhlig. Pp. xxiv+1110. (Vienna: F. Tempsky; Leipzig: G. Freytag, 1903.) Price 78 kronen, or 65 marks.

THE publication of this elaborate and serious work implies a high regard for scientific education in the countries for which it is immediately intended. It is not a popular correlation of the scenic and geological features of the Austro-Hungarian Empire, such as would appeal to the ordinary traveller; and yet, now that it has appeared, we feel that no one can properly understand the regions dealt with until he has consulted this treatise, and thus brought himself abreast with current views. We recently had occasion to notice (NATURE, vol. lxviii. p. 550) the admirable series of brochures prepared in Vienna for the Geological Congress of 1903. The Bosnian guide then foreshadowed has since appeared, and sums up a surprising amount of recent observations made in the occupied provinces. But these publications do not detract from the value of the great work now before us, which is essentially a book for the library, clear, readable, and stimulating. Its reviews of successive opinions on this or that controverted area are of considerable mental value, and the authors state their own conclusions with a display of argument and reasoning that is rare in works of reference. As in a good deal of Austrian writing, the human man, scaling the hillside, or watching the great rivers swirling through the plains, is apparent through the topographical and geological details; and even the pages on petrography, when thus led up to, have an impression of the open air.

Prof. Eduard Suess contributes an introduction, in which he relates the growth of geological observation in the empire, from the mining operations of the sixteenth century to Partsch and Haidinger in 1850. The Bohemian region is then dealt with by Franz E. Suess in 322 pages, accompanied by landscape-illustrations that convey much of the character of the country. We thus see the white quarry on the Schlossberg of Brüx, the pastures of Eisenstein under the forest-rim, and one of the great black open workings of the brown-coal area in the north. The author shows well how the Bohemian region spreads beyond political Bohemia, and that, while watersheds divide nations, the boundaries of hill and plain define geological areas. If we reach Eisenstein, for example, we must go forward and make the plunge through the Bavarian forest to the Danube; on the other hand, the easy undulating country beyond Habern leads us inevitably to inquire into the structure of Moravia. While the great Bohemian "horst" is part of a range that arose during the movements of Middle Carboniferous times, its fundamental rocks are largely pre-Cambrian. The central granites have penetrated these gneisses and phyllites at a period which may be later (p. 56) than the Ordovician, and have profoundly modified and intermingled with the gneisses. The schists, on the other hand, possibly through their having been nearer the surface at the time of the intrusion, show a fairly sharp line of contact. Similar phyllites appear in Moravia in the cores of gneissic anticlinals, reversing the usual relations of such masses. Unless thrust-planes can be called in, it is clear that this region offers much room for speculation. Dr. F. E. Suess (p. 76) urges that considerable movements took place in Moravia before the great bow of old rocks, stretching from the Sudetic to central France, was folded and upheaved in the Carboniferous period. This is rendered likely by the antiquity of the rocks themselves, and is supported by the occurrence (p. 114) of pebbles of the early gneisses and amphibolites in pre-Cambrian conglomerates near Přibram.

The famous question of Barrande's "colonies" is dealt with historically and succinctly (p. 141). Among other interesting details, we can only refer to the evidence for the existence of central European deserts in Permian times; to the almost complete absence of marine Mesozoic deposits from Bohemia until the entry of the amazingly world-wide Cenomanian sea (p. 166); and to the comparatively recent origin of some of the ore-deposits in the Erzgebirge (p. 243). An excellent coloured map concludes this section.

Dr. C. Diener then enters on his difficult task of describing the Eastern Alps and the Dinaric Karst. He traces the central zone from the Swiss border, until it breaks off against the incurving areas of subsidence on the fringe of the Pannonian plain. The gneissic axis of northern Styria alone survives, and connects the Alps below Vienna with the Karpathians. While the author's debt to Prof. E. Suess is manifest and acknowledged, he feels bound to join those critics who regard the Alps as resulting from lateral thrusts in two opposite directions, instead of from a one-sided action (pp. 637 and 641). He is unable to recognise, either from the lie of the folds or from the curve of the whole chain, the outer from the inner side of a mountain system. The Dinaric folds thus present their concave side to the Servian mass against which they have been pressed, while the area of subsidence occupied by the Adriatic lies on the concave side of the Alps and on the convex side of the Dinaric system. Very many geologists will agree with Dr. Diener when he says of the southern Alps,

"Hebung, nicht Senkung, ist also hier der Effekt der Zusammenfaltung gewesen. Eine wirkliche Senkung hat nur bei dem jüngeren Einbruch des Adrialandes stattgefunden" (p. 638).

The remarkably late origin of the Adriatic subsidence is emphasised on pp. 607 and 629, the alluvial sands of southern Istria being probably involved, and the movements being certainly post-Pliocene. The Alps, on the other hand, are regarded as having remained stationary at this epoch, in opposition to the views of Dr. Heim.

The island-like masses of folded rocks that rise, as a welcome feature, above the lower Sava plain are once more regarded as the partially buried spurs of the eastern Alps (p. 566), and not as portions of an older system. Dr. Diener finds himself also opposed to the torsional views of Mrs. Ogilvie-Gordon in re-

gard to the huge blocks of dolomite in Tyrol (p. 548), and believes that these weighty masses have sunk down amid the yielding tuffs and sediments deposited upon their flanks. The reef problem is dealt with cautiously (p. 541, &c.), and the term "reef" is used, following Prof. Suess, as the equivalent of "massive unstratified limestones and dolomites," rising amid strikingly contrasted sediments. It is unfortunate that the latest evidence brought forward by Mrs. Ogilvie-Gordon as to the age of the igneous intrusions round Predazzo was published too recently to receive adequate notice in this volume, though her arguments and those of Rothpletz are briefly mentioned.

For those who desire a general history of the Alps, adorned with modern references, we may commend the whole seventh "Abschnitt" (pp. 589–610) as a clear and even spirited summary. The discussion of mountain-structure that follows shows the independence and vitality of the school which Suess has founded in Vienna, a school of progressive inquiry unhampered by dogmas, active in unearthing problems, but willing to wait for explanations.

Dr. V. Uhlig is given 260 pages for the exposition of the Karpathian lands, and occupies them with admirable clearness. Like his predecessor, he balances arguments, and states his own conclusions with the modesty of a true explorer. This is particularly noticeable (p. 904, &c.) in his account of the origin of the central *massif* of the Karpathians, which he regards as pushed up by pressure from all sides into and partly through its former Mesozoic covering. One-sided tangential movement will not, in his opinion, in any way satisfy the facts observed (p. 910).

The illustrations and sections accompanying Dr. Uhlig's descriptions are more than usually attractive. We see patches of Eocene conglomerate resting on the central granite of the Tatra, and crystalline schists, on the other hand, thrust up over Neocomian limestone at Bárat Lehota, and sending off dyke-like tongues into the cracks opened in the latter. The fascinating question of the "Klippenzone," referred to by us in a previous review, receives full treatment. The beautiful landscape on p. 771 recalls many of the deep wooded valleys, among sheer limestone cones, which intersect the frontier lands of Arva. The tempting theory that the "Klippen" float as detached fault-blocks amid the softer Flysch deposits is set aside (pp. 791–4), in face of the banks of Upper Cretaceous conglomerate worn from them, and found so repeatedly against their flanks. Examples of these occur from the west end of the chain down to Transylvania (p. 809).

The great Flysch or Karpathian Sandstone series has yielded foraminifera in places, but is otherwise singularly devoid of organisms. Zuber has aptly compared it with the huge delta deposits of the Orinoco. Rock-salt and mineral oil characterise the Miocene horizons in Galicia, and Dr. Uhlig (p. 864) accepts an unconformity between these and the Karpathian Sandstone. He then shows how the present broken condition of the salt-beds may be due to post-Miocene earth-movements.

The important volcanic zone on the inner side of the mountain-ring raises again (p. 879) the question of the relations of the igneous rocks at Selmeczbánya. Prof. J. W. (not "C. W.") Judd is quoted, and the existence of a great central volcano is left as a possible solution. It is pleasant to find a photograph of the lofty obsidian cliff of Geletnek among others of this picturesque area. The rich ore-deposits of northern Hungary occupy cracks in the Miocene lavas, and are among the latest manifestations of the solfatara stage of the eruptions. While the Mesozoic rocks of the Karpathians were folded in early Eocene times, the volcanic outbreak can only be connected with the slighter post-Miocene movements, and appears to have accompanied the general sinking of the lowland.

We cannot do full justice, in concluding this notice, to Dr. Rudolf Hoernes's section on the plains. The Cainozoic history of the empire is involved in that of these great wind-swept level lands. We are taken from the basin of Vienna, which is really an area of depression formed within the body of the Alps, to the sandy reaches on the edge of the Government of Warsaw, where soil and vegetation have difficulty in clinging to the surface (p. 1049). The salt-beds of Wieliczka (p. 942) again come in for treatment, since the separate publication of the four divisions of the volume renders some overlapping unavoidable.

The ravine of the Danube east of Passau, already touched on picturesquely by Dr. F. E. Suess (p. 105), receives full discussion here after an interval of a thousand pages. Following Penck, the general conclusion is that the Danube flowed in pre-Glacial times over the detrital deposits of late Cainozoic age, cutting broad valleys in these, and ravines where it reached down to the underlying ancient rocks. The present prominence of the latter rocks is due to the denudation of the more yielding Cainozoic strata.

Of the four authors, Dr. F. E. Suess perhaps best realises the landscapes in his word-pictures; but the whole book has a literary value, and is thus all the more competent to stimulate observation and research. Its modernised spelling, such as "Zentralkern" and "Gneise," is perhaps a sign of its virility. The absence of an index will surely soon be rectified.

GRENVILLE A. J. COLE.

A NEW FRENCH TREATISE ON CHEMISTRY.

Traité de Chimie Minérale. Published under the direction of Henri Moissan, with many collaborators. Tome Premier—Métalloïdes; Tome Troisième—Métaux. Pp. xiii+527 and 672. (Paris: Masson et Cie., 1904.) Price 125 francs net.

THE recent advance in inorganic chemistry, to which M. Moissan has in no small degree contributed, has rendered it advisable, in his opinion and in that of his co-workers, to take stock, so that those engaged in research in that branch of chemistry may have in an accessible form an account of the whole field and a full bibliography of published memoirs. It is the laudable ambition of the editor to point out what gaps still remain unfilled, and where research may most profitably be undertaken. The atomic theory is

assumed as a basis of method, but in his preface M. Moissan says :—

"Nous apportons, sur ce sujet, des idées éclectiques, et la raison, éclairée par l'expérience, sera toujours notre seul guide."

The geological and mineralogical sources of substances are considered, but the details of physical and analytical chemistry are not touched. Industrial operations are sometimes chosen to illustrate chemical change, and, where thought desirable, the prices and tables of production of different countries are introduced. The work is primarily intended for those engaged in research, in industry, and in teaching. Among the thirty-two contributors may be mentioned the names of Charpy, Étard, Le Chatelier, Lemoine, Sabatier, and Vogt, besides many others of good reputation.

The introduction by the editor gives a historical sketch of the classification of the elements. In the present state of our knowledge of elementary bodies it is interesting to meet with the unprejudiced words of Lavoisier :—

"If, by the word element, we mean the simple and indivisible molecules of which bodies are composed, it is probable that we do not know them; but if, on the other hand, we apply the name element or principle to the last term at which chemical analysis arrives, all substances which have not hitherto been decomposed are for us elements."

The bearing of spectrum analysis on the question of the unity of matter is briefly touched on, and Moissan says that in his own high temperature work no sign of transmutation has ever been observed. He inclines, however, to the supposition of the unity of matter, and in alluding to the recent work connected with radio-activity, he believes that "we are witnessing the dawn of inorganic chemistry, a subject not long ago regarded as exhausted."

Various attempts at classification are next considered, but not even the periodic table is adopted. The reviewer cannot agree that the method followed presents any advantage whatever. The first family comprises hydrogen and helium, and the reason given for this curious collocation of elements is that helium is not well known! Carbon is separated from silicon, because the latter element forms no large number of "organic" compounds, and because the halides of silicon, like those of titanium and zirconium, are decomposed by water. While in most groups the element of lowest atomic weight is discussed first, cæsium begins the metals of the alkali group, because of its chemical activity; for the same reason the nitrogen group should begin with phosphorus. The final statement that the author thought it better to group the elements in accordance with their known properties rather than to give them to the reader in the disorder of alphabetical order seems hardly a happy way of determining which method of classification is the best, seeing that no particular properties are chosen, the criterion of resemblance sometimes being the appearance of the element, sometimes its melting-point, sometimes the stability of its salts in presence of water, and sometimes none of these, as where cobalt is placed in the same group as uranium, and lead and tin are separated from each other.

The result is, that without an index, which has not yet appeared in any one of the published parts, it is an almost hopeless task to find any desired compound. Gmelin's plan, perhaps, may serve as guide, that is, to find out the elements which have been treated of already, and to take the last in the formula of the compound as an index. But this leads to such an anomaly as having to look up bismuth thiocarbonate under "carbon," while potassium thiocarbonate comes under the heading "potassium." The amido-derivatives, too, are to be found after the salts from which they are prepared, and do not form a group by themselves, similar as they all are to each other.

Subject to these criticisms, however, the work is very complete, and is a most valuable compilation. It is unfortunately not free from omissions; for example, in discussing the determinations of the density of hydrogen, the work of Lord Rayleigh has been overlooked. Again, it is stated on the authority of Lunge (1879) that the greatest amount of chlorine in the world is made at the St. Rollox Works in Glasgow, a statement which is now unfortunately inaccurate. The spelling of proper names, also, leaves room for correction; Brareton-Baker, Tadeusz Estreicher, and Stass are among those which have caught the reviewer's eye. But, as before remarked, the index of literature is very large, and the number of facts given is greater than what is ordinarily to be found in a text-book, while the information is generally up to date, and these are advantages which cannot be overlooked.

ELECTRIC TRAMS.

Electric Traction. By J. H. Rider. Pp. xvi+453. (London: Whittaker and Co., 1903.)

THE name of the author and his position as chief electrical engineer to the London County Council Tramways are sufficient to recommend this book to anyone interested in electric traction. Nor do we think that anyone who takes it up in the hope of gleaning some useful or suggestive information is likely to put it down with the slightest feeling of disappointment. The style is terse, but eminently readable; the opinions expressed by the author are often, no doubt, open to argument, but they have the great merit of conveying the impression that they are the opinions of a man who knows practically all that there is to be known about his subject, and who does not hesitate to state his own convictions, whether they are likely to be in agreement with those of other people or not. For example, we may refer to the little outburst of evident irritation at the need for the objectionable but compulsory guard-wires. These, the author holds, "do not strike at the root of the matter, which is to prohibit entirely uninsulated wires of any kind crossing above the trolley wires." Here speaks not the expert, but the tramway engineer; perhaps if fate had destined Mr. Rider to be a telegraph engineer, we

should have been told that the only thing to do was to prohibit entirely uninsulated wires of any kind from crossing below the telegraph wires. Why should the telegraph wire be banished underground rather than the overhead equipment changed to the conduit system which Mr. Rider has shown us can be so efficient? We fancy the objection which would be made to the change by either party would be the same—that they would prefer the other side to make it and to pay for it.

The ancient recipe for cooking a hare applies with particular force to the design of a system of electric tramways; the motto of the tramway engineer should always be "First catch your passenger." One cannot read this, or, indeed, any comprehensive book on electric traction, without being strongly impressed by the degree to which the whole of the engineering depends ultimately on the halfpenny passenger. The engineer builds a bridge, dams a river or constructs a railway from the Cape to Cairo, and the work is a piece of engineering almost pure and simple, but he may design and equip a first class traction system—generating station, engines, dynamos, cables, track, line and cars—and if he is out of his reckoning as to the time the housewife goes to market all his energy has been wasted. It is she who determines the kind of car and the kind of service, and, these once settled, everything else follows almost as a matter of course. It is here really that electric tramways and electric traction score so heavily; they have the flexibility which enables them to be designed to meet and to satisfy the requirements of the public in a way which cannot be done by the omnibus on the one hand or by the steam railway on the other. The fact that electric traction came into being when these other means of transport were in strong possession of the field has been to its own advantage; it has had to cater for the requirements of the public in a way to attract them from its rivals, and the success with which it has done so is shown by the reaction on the railways, which are one by one resorting to electrification as their only salvation.

Electric tramway and railway development in England has been for a long time retarded from various causes, but of late years it has been making steady progress. Though much has already been done, there is still a vast amount to do. Our large cities all afford transit problems which it is safe to say no other method of traction yet known can solve so satisfactorily, and when these, as socially the more pressing, have been tackled, the question of light railway construction between town and town still offers great fields for development. We have not here the opportunities which the Americans possess but we have problems of our own at once more difficult and more urgent of solution. London in particular is a case in point, and there can be no doubt that once the Royal Commission now sitting has reported electric traction schemes for London will be plentiful. The electrical engineer who decides to go in for traction work is certain before long of great opportunities; he cannot better prepare himself for taking advantage of those opportunities than by reading Mr. Rider's book.

MAURICE SOLOMON.

OUR BOOKSHELF.

Milk, its Production and Uses. With Chapters on Dairy Farming, the Diseases of Cattle, and on the Hygiene and Control of Supplies. By Edward F. Willoughby, M.D. (Lond.), D.P.H. (Lond. and Camb.). Pp. xii+259. (London: Charles Griffin and Co., Ltd., 1903.) Price 6*s.* net.

ALL medical men and hygienists must necessarily know something about milk and its production, and this work, in a comparatively small compass, deals very fully and adequately with the whole subject. The author, being scientific adviser to one of the largest of the London dairy companies, has had practical experience in all branches of the subject, and his views, therefore, are worthy of confidence. The first four chapters are devoted to a consideration of the various breeds of cows, the qualities of the milk they produce, and their housing, feeding, breeding, and diseases.

In the fifth chapter the legal aspects of diseases of cattle are discussed, and a useful summary of the "Diseases of Animals Acts" and of the "Dairies, Cowsheds and Milk Shops Orders" is given.

The important subjects of the elimination of tubercle and the inspection and control of cowsheds are briefly treated. The physiology and dietetics of milk, pasteurisation and sterilisation, condensed, skimmed, and separated milks, therapeutics of milk, koumiss and other milk preparations, and diseases conveyed by milk, all receive brief attention.

The book concludes with chapters on the dairy, on milk analysis, on control of adulteration, with an abstract of the Foods and Drugs Act, and on the bacteriological examination of milk. The whole work is eminently practical and readable. As regards the conveyance of scarlatina by milk, the well known Hendon outbreak is detailed, but no reference is made to Prof. Crookshank's researches, which throw considerable doubt on some of the conclusions arrived at by the officials of the Local Government Board. The author considers that the alleged tendency to scurvy or scurvy rickets in infants brought up on sterilised milk is not proven, and with this we agree. It is stated (p. 142) that Nuttall and Thierfelder failed to rear young rabbits and fowls brought into the world under aseptic conditions so that their intestinal tracts were free from bacteria. This is not the case; Nuttall and Thierfelder found that guinea-pigs (not rabbits) so reared were even more vigorous than animals reared under ordinary conditions.

The book will prove a useful work of reference, especially for medical officers of health, and the numerous excellent illustrations add considerably to its value.

R. T. HEWLETT.

A Treatise on the Principles and Practice of Dock Engineering. By Brysson Cunningham, Assoc.M.Inst.C.E. Pp. xviii + 559. (London: Charles Griffin and Co., Ltd., 1904.) Price 30*s.* net.

THE author of this book is on the engineering staff of the Mersey Docks and Harbour Board, which has control over the largest and most efficient system of docks in the world. During the last few years, under the direction of Mr. Lyster, the engineer-in-chief, these docks have been modernised and brought up to date. New deep-water basins and repairing docks have been built; the entrances and sills of some of the old docks have been lowered. Transit sheds and cranes of modern type have been erected, so that these docks are now able to deal with the largest class of vessels yet built, and to load and unload the largest

cargo steamers in the most rapid and efficient manner possible.

Mr. Cunningham has therefore had unrivalled opportunities of acquiring both a theoretical and practical knowledge of dock construction, and in the volume now under notice he has brought together in a concise and well organised form the results of the knowledge thus acquired. The author has not, however, relied solely on his own experience, but has freely made use of the information contained in the numerous papers on dock matters contributed to the *Proceedings* of the Institution of Civil Engineers and to the numerous reports of the International Navigation Congresses and other technical societies. Of these he has evidently been a diligent reader, as few points of interest in the *Proceedings* of the societies or in the technical journals that have been dealt with during the last few years seem to have escaped his notice.

While the study of this book may be regarded as essential to the younger engineers engaged in dock work, it will be invaluable as a book of reference to the expert engaged in this branch of engineering and its cognate interests.

The book is divided into twelve chapters, dealing in an exhaustive manner with the designing and construction of docks, the materials and plant required, the theory of construction of the walls and gates, the equipment and working of docks when constructed, the appliances required for the handling and transport of cargoes to and from the docks, and for repairing the vessels. The book is well illustrated, there being no less than 34 folding plates and 468 illustrations in the text. The book does great credit both to the author and to the publisher, but, of course, the greatest merit belongs to the former for having furnished the dock engineer with such a valuable aid to his work.

Electric Lighting and Power Distribution. Vol. ii. By W. P. Maycock, M.I.E.E. Pp. xxii+684. (London: Whittaker and Co., 1903.) Price 7*s.* 6*d.*

THIS little book covers a very great deal of ground, so that it is hardly necessary to say that no subject is discussed in any great detail. The opening chapters deal with dynamos, alternating currents and alternators, and these are followed by a chapter on electricity meters, in which most of the leading types are described and illustrated. The next chapter deals with motors; a dozen pages in this chapter are all that are devoted to electric tramways and railways, which will give some idea of the amount of consideration which each branch receives. Other chapters deal with batteries, transformers, and generating stations. The treatment throughout is of a very elementary character, but the descriptions are clear and concise, and the illustrations well selected and very clearly reproduced, so that the book should be of service to the student for the City Guilds and similar technological examinations, for whom it is primarily intended.

Builders' Quantities. By Herbert C. Grubb. Pp. viii+227. (London: Methuen and Co., 1904.) Price 4*s.* 6*d.*

THIS book has been prepared more particularly for the use of candidates studying for the examination in builders' quantities held by the City and Guilds of London Institute. The modes of measurement and examples of "taking off" are given in order for the work of all the trades employed in the erection and completion of a building; and these sections are followed by explanations of squaring dimensions, abstracting, and billing. The text is illustrated by seventy-seven figures.

LETTERS TO THE EDITOR.

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

The Origin of the Horse.

THE receipt of a copy of Prof. J. C. Ewart's admirable paper on "The Multiple Origin of Horses and Ponies" suggests a few remarks. The paper in question is from the *Transactions* of the Highland and Agricultural Society of Scotland, 1904—one could wish that it had appeared in a publication which comes more regularly under the notice of zoologists. In a previous paper (*Proc.* Roy. Soc. Edinburgh, 1903) Prof. Ewart had shown conclusively that *Equus prjevalskii* was not a hybrid between the kiang and the common horse, and had arrived at the conclusion that it might very well rank as a valid species. Lydekker in 1902 had proposed to regard *E. prjevalskii* (or *przewalskii*) as a subspecies of *E. caballus*, and now Prof. Ewart does the same, while recognising also two other subspecies, *E. c. typicus* and *E. c. celticus*. The animal named *typicus* is the Norse horse, which is arbitrarily selected as the type of the Linnean *caballus*. The Celtic pony, still surviving in the pure state in Iceland, is given the new name *E. c. celticus*. In its way, Prof. Ewart's demonstration of the distinctive characters of this animal deserves to rank with Darwin's treatise on the primrose, as an example of genius applied to common things. The case is so clear that the author himself is evidently half inclined to regard the Celtic pony as a valid species, and it seems to me that the facts justify us in recognising three species of living horses, *E. prjevalskii* (Poliakoff), *E. celticus* (Ewart) and *E. caballus* (L.). The indications are that these animals were quite distinct in the wild state, and the fact that various blends between *caballus* and *celticus* exist in domestication is no more proof of specific identity than the same sort of thing is among the dogs, which nobody doubts to have originated from more than one wild species.

The use Prof. Ewart makes of the prehistoric cave drawings of horses is most suggestive. Possibly these sketches may have been taken a little too seriously in some instances, too little allowance being made for eccentricities in drawing. Fig. 27, from the Kesserloch cave, has a remarkably long body, and one might joyfully recognise the *Equus scotti*, Gidley, were it not that that animal inhabited the plains of Texas and New Mexico.[1] Prof. Ewart accepts the opinion that the living American horses are wholly of Transatlantic origin. While this is probably correct, I was surprised on looking into the matter a few years ago to find that the evidence was not so complete as I had supposed. It is said that the natives showed great surprise at the horses of the Spaniards, being evidently unacquainted with the animals. This was to be expected, for if wild horses lived in America at the time of Columbus, they surely were not in the "tierra caliente," but rather to the

[1] The New Mexico record is based on a molar tooth found by Miss Ada Springer in the Pleistocene beds of the Arroyo Pecos, Las Vegas, and examined by the writer. It differed in no respect from Gidley's description and figure. Mr. Gidley kindly made for me a number of skull-measurements from the types of *E. scotti*, and I found upon comparisons that the five specimens were much more uniform than a similar series of *E. caballus* picked at random would be. This may be attributed no doubt to the greater uniformity of the wild species, but also to these particular specimens being apparently (from the circumstances of their discovery) members of the same herd. The skulls were 571 to 590 mm. long, and differed from any *caballus* of which I had measurements in (1) the rather longer muzzle, with the upper dental series (molars and premolars) considerably longer, 195 to 204 mm., and (2) apparently in the greater breadth between the orbits above, but Mr. Gidley afterwards wrote that he found that while the breadth between the *anterior* borders of the orbits of *scotti* is slightly greater than in large skulls of *caballus*, the breadth between the *posterior* borders is less; hence it would seem that the eyes of *scotti* looked less forward than those of *caballus*. The other measurements:—zygomatic breadth, greatest breadth of muzzle, least breadth of palate, distance between molars of opposite sides, and the greatest breadth of posterior nares, all fall within the limits of variation of *E. caballus*. Hence it is apparent that *E. scotti* was in many respects similar to *caballus*, as Mr. Gidley indicated in his paper on the subject. The bones other than the skull, taken separately, could not be distinguished from those of *caballus*. Other differences in the skulls than those mentioned have been fully described and illustrated by Mr. Gidley, and the facts need not be repeated. No doubt a more minute study of the osteological characters of fossil horses would throw valuable light on the significance of variations in the living forms.

north, in the region of the prairies. Moreover, even if the natives had known the horse, they might well have been astonished at the horse-and-man combination.[1] Then it is difficult to understand why Equus became totally extinct, since subsequent events showed that vast areas were admirably adapted to it. Prof. Ewart informed me (*litt.* 1902) that the Chinese were alleged to have visited America about the eleventh century, and reported it as the "land of women, the horse and the vine." This tradition is apparently not to be regarded very seriously, but the antiquity of the genuine *Equus caballus* in North America is supported by O. P. Hay in his excellent catalogue of the fossil Vertebrata of North America (1902), p. 622. This author boldly lists *E. caballus* as Pleistocene on this continent, and while admitting that "in some cases the identifications have been open to question," and "in other cases the remains may have been derived from the introduced race," he adds, "the former existence of the species in Alaska and in California appears well established." Of course, the term *E. caballus* must here be understood in the wider sense. Prof. Ewart also remarked, in the letter just cited, that the Spaniards at the time of the conquest used small-headed horses, "the offspring of the *E. fossilis* of Asia in all probability," whereas the characteristic "buckskin" pony of our south-west is a relatively large-headed animal. Furthermore, Mr. Wilfred Blunt, through my brother, Mr. S. C. Cockerell, communicated the statement that "the Spaniards never rode mares, and can hardly have brought any but stallions with them in their ships to their colonies." Hence the early abundance of wild horses in North and South America appears very remarkable. With reference to the presumed early absence of horses, one may also remark that so common an animal as the "antelope" (Antilocapra) was not made known to naturalists until about 1815, and a perfectly new wild sheep was discovered in northern Mexico in 1901! Even the known variability in colour of the wild horses might be thought of as a Mendelian phenomenon, resulting from the mixture of different types, and the infusion of new blood could be conceived to have resulted in greater vigour and consequent increase in numbers.

T. D. A. COCKERELL.

Colorado Springs, Colorado, U.S.A.

THIS paper, only slightly abridged and with about one-third of the figures, appeared in NATURE of April 21 (vol. lxix. p. 590). I am more than "half inclined to regard the Celtic pony as a valid species" and to recognise three species of living horses. I prefer, however, to leave systematists to decide whether Prjevalsky's horse and the Celtic pony should be regarded as species or merely as varieties.

J. C. E.

Entropy.

AN author expects some unfavourable reviews, and, if wise, profits largely by them; but Prof. Perry's review of "Entropy" in NATURE of April 14 is simply an attempt to brush away a book the object of which is to eradicate what, I submit, is a very widespread mistake, because the reviewer has himself not only made the mistake, if mistake it be, but championed it. This mistake is that entropy is conservative in irreversible change; that the entropy of a body is increased only by its taking in heat, or that $\int dH/\theta$ is the entropy in irreversible change; or that dH/θ is a complete differential. In Prof. Perry's own words, "There is a property of the stuff called its entropy ϕ, which is such that any change in it, $\delta\phi$ if multiplied by t the absolute temperature gives δH or $\delta H = t\delta\phi$." "ϕ is to heat re-received H something like what v is to work w." "If we divide every δH by t, . . . every amount δH being divided by the t at the time, and if we call δH divided by the t by the name, entropy, we shall find that when the stuff is brought back to its old state again, we have just given out as much entropy as we have taken in. The account balances exactly."

In a note to a presidential address I pointed out that such statements are numerically correct in reversible changes only, that in all irreversible changes they are not accurate, and that they thus give a wholly wrong idea of the function entropy. There was no question, and never has been, about reversible changes, that is to say, changes where p and θ are uniform throughout the working substance; the whole of my criticism refers to irreversible changes alone.

Prof. Perry then started a correspondence in which Prof. Poincaré and Prof. Planck were good enough to join, and also showed how Prof. Perry was wrong (*Electrician*, March 13, 1903). I quote from Prof. Planck's letter:—

"The controversy excites my attention the more, when, to my astonishment, I see a man so well known and so eminent in science as Sir Oliver Lodge[1] putting forward ideas on thermodynamics (*Electrician*, January 23, p. 460) which I combated ever since the commencement of my studies in that science."

"But how can I hope with my words to make any impression on such writers when Mr. Swinburne's excellent articles have failed to effect any change in their preconceived ideas? For, with one reservation,[2] what he has written in the *Electrical Review* (January 9, p. 52) is, in my opinion, one of the best and clearest expositions of the subject that has ever been written, especially where he points out that Nature never undertakes any change unless her interests are served by an increase of entropy, while man endeavours so to make use of those changes allowed by Nature that his own interests—namely, the acquisition of available energy—are served as completely as possible."

Science can never be a matter of authority, but I quote Prof. Planck because Prof. Perry now reviews the book as if his definition of entropy was universally accepted in thermodynamics, and adopts the tone that anyone who differs from himself and develops Clausius's inequality, $\int dH/\theta < \phi$ for all irreversible changes, is wrong *prima facie*.

Though the review contains quotations from the little book, they are always incomplete, so as to give as far as possible an absurd meaning. Thus the quotations about errors in text-books look as if I said text-books on thermodynamics are wrong. What I do say is that books on physics and steam engines define ϕ as $\int dH/\theta$, whereas books on thermodynamics show that is accurate for reversible changes only. The whole gist of my book is the application of Clausius's principle of increase of entropy. Books on steam engines, and generally on physics, as opposed to those on thermodynamics, say $d\phi = dH/\theta$, and dH/θ is a complete differential. If θ means the temperature of the working substance when that temperature is not uniform, dH/θ has no meaning, and is not a complete differential. By θ in irreversible change, as I have often explained, I mean the temperature at the separating surface through which dH passes. If no meaning can be given to dH/θ in irreversible change, my criticism that dH/θ is not a complete differential, except in the ideal case of reversibility, is still valid. "It is hardly believable that in a dynamical illustration he should imagine the momentum of a system of two colliding bodies to be increased by the collision" is calculated to give the impression that I am ignorant of elementary mechanics. The context is discussing the sum of the scalar momenta of gas particles. This increases when some isolated gas equalises its temperature at constant volume. "But as we have the foot-pound,

[1] Some of the aboriginal pictographs show horses, but these are apparently of recent date. Unfortunately we have no ancient American drawings of animals comparable to those of Europe.

[1] The reference to Sir Oliver Lodge occurs because he wrote an article on entropy defined so that $H = \int \theta d\phi$, which I take it he has recalled. It was because I thought the weight of his authority might tell harmfully that I sent the correspondence to two leading authorities on thermodynamics.

[2] This was my statement that $d\phi$ is never a complete differential in irreversible change. For $d\phi$ to be a complete differential in terms of, say, $d\theta$, dv, we must have $d\phi = Md\theta + Ndv$, where $\partial M/\partial v = \partial N/\partial \theta$. To prove $d\phi$ a perfect differential during any irreversible change the equation must be true while the change is going on. It is not accurate to put the value of θ or of p which obtained before the change started, or would be reached if the change were arrested and the substance allowed to come to uniform temperature and pressure. Prof. Planck is so much better a physicist and mathematician than I am that I do not contradict such an authority; I merely say there is a misunderstanding, which may be mine, and I submit my contention. My view is that the physical meaning of a complete differential in mechanics is not only that the integral is completely determined by the coordinates, but that it is conservative. Lagrange's treatment of mechanics really involved the conservation of energy, that is to say of the forms he discussed.

and I think the poundal, as units of energy" looks as if I confuse force and energy. The context shows that I object to non-metric units as unscientific, and therefore do not care which unit bears the name poundal. The statement that I want to have Claus instead of Rank for the British unit of entropy is wrong. The claus is the unit of entropy in the practical metric system where the joule is the unit of energy. The rank is a name proposed by Prof. Perry for $\int dH/\theta$, and as this is not entropy in any real change, I cannot adopt it as a unit of entropy. As to $d\chi$, I will deal with that elsewhere; it is a side issue. The statement that I talk of "the entropy of a quantity of heat" is wrong. Prof. Perry holds that entropy is a factor of heat. I dissent, and agree with Prof. Planck that entropy is not a factor of energy. So far from talking of the entropy of a quantity of heat, I have explained very fully how and why entropy is in no sense a factor of heat.

I would not write were a review in NATURE not particularly important, and I trust you will, in fairness to my publishers and myself, allow this letter to appear.

41 Palace Court, W., May 1. JAMES SWINBURNE.

MY sole object in the controversy to which Mr. Swinburne refers was to show that, like most of the other writers of whom he complained, I have never either made or championed the mistakes he speaks of at the beginning of this letter. As to my notice of his book, I cannot admit that I have misrepresented him except as to the *claus*. I made a mistake in saying that his claus is what is sometimes called a *rank*. As he now says that the momentum of which he spoke was a *scalar* momentum, I submit that I was quite fair in my comments. I cannot admit that his $\theta\chi$ diagram is a side issue. JOHN PERRY.

Origin of Plants Common to Europe and America.

THAT there is a resemblance between the floras of Canada and northern Europe, and again between the floras of Canada and of eastern Siberia and Japan, is well known. Including the horsetails and ferns with the flowering plants, probably about 575 species are identical in Canada and Europe, and again about 330 in Canada and Japan or the River Amur country. A large number of these are common to the three continents. The hypothesis generally accepted has been that, in some comparatively recent epochs, there has been a connection between Europe and America which facilitated the intermingling of the plant life of the two continents. The late Prof. Asa Gray suggested the probability that the migration of European plants had taken place across Asia to America. Lesquereux, from his studies of the flora of the Dakota group, on the other hand, maintained that the North American flora is not now, nor has it been in past geological ages, the result of migration, but that it is indigenous. It has long been known that species now extinct occurring in the Miocene of Europe had appeared in America at an earlier period. Lester Ward enumerates eleven species—all now extinct—as common to the Laramie group in the United States and the Eocene of Europe, and shows further that at least two living species now found in both Japan and America date their origin in America as far back as the Eocene. Twenty years ago my own studies in the distribution of Canadian plants also convinced me that whilst facilities had existed for migration in both an easterly and a westerly direction, Canada was the point of origin of many of the species now identical in Europe and America. This conviction has been heightened by further knowledge of the range in Canada of these identical species and by further discoveries during recent years of plants in the Pleistocene clays of Canada. Of seventy fossil species in these Pleistocene clays at Toronto, Ottawa and elsewhere, twenty occur at the present day in both Europe and Canada, fourteen are similarly Asiatic and Canadian, whilst eleven are common to the three continents. This, if it does not necessarily indicate that in Pleistocene times the intermingling of these floras had already been effected, at least shows that in this period these identical species were present in Canada, and had here their place of origin if there is nothing to indicate their presence at as early a period in Europe or Asia. In its vast areas of exposed Laurentian and Huronian formations, Canada has an old look about it, and must have furnished a home through long past ages for the growth and diffusion of northern temperate plant life, when other sections of the globe have from time to time been under water.

The peculiarities of the present range over Canada of many of these identical species also afford suggestions. Whilst many of them are distributed somewhat generally over the country, and many are high northern or Arctic, quite a number do not range west of Lake Superior; others have not been found west of the Rocky Mountains, whilst some are confined to British Columbia and Alaska. In view of their occurrence also in either Asia or Europe, this circumscribed range of so many species suggests their antiquity, and that the elevation of that lofty barrier, the Rocky Mountains, and the disturbance of the relations of land and water in Manitoba and the North-West Territories in more recent times, has resulted in these plants being confined to their present range where forest conditions were more suitable, and has led to the treeless prairies and plains being tenanted by new groups of species specially suited to the new conditions there, when the land rose to its existing level. A. T. DRUMMOND.

Toronto, April.

Moisture in the Atmosphere of Mars.

IN your issue of May 5 I see a note in the astronomical column on Mr. Lowell's theory of the Martian canals. It is perhaps not just to criticise it on so short a summary, but there is a point on which I should like to ask a question. If, as Mr. Lowell says, there is not sufficient moisture on the planet to produce vegetation, how does the water return to the poles ready for the next summer? The only way, it seems to me, is by evaporation. His suggestion of artificial waterways to carry the water from the polar caps implies the existence of an atmosphere sufficiently dense to enable intelligent beings to live. That being so, is it not just as plausible that the evaporated water should condense in the form of rain on the general body of the planet as well as at the poles? although, of course, the excessive cold would account for an increased fall at these extremities.

Bournemouth, May 10. ARTHUR J. HAWKES.

Radium and Milk.

IN the souring of milk the amount of lactic acid developed may reach 0·80 per cent. in three or four days when the milk solidifies. In view of Sir O. Lodge's suggestion (NATURE, October 1, 1903), I have made experiments comparing the rate of acidification, in two to three days, with and without the influence of radium rays from a 5 mgrm. radium bromide tube. The differences in five cases did not exceed the limit of experimental error, 0·01 per cent. of lactic acid, and in a sixth case with the milk solidified the difference only amounted to 0·05 per cent. of lactic acid. It therefore appears to me that under normal conditions radium rays have little or no effect on the functions of the lactic acid bacillus. WILLIAM ACKROYD.

Halifax.

THE BANTU RACES OF SOUTH AFRICA.[1]

NOTHING so good as this book dealing with the Negro indigenes of southern Africa has yet appeared. Mr. Dudley Kidd's work is therefore entitled to take the first rank on this subject, at any rate as far as the Bantu races of South Africa are concerned.

It is a national humiliation to us to reflect that as a Government we have been connected with South Africa for more than a century, that is to say, two-thirds as long as our imperial connection with India has lasted, and yet that by Government endeavour or

1 "The Essential Kafir." By Dudley Kidd. Pp. xiii+436. (London A. and C. Black, 1904.) Price 18*s*. net.

private research so little of value has been published in the English language on the native human races of Africa south of the Zambezi. The present reviewer does not overlook the excellent but incomplete work of the late Dr. Bleek, of Sir George Grey and of McCall Theall, nor should the short work by Theophilus Hahn on the Supreme Being of the Hottentots be left unmentioned. The author of the work under review is also right in calling attention to the value of the Rev. Canon Callaway's work, published in the 'sixties of the last century on the religious system of the Zulus; and the writings of the French Protestant missionary Casalis on the Basuto and Bechuana languages should not be left unrecorded.

The author gives at the end of his book, "The Essential Kafir," a bibliography of the works written in English and French on the Hottentot, Bushmen and Bantu races of Southern Africa. He has omitted to include a variety of books in the German language on the Damara (Ova-herero) people and language. But these (which are by no means final, comprehensive, or even particularly valuable) have owed nothing in their inception to the British rule over South Africa. Consequently the slur still remains, especially when we compare such a list as is given in the Appendix to "The Essential Kafir," with a list which might be compiled of works on the native races and languages of India, or even of British Central Africa. It is difficult to understand why scientific Anthropology has played so poor a part in British South Africa; but no doubt it is due to the fact that the great personages, appointed or self-made, who have ruled over or have influenced South Africa during the last hundred years, never, with the exception of Sir George Grey, took the slightest interest in these questions, or cared to enlighten themselves or others on the characteristics of the native races whose doings or misdoings were provocative of so much bloodshed and expenditure of money.

Even those who have left on record their studies of the Negro races in South Africa—with the exception of Dr. Bleek—seem to have carried on those studies with little or no reference to the lands beyond the Zambezi. Many South Africans fancy that the linguistic term Bantu, which was first coined by Dr. Bleek, applies wholly to the Zulu-Kafir-Bechuana peoples of the South African Colonies, and do not realise that it was intended by Dr. Bleek, and has since been used, to cover nearly all that section of the Negro race which inhabits the southern half of Africa between the northern limits of the Congo basin and the Equatorial Lake regions and the eastern districts of Cape Colony.[1]

FIG. 1.—A Swazie making Fire by Friction. From "The Essential Kafir," by Dudley Kidd.

Consciously or unconsciously, Mr. Kidd in the book under review brings out emphatically the "Central African" characteristics of the Zulu-Kafir people. (It would be a good thing for consistency of speech if we induced the world at large to drop the term "Kafir," and to apply some such name as Zulu to all those Bantu tribes in South Africa—as apart from the Bechuana, the Herero, and the Zambezi people—which speak dialects of the Zulu language. Kafir—originally spelt Caffre—was the Portuguese rendering of the Arabic "Kafir," plural "Kufar," which means "infidel" or a race not believing in Islam. When the Portuguese vessels first rounded the Cape

[1] Dr. Bleek's use of "Bantu" was more connected with linguistic classifications. Whether there is a negro physical type which is connected with the making of this distinct group of languages is still undetermined; Dr. F. Shrubsall, the anthropologist, thinks there is.

of Good Hope and touched at the coast of south-east Africa, they found Arabs or Arab half-castes trading there, and learning that these called the black natives of the country "Kafirs," they adopted this term henceforth as the designation of the Bantu coast races of southern Africa, and passed on this word to the Dutch, who handed it over to the English. Mr. Kidd, by his excellent and detailed description of Kafir customs, myths, folklore, songs, dances, and implements, shows how inseparable these people are in classification from the Negro races of tropical Africa. This deduction is in varying degrees affected by an examination of South African Bantu languages. Of this subject Mr. Kidd does not treat at any length, but it might be mentioned that a careful study of such linguistic works as those of the late Dr. Bleek brings out the following points :—

A study of the existing languages of the Ova-herero of south-west Africa, of the many Bechuana tribes of central South Africa, and the languages of the Zulu-Kafirs from Cape Colony on the west and south to the Portuguese district of Inhambane (Nyambane) shows that there is fundamentally a common though remote parentage to these languages so far as the vocabulary and grammatical structure are concerned; that is to say, that there is more evidence of inter-relationship between these three groups than there is between any one of them and the Bantu languages to the north and north-east. But there are still very striking differences in phonology between the Herero, Bechuana, and Zulu groups, showing that the history and wanderings of each section must have differed considerably. The Bechuana languages are the most altered from the original Bantu structure, but they are without the clicks which seem to give a Hottentot aspect to the Zulu dialects, and I believe that very little that is Hottentot can be traced in the etymology of the Bechuana vocabulary. But the phonology of this language is so peculiar as to suggest its great isolation at one period from other Bantu dialects. Some students of Bantu languages, however, have thought that the Bechuana races may have been the pioneers of the Bantu invasion into the regions across the Zambezi.

Physically speaking, the various sections of the Bechuana people exhibit far more traces of intermixture with the Hottentot-Bushmen type than is shown by the Zulu-Kafirs or by the real Herero (Damara) people.[1] The languages of the Herero group, though they possess marked characteristics in phonology, are of a very pure Bantu type, and gradually link up northwards with the languages of the Congo coast and with the Bantu speech of the southern portions of the Congo basin. The Zulu language retains some primitive characteristics in the form of the prefixes, which have been changed or lost in the Bechuana or Herero groups. Yet in other respects the Zulu dialects have departed widely from the Bantu standard, especially in vocabulary. This language group is a curious mixture of archaic Bantu features and inexplicable elements which, if not "Non-Bantu," cannot be definitely traced to any known Bantu group of tongues. In a few cases words of this description are of Hottentot origin, but this does not explain many of them, which would appear to have been absolutely invented by the Zulu people, no doubt owing to that strange custom (by no means unknown elsewhere in Africa), of "hlonipa," by which a constant local change of vocabulary takes place owing to the dislike to mentioning names of things which resemble the names of relatives; so that if there be a prominent person in the tribe, for instance, whose name is actually equivalent to "ox," or even whose name sounds like the word for ox, in that village or community the ox will henceforth be known by a paraphrase or by a substituted word.

In many respects—as Mr. Kidd's work shows over and over again—the Zulu-Kafir race would seem to have been the last arrived of the Bantu peoples in southern Africa, and to have reached that part of the continent at no very remote period—possibly not more than 1,500 to 2,000 years ago. In some of their characteristics the Zulus irresistibly recall the manners and customs of such Nilotic-Negro races as the Masai, though there is absolutely no linguistic connection between the two peoples. No doubt this can be explained by assuming that the original Bantu group from which the Zulu sprang had sent several previous branches to invade South Africa, which may have been the originators of some of the Zambezi tribes, of the Bechuana and the Herero, and that in this original home, somewhere up in east-central Africa, the Zulu peoples came into contact with Nilotic-Negro races from whom they borrowed customs, arms, and methods of warfare, and with whom they shared religious beliefs. When the Zulus started forth on their southward migration their progress seems to have been a relatively rapid one. We need not be astonished at this when we reflect on the remarkable speed with which a small section of the Zulu people in the first decades of the nineteenth century rushed back into Central Africa, reaching in their raids and settlements even the vicinity of the Victoria Nyanza.

The author has much to say of interest on the vexed question of the clicks in Zulu. There are three clicks in this Bantu language—the only Bantu form of speech which possesses these sounds. Some have considered that they were borrowed from the Hottentot, but of late there has been a tendency on the part of students like Mr. Dudley Kidd and Miss A. Werner to argue that these modern clicks in Zulu have been separately developed without Hottentot parentage. Mr. Kidd points out that at the present day the clicks subsist far more in the language of the women than in that of the men. It should be noted that amongst the settlements of Zulus in east-central Africa, which are about seventy years old, the clicks are rapidly disappearing. Dr. Bleek pointed out in his linguistic studies that certain strong intercalated aspirates met with in Swahili, and in one or two other East African Bantu dialects were not dissimilar to a vanishing click.

The space at my disposal does not permit of my dealing further with the interesting problems raised by this book, which, however, I must repeat, is perhaps quite the best that has yet been written or compiled about the Bantu negroes of South Africa. The hundred plates that illustrate this book are all photographs of perfect execution and singular aptness.

H. H. JOHNSTON.

[1] Except of course the Hill Damaras, who are a mysterious tribe of mountain people in the northern parts of German South-west Africa—a black race similar in appearance to some of the more degraded Negro tribes of West Africa, but speaking a corrupt dialect of Hottentot.

PROF. E. J. MAREY.

OF the two veteran Frenchmen who entered on their careers as physiological discoverers half a century ago, Marey and Chauveau, the first has left us. The second is in full vigour and is at this moment engaged in active laboratory work.

Marey died on Sunday night after an illness of much suffering. His earliest investigations had for their purpose the devising of methods by which the arterial pulsations could be made to inscribe themselves on an equably moving surface so as to obtain a graphic record from which their time-relations could be determined. One of the earliest products of these

methods was the invention of the sphygmograph, of which the original form (1863) has not undergone any important modification. From the arteries he proceeded to the heart, and for this associated himself with Chauveau, with whom his early friendship persisted unbroken to the end. It was to this association of two able men, one of whom was at that time the most skilful of living experimenters, while the other possessed an equally exceptional faculty of mechanical invention, that we may attribute the splendid researches on which our present knowledge of the motion of the heart is founded.

The results of these investigations were communicated to the Academy of Sciences in the early 'sixties, and soon after published in Marey's first book ("Physiologie Médicale de la Circulation du Sang") in 1863. This work was followed by others, of which were the "Travaux du Laboratoire," published annually by M. Marey after he had succeeded Bernard as professor in the Collège de France. In these he completed the development of the "graphic method" in its relation to the circulation, and extended its application to other bodily movements, particularly to those of locomotion, including the flight of birds. It thus happens that the "kinematographic" method, which in later times has not only been vulgarised for public entertainment, but has served a higher purpose as a guide in the artistic representation of animal motion, was in the first instance devised by Marey for the purpose of physiological research.

It would be difficult to over-estimate the value of Marey's work to the science to which, for the last half-century, he has devoted himself. Full of original ideas and fruitful in resources for carrying them into effect, his ingenious methods have not only served his own purposes, but have been made available by other workers in all investigations relating to the mechanical functions of the animal body. It would be difficult to find a single instance of a research in the carrying out of which these methods have not been employed.

PROF. WILHELM HIS.

PROF. WILHELM HIS, whose death was announced from Leipzig on May 1, at the age of seventy-three, altered and extended our knowledge of human anatomy more than any man of his time. He discovered and wrote the history of the human body during the first and second months of conception, and thus filled in what, until his time, was almost a blank. He introduced more accurate methods of studying the form and relationships of the various organs of the body. Pupils went to him from all parts of the earth and carried back to their native universities the quiet, honest spirit of investigation, the complete methods and the accurate technique His had introduced in his laboratory at Leipzig. His influence to-day is world-wide; it is especially evident in the remarkable progress in embryological research made recently in the United States.

As His entered to lecture one was struck by the absence of those bodily features one expects in a German professor. He was a Swiss by birth and education, having been born at Basel in 1831; in appearance he might have been an Englishman. His narrow, longish head, black hair, regular profile, long sallow face, and nervous temperament indicated his descent from a Celtic stock. He taught quietly, clearly, and concisely, illustrating his subject as he spoke by marvellous drawing on the blackboard. He relegated lady-students to the back-bench. Long after the university doors were shut, a light could be seen in the window of his private room, for to him work was also amusement.

His career as a medical student is interesting. It began at the University of Basel when he was eighteen, and finished there in 1854 when he was in his twenty-third year, but during that period he visited and worked at the Universities of Bern, Berlin, Würzburg, Vienna, and Prague, selecting what was best at each place. After graduating he studied in Paris. In 1857, then twenty-six, he succeeded Meissner as professor of anatomy and physiology in Basel, and commenced his life's work.

It is always a matter of the utmost interest to know the circumstances that determine the direction of a successful line of research. His, in his student days, while working at Würzburg with Virchow, then a young enthusiast, commenced and afterwards finished an investigation into the structure of the cornea of the eye, and in the early years of his professorship published, with Billroth, a research into the structure of lymphatic glands and allied bodies. A lecture which he heard Remak give in Berlin on the developments of glands was really the starting point of his embryological work. The point which struck him as marvellous was the development of a gland such as the liver from two of the three primary layers of the embryo. He commenced to investigate the origin and the part which each of these three primary layers played (ectoderm, mesoderm, and hypoderm) in the development of each part of the body, first in fowls and lower vertebrates, and subsequently in the then almost unknown early human embryo.

Every advance in science rests on the introduction of a new method By the methods he employed His succeeded where other men had failed. The early human embryo is minute and jelly like; it has to be hardened and stained before it can be cut in microscopic sections; it has to be stained to differentiate its various constituent layers; it has to be cut with a mathematical regularity in order that each section may be magnified and modelled in wax so that, by placing these wax magnifications together, a reconstruction of the embryo may be obtained. Although His did not invent any one of these details, yet he improved each of them and applied them to the study of embryos with an accuracy that never has and never will be surpassed. Duplicates of the models thus constructed are to be seen in all anatomical museums, and are of the greatest service to those who teach as well as to those who pursue embryological research.

The work of Prof. His is not marked by brilliant generalisations or discoveries, nor can his outlook on the kingdom of living things be said to be a wide one. He represented most realistically what he saw, but his power of interpreting embryological facts was limited by his neglect of comparative anatomy. Perhaps the greatest of his discoveries was the manner in which nerve fibres are developed. He was the first to see that they were processes produced by nerve cells. If his limitations are mentioned, it must also be admitted that most of what we know of the early development of all the systems of the human body we owe to him.

Ludwig, who made Leipzig the Mecca of physiologists, early recognised the ability of the young Swiss anatomist, and was instrumental, in 1872, in having him appointed director and professor of anatomy in the University of Leipzig. During the thirty-two years he laboured there, the younger anatomists flocked to him, and by placing his time, advice, and encouragement freely at their disposal, he rendered them deeply his debtors.

NOTES.

IN connection with the assembly of the International Association of Academies next week, the international council of the International Catalogue of Scientific Literature will also meet. The following are the members of this council, and the countries they represent:—Prof. H. E. Armstrong, F.R.S., Great Britain; Prof. H. Poincaré and Dr. J. Deniker, France; Dr. W. T. Blanford, F.R.S., India; Dr. M. Knudsen, Denmark; Prof. R. Nasini, Italy; Captain H. J. Lyons, R.E., Egypt; Prof. A. Famintzin, Russia; Prof. Dr. Karl von Than, Hungary; Dr. J. Brunchorst, Norway; Monsieur D. G. Métaxas, Greece; Prof. Dr. D. J. Korteweg, Holland; and Prof. A. Liversidge, New South Wales.

THE Weights and Measures (Metric System) Bill was read a third time in the House of Lords on Tuesday, and was passed with various amendments proposed by the public departments to the Select Committee to which the Bill was referred.

SIR WILLIAM RAMSAY has just been elected an honorary member of the "Bunsen Gesellschaft."

PROF. G. H. DARWIN, F.R.S., has been elected a foreign associate of the U.S. National Academy of Sciences.

WE regret to see the announcement of the death of Prof. G. J. Allman, F.R.S., for more than forty years professor of mathematics in Queen's College, Galway.

THE council of the Geological Society of London has this year awarded the Daniel Pidgeon fund to Mr. Linsdall Richardson, of Cheltenham.

THE *Times* correspondent at St. John's, Newfoundland, states that Lieut. Peary is chartering the sealer *Eagle* for a cruise to Littleton Island, from July to September, in preparation for a four years' stay in the Arctic regions, beginning next season.

A MATHEMATICAL society of Vienna has been organised, the meetings of which are to be held monthly. The officers are Messrs. G. von Escherich (president), E. Müller and W. Wirtinger (vice-presidents), A. Lampa (secretary), and A. Gerstel (treasurer).

A FUND has been started by the Faculty of Sciences and the Engineering School of Rome with the object of raising some kind of memorial to the late Prof. Cremona. The secretary is Signor I. Sonzogno, 5 Piazza San-Pietro in Vincoli, Rome.

THE Royal Academy of Sciences of Madrid offers for 1905 a prize for the best essay written in Spanish or Latin on the following subject:—"A complete study of a special class of singular integrals arising from differential equations for which the values of the derived functions become indeterminate when certain relations exist between the simultaneous values of the principal variables."

FURTHER particulars have been recently issued regarding the mathematical congress which, as announced last summer in NATURE, is to take place at Heidelberg from August 8 to 13. There will be six sections, and in addition five conferences presided over by Profs. Wirtinger, Greenhill, Darboux, Segre and Königsberger. It is proposed to hold exhibitions of mathematical models and of mathematical books.

A SERIES of prizes is offered by the mathematical and natural science section of the "Jablonow" Society of Leipzig for themes connected with the following subjects:—For 1904, the chemical differentiation of rock magmas; for 1905, the causes of plasmic currents in vegetable cells; for 1906, the analogues of Bernouilli's numbers in the study of elliptic functions; and for 1907, the laws of photoelectric currents. Full particulars are obtainable from the secretary, Prof. Wilhelm Scheibner, 8 Schletterstrasse, Leipzig.

A BRIEF notice of the late Edmund Hess, who died at Heidelberg on December 24, 1903, is given in a note in *L'Enseignement mathematique*, vi., 2. Hess was born at Marburg on February 17, 1843, and studied mathematics there from 1860 to 1862. The next year he went to Heidelberg, where he studied under Hesse, from whom he acquired his taste for geometry. He subsequently occupied the post of assistant at the Observatory of Göttingen, and in 1866 returned to Marburg, where he held office at first as extraordinary and later as ordinary professor. His papers deal exclusively with geometry, the subjects including "theory of the division of the sphere" and "contributions to the theory of configurations in space."

THE ninth annual congress of the South-Eastern Union of Scientific Societies will be held at Maidstone on June 9–11. Mr. F. W. Rudler, the president-elect, will deliver an address on the evening of June 9, and papers will be read on the mornings of June 10 and June 11. There will be several excursions to places of interest to naturalists and archæologists. The hon. general secretary is Mr. G. Abbot, 33 Upper Grosvenor Road, Tunbridge Wells.

ON Tuesday next, May 24, Mr. H. F. Newall will begin a course of two lectures at the Royal Institution on the solar corona; on Thursday, May 26, Mr. H. G. Wells will deliver the first of two lectures on literature and the State; and on Saturday, May 28, Sir Martin Conway will begin a course of two lectures on Spitsbergen in the seventeenth century. The Friday evening discourse on May 27 will be delivered by the Prince of Monaco on the progress of oceanography, and on June 3 by Prof. Svante Arrhenius on the development of the theory of electrolytic dissociation.

A CORRESPONDENT directs our attention to a singular mistake of dates in Mr. Herbert Spencer's "Autobiography." Referring to his visit to Montreal in 1882, Mr. Spencer states (vol. ii. p. 392):—"The meeting of the British Association had ended before our arrival." The meeting of the British Association in Montreal was in 1884, so this was probably a meeting of the American Association for the Advancement of Science which Spencer refers to. This conjecture appears to be confirmed on p. 384, where in a letter to Prof. Youmans he refers to the possibility of attending the meeting of the association at Montreal and supporting Prof. Youmans in his position of chairman of the Committee of Science Teaching.

DURING the anniversary meeting of the Royal Geographical Society on Monday, the Royal medals for the encouragement of geographical science and discovery were presented; the Founder's medal to Sir Harry H. Johnston, for his explorations and investigations in Africa, and the Patron's medal to Commander Robert F. Scott, R.N., for his conduct of the National Antarctic Expedition, and especially for his sledge journey to 82° 17′ S. The following other awards were also made:—the Murchison grant for 1904 to Lieut. Colbeck, for his services to the society while in command of the relief expeditions; the Cuthbert Peek grant for 1904 to Don Juan Villalta, for important geographical dis-

coveries to the east of the Andes, while in command of a Peruvian exploring expedition; the Gill memorial for 1904 to Captain Irizar, Argentine Navy, for his very successful expedition for the rescue of the Nordenskjöld Antarctic Expedition; the Back grant for 1904 to Dr. M. A. Stein, for his valuable geographical work in Central Asia, and especially for his mapping in the Sarikol and Kwen-Lun ranges.

THE Russian papers report that a rather severe shock of earthquake occurred at Shemakha (Caucasus) on April 28 at 6.30 p.m.

A NEW expedition, under M. Tolmachoff, is being organised by the Russian Geographical Society for the exploration of the region between the mouths of the Yenisei and the Lena.

RECORDS obtained by observers in several parts of the world suggest that an appreciable general diminution of the transparency of the earth's atmosphere took place some time during the year 1902, but disappeared at some time during 1903. As this is an important matter and may possibly be made the basis of an explanation of other meteorological phenomena, Prof. Cleveland Abbe, U.S. Department of Agriculture (Weather Bureau), Washington, D.C., asks observers to send him any records that will assist in defining the dates of beginning and ending, and the extent of this change in transparency. Such records may consist of photometric or photographic observations of the brightness of the stars, changes in the solar or stellar spectra, unusual prevalence of halos, large Bishop's ring, or haze; observations of heat received from the sun, as made with actinometers or pyrheliometers; observations of the polarisation of the blue sky light and of scintillation of the stars. It is proposed to incorporate the results of the inquiry in a general article on the subject of atmospheric transparency.

WE have received notice from Dr. H. Hergesell, president of the International Committee for Scientific Balloon Ascents, that a new edition of the useful cloud atlas, prepared at the request of the International Meteorological Committee by MM. L. Teisserenc de Bort, H. Hildebrandsson and A. Riggenbach, and issued in Paris, under the special superintendence of the first named gentleman in 1896, will be undertaken if sufficient interest is taken in the matter by scientific men. We believe the atlas in question to be the best of the kind, and that the beautiful representations of various types of clouds have been of great use in connection with the scientific balloon and kite observations to which we have frequently directed attention. Dr. Hergesell (Strassburg) states that he will be glad to receive and to send to M. Teisserenc de Bort any suggestions from persons who have used the atlas, with the view of improving the proposed new edition.

THE report and results of observations for the year 1903, issued by Mr. J. Baxendell, meteorologist to the Southport Corporation, shows that the high-class work carried on at the Fernley Observatory has been fully maintained. The various experiments on anemometers have been continued, and several improvements in connection with self-registering apparatus have been effected. A new instrument for continuously recording the variations in the inclination of the wind was designed and constructed by Mr. Halliwell, chief assistant at the observatory, and is now at work at the anemograph station. A useful article on the meteorology of Southport was prepared during the year for the "British Association Handbook" of local information for the Southport meeting. The usual interesting comparison of statistics of various health resorts is appended to the report.

AT Leeds on May 12 Prof. Clifford Allbutt, F.R.S., opened a new public dispensary, the building of which has cost 33,000*l*. In the course of an address Prof. Allbutt remarked that medical men are engaged in destroying their own means of livelihood by preventing disease, and have attained very remarkable success. Diseases which were once rampant are now diminishing. Typhus has never been seen by some members of the medical profession. Typhoid fever has been reduced to a nominal amount, and there has been a reduction of pulmonary consumption all over England. Discoveries as to the nature of malaria have changed the face of important countries. Prof. Allbutt urged that preventing disease is more congenial than curing it, and suggested that a rise of the standard of general health would be achieved by the careful study of the origin and causes of disease in such an institution as that of the Leeds General Infirmary.

A COPY of the *Peterborough Advertiser* of May 7 has been sent to us, containing the announcement that radium has been found in beds of Oxford Clay near Fletton, Huntingdonshire. No particulars are given, but a long descriptive article on the discovery suggests that it will make "brickfields better than gold mines." These sanguine anticipations will perhaps be tempered by the following extract from a paper by Prof. J. J. Thomson, read before the Cambridge Philosophical Society on February 15:—"Radium was found in garden soil from the laboratory garden, in the Cambridge gault, in gravel from a pit at Chesterton, in still greater quantities in sand from the sea-shore at Whitby, in the blue lias at Whitby, in powdered glass, in one specimen of flour, and in a specimen of precipitated silica."

A NOTE in NATURE of May 5 (p. 12) refers to some results obtained by Prof. A. Stefanini and Dr. L. Magri concerning the action of radium on the electric spark. Mr. R. S. Willows writes from the Cass Institute, Jewry Street, E.C., to say that he has been making observations on this subject for some time, and has come to practically the same conclusions as those arrived at by the Italian physicists. He remarks:—"My experiments are not sufficiently advanced to justify me in stating completely my results, but since the action can be greatly hindered by a magnetic field, I have come to the conclusion that it arises from the β rays given off by the radium."

IN continuation of notes in previous numbers recording the progress of geographical research in Madagascar, the April issue of *La Géographie* contains an account of the geodetic and cartographical work carried out during 1902 and 1903. A sketch map showing the different triangulations and a table of determined positions accompany the article.

THE May number of the *Geographical Journal* contains short articles of varied interest ranging over many parts of the subject. The president summarises the second season's work of the *Discovery* in the Antarctic regions. Captain Philip Maud writes on the exploration of the southern borderland of Abyssinia; Lieutenant Irizar on the rescue of the Swedish Antarctic Expedition; Colonel G. E. Church on the Acre territory and the caoutchouc region of south-western Amazonia; and Mr. Claud Russell on a journey from Peking to Tsitsihar. Dr. Vaughan Cornish contributes an elaborate discussion of observations on the dimensions of deep-sea waves, and there are papers on a bathymetrical survey of the lakes of New Zealand by Mr. Keith Lucas, and on peat moors of the Pennines by Mr. C. E. Moss.

THE Geological Society of Belgium has issued a special memoir on the flow of underground waters in limestone regions. This is edited by M. E. Van den Broeck (Brussels, April). Having regard to the importance of determining the source of water used for drinking purposes, the underground course pursued by it, until it issues again in the form of springs, must if possible be ascertained. Observations on this subject are now brought forward and discussed. The use of colouring matters is generally regarded as the best means of determining the question, and especially with regard to the time occupied by the water in its transit through the strata. Fluorescein, which gives a green tint, has been held by a number of hydrologists to afford the most satisfactory results, while others have expressed the opinion that it serves to retard the flow of water, and that different matters in solution or in suspension have travelled more rapidly. It is, however, maintained that neither floating objects nor matters in suspension can give so true a notion of the flow as substances in solution, but the substance in solution must not augment the density. It is admitted that light, carbonic acid and peaty soil tend to decolorise the fluorescein. The influence of light is most important, and must be obviated. The decolorisation produced by carbonic acid can be counteracted by ammonia. It is generally concluded that fluorescein will prove the existence of communication between two points, and will give the best approximate idea of the time taken in transit. The fluorescope is necessary to detect its presence.

A PHOTOGRAPHIC portrait of Francis Galton, admirable both in execution and as a likeness, is given in *Biometrika* (vol. ii. part iv.). The accompanying sketch of the same subject is also good and characteristic. The most important memoir in the part is Prof. Karl Pearson and Dr. Alice Lee's paper on the inheritance of physical characters. This embodies the fruit of many years' arduous labour, and establishes several results of high importance. Among these are the existence of statistical evidence of sexual selection, and the near approach to uniformity of the regression value of both physical and psychical characters as shown in fraternal inheritance. The former point receives indirect confirmation from a paper on assortative mating. Variation in *Ophiocoma nigra* is dealt with by Mr. D. C. McIntosh, and Mr. W. P. Ellerton contributes tables of powers and sums of powers of natural numbers up to 100. In the miscellanea, Prof. Pearson takes occasion to offer a vigorous defence of the position that "biometry is essentially a science of exact quantitative definition, and if it is to be of service in rendering anthropology an exact branch of science, it must replace vague ideas by numerically definite conceptions."

THE results of the important experiments on the crossing of Japanese waltzing and albino mice, reports of which have already appeared, are collected and fully discussed by Mr. Darbishire in *Biometrika*, vol. iii. part i. While certain of the crossings gave results in accordance with Mendel's law, Darbishire shows reason for the view that ancestral influence cannot be excluded, and that Mendel's theory of the purity of gametes receives no support from the present series of experiments. Referring to the variability of "heterozygotes" and their divergence in character from the parental standard, the author observes:—"It seems to me that we have not got any further in this direction than Darwin had when he called phenomena of this kind reversions to ancestral condition." Incidentally, he shows that the results of his crossings afford no instance of telegony. Among the other memoirs in this part is the record of a striking and valuable experiment by Mr. A. P. di Cesnola on the protection from enemies secured by the coloration of *Mantis religiosa*. So far as the experiment went, the proof of protection enjoyed by the mantis in appropriate surroundings appeared to be complete, while it was also made clear that both green and brown forms are eaten by birds or ants when recognised. New ground is broken by Mr. Greenwood in a paper on the variability and correlation of the human viscera, and Prof. Weldon shows that Mendelian segregation does not, as has been suggested, obtain among human albinos in Sicily.

IN the *Independent Review* for May, Dr. A. R. Wallace completes his survey of the chain of evidence connecting the "Islands of Wák-Wák" of the "Arabian Nights" with the Aru Islands, the home of the great bird-of-paradise. Hasan's journey through the "land of wild horses" is shown to refer to Tibet, whence the traveller crossed China to the sea, and eventually reached the Malay Peninsula. The apparently supernatural marvels encountered on the voyage from Malacca to the Aru Islands are all ingeniously demonstrated by Mr. Wallace to rest on a substratum of actual fact. Not that Hasan himself ever reached those islands, of which he was told by those who had accomplished the journey. Two separate legends appear to have been combined in the story of Hasan as we now know it. "The one is founded upon the magnificent plumage of the bird. . . . On the other hand, the cry 'wák-wák,' as distinctly stated by the General, gave the name to a mountain, and also to the islands themselves, and was said to be made, not by any bird, but by human heads which grew upon trees, and at daybreak gave forth this cry. . . . There is not a word in the whole story to show that there was thought to be any connection between the mysterious voices and the magical plumes."

WE have received from the publishers (Messrs. Cassell and Co., Ltd.) a copy of a new popular edition of that useful little work, "The Field Naturalist's Handbook," originally compiled by the late Rev. J. G. Wood, and revised by the Rev. T. Wood. As the new edition is published at the price of one shilling, it is within the reach of all, and everyone interested in field natural history should buy a copy. Perhaps it may be well to remind our readers that the work is restricted to three groups specially favoured by collectors, namely, butterflies and moths, wild plants, and birds' eggs, and the proper seasons to look for the various kinds of each group are fully recorded in the tables. The scientific nomenclature, so far at least as Lepidoptera and birds are concerned, is of an old-fashioned type, but perhaps in the main it is none the worse for this, although some restriction of the scope of generic names would certainly have been advisable in the case of the ducks. In works of this nature it would perhaps be nowadays advisable to speak of "a scientific name" rather than "the scientific name" of a species. This little volume, which is an excellent example of careful editing, deserves a wide circulation.

A THIRD edition, which has been revised and enlarged, of Mr. W. Perren Maycock's "First Book of Electricity and Magnetism" has been published by Messrs. Whittaker and Co.

"THE Psychological Index, No. 10," a bibliography of the literature of psychology and cognate subjects for 1903, has been published in connection with the *Psychological Review*. The index has been compiled by Prof. Howard C. Warren, of Princeton University, with the cooperation of M. G. Revault D'Allonnes, of Paris; Mr. F. G. Bruner,

of Columbia University; and Mr. C. S. Myers, of the University of Cambridge.

MESSRS. PASTORELLI AND RAPKIN, LTD., have submitted to us for inspection specimens of their patent "dial" barograph and of their student's standard barometer. In the case of the barograph we notice that the action of both dial hand and recording arm is simultaneous, the same movement controlling the two. Should the pen not indicate upon the chart a reading coinciding with that shown by the dial hand, this can be rectified by means of a milled head at the side of the dial case. Another milled head moves pen and dial hand simultaneously, and thus makes it possible to set the instrument to agree with a standard barometer, or to adjust for altitude correction. The student's standard barometer is constructed on the Fortin principle, and provides an accurate instrument at a moderate cost.

THE new issue—that for 1904—of the "Statesman's Year-Book" (Macmillan, 10*s.* 6*d.* net), edited by Dr. Scott Keltie with the assistance of Mr. I. P. A. Renwick, contains several novel and valuable features. The introductory section of the volume includes statistical tables and diagrams exhibiting with admirable clearness the conditions of British trade and shipping from 1860 down to last year. A diagram is also included showing the distribution among the various fleets of the Belleville and other boilers. Panama, as an independent State, is accorded a separate section, as are also the See and Church of Rome, which in former issues have appeared together as a section under Italy. The statistics in other parts of the volume (which runs to 1398 pages) have been brought up to date by the aid of official returns. The annual publication of this compendium of the most trustworthy information available as to the various States of the world is a convenience to everyone interested in political geography and a necessity to all who have to make use of books of reference.

THE additions to the Zoological Society's Gardens during the past week include a Black-eared Marmoset (*Hapale penicillata*) from South-east Brazil, presented by the Hon. Mrs. Algernon Bourke; four Smith's Dwarf Lemurs (*Microcebus smithi*) from Madagascar, a Bosman's Potto (*Perodicticus potto*) from West Africa, presented by Mr. Percy H. Stormont; a Mona Monkey (*Cercopithecus mona*) from West Africa, presented by Mr. W. Hughes; a Common Raccoon (*Procyon lotor*) from North America, presented by Mr. P. Estcourt Holland; three Blood-breasted Pigeons (*Phlogaenas luzonica*) from the Philippine Islands, presented by Dr. L. Wynne Davies; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. J. Smyth; two Lobed Chameleons (*Chamaeleon parvilobus*) from South Africa, presented by Mrs. Cox; a Tarantula Spider (*Avicularia avicularia*) from the Lower Amazons, presented by Mr. J. W. A. Watkins; an Antilopine Kangaroo (*Macropus antilopinus*) from North Australia, a Yellow-handed Howler (*Mycetes beelzebul*) from the Lower Amazons, a Senegal Galago (*Galago senegalensis*) from Senegal, a Common Wolf (*Canis lupus*), two European Sousliks (*Spermophilus citellus*), European; a Dingo (*Canis dingo*) from Australia, two Grooved Tortoises (*Testudo calcarata*) from South Africa, deposited; two Spoonbills (*Platalea leucorodia*), two Cayman Island Amazons (*Chrysotis caymanensis*) from the Grand Cayman, purchased; a Corean Bull (*Bos taurus*, var.), three Crab-eating Raccoons (*Procyon lotor*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

JUNE METEORS.—June does not usually prove itself a very prolific month in furnishing meteors, and a sufficient reason is found in the strong twilight prevailing in high northern latitudes at this period. But there are a few very interesting showers to be observed. Very brilliant meteors are often directed from near Antares (α Scorpii), the radiant being at 252°–21°. Nearly every year one or several fireballs from this southern stream appear over England, but the observations are often not sufficiently exact and numerous for their real paths to be determined.

There is an active radiant in June from 313°+60° near α Cephei. These meteors are swift, and they may quite possibly be connected with comet 1850 I., which has a radiant on June 23–24 in same position.

There is another shower in Cepheus from 335°+57° near ζ, which is particularly well defined at midsummer, and seems to be actively continued during July, August and September.

June is also a good month for Cygnids. There are fairly active showers from β, θ, δ and α Cygni. In June, 1887, a number of meteors were seen diverging from radiants at 252°+11° (near α Herculis), 274°+69° (ω Draconis), and 280°+43° (α Lyræ). It is probable that all these showers recur annually, though with variable strength.

A SPECTROHELIOGRAPH FOR THE CATANIA OBSERVATORY.—Prof. Orlando, the Italian Minister of Public Instruction, has granted L3000 (125*l.*) to the Observatory of Catania for the purchase of a spectroheliograph. The acquisition of such an instrument will enable Profs. Ricco and Tacchini to participate more fully in the proposed international daily study of the solar phenomena, and thereby add to the important solar work which has already been performed at the Observatory of Catania.

THE PARALLAX OF λ ANDROMEDÆ.—In a letter to the May issue of the *Observatory*, Mr. J. E. Gore directs the attention of those astronomers who are engaged in parallax determinations to the spectroscopic binary λ Andromedæ. From a consideration of the published elements it appears that the mass of the bright component of this system is only about one-tenth that of the sun. In order that a body with this mass and with a surface luminosity equal to that of the sun might appear as bright as λ Andromedæ (mag. = 4·0), it would have to be comparatively near to the earth. Mr. Gore's theoretical value of the parallax is 0″·34, and this is probably too low, for a comparison of their respective spectra leads to the conclusion that the surface luminosity of the sun is the greater. The star has a considerable proper motion, equal to 0·0157 in R.A. and 0″·425 in declination, according to the Greenwich ten year catalogue.

THE REPSOLD REGISTERING MICROMETER.—In No. 3943 of the *Astronomische Nachrichten*, Prof. K. Oertel discusses the results obtained with the Repsold self-registering micrometer which is attached to the meridian circle of the Munchen Observatory.

An analysis of these results leads Prof. Oertel to claim many advantages for this instrument as compared with the older form of micrometer. Among other advantages he mentions the following:—The personal equation is either entirely absent or extremely small. Differences of magnitude in the observed stars do not influence the results. The accuracy of the results is greater than in the older method. The observations take less time, one observer being able to observe between thirty and forty stars, in both co-ordinates, during one hour.

THE SPECTROSCOPIC BINARY β AURIGÆ.—In an article published in No. 3944 of the *Astronomische Nachrichten*, Prof. Vogel contests the validity of Herr Tikhoff's conclusions (*Astronomische Nachrichten*, No. 3916) concerning the system of the spectroscopic binary β Aurigæ, which stated that the system was probably made up of two separate pairs, and that the period was 3d. 23h. 30·4m. From the reduction of thirty-nine spectrograms obtained between December 22, 1903, and February 9, 1904, Prof. Vogel concludes that the period is 3d. 23h. 2m. 16s. ± 5s., and that the orbit is nearly circular in form. He also states that the reason for believing the system to be made up of *four* bodies is, to him, obscure.

THE EDUCATION OF EXAMINERS.[1]

THE subject that I have chosen for my presidential address may at first sight seem far from inviting. Yet, in spite of the unusual title of my paper, I undertake to say that most of you present here to-day will follow the results which I shall lay before you with ease, and will find a growing interest in certain ideas which cannot but prove novel to those of you who have not before thought of examiners as belonging to the human race, and therefore capable of education.

In a sense we are all examiners. We note and tabulate events and their causes. We distribute mankind into ethnological groups, or compare them as industrial workers. We ascertain their wants and their means of satisfying those wants. We examine and record the growth of custom, the physical and mental development of the human being, the changes in the mind itself and the order of such changes, the progress and decay of language, the distribution of wealth, the progress of society. Even the laws of statistics are submitted to examination.

Thus, side by side with the advance of theory in connection with all the sciences that fall under this section (archæology, education, mental science, philology, political economy, sociology, statistics), goes the scrutiny of results. It is justifiable, therefore, to think that an examination of methods of examination, even in connection with only one of those subjects, will throw a light upon such methods in general. I propose to-day to consider that small part of education which consists in the testing of the results of study by written papers.

You will perhaps wonder how it is that I have taken such an interest in the doings of examiners. The fact is that I am one of the few persons who have been for a lengthy period in the position of an examiner of examiners. In the position which I held in the Civil Service Commission for nearly fifteen years, it was my daily task to consider the character of the papers set by some of the highest dignitaries at Oxford and Cambridge, and other universities, to candidates for appointments in the English Civil Service. I had, moreover, to investigate the marking of the written answers of candidates, and to say whether the general results appeared to me to be fair and trustworthy.

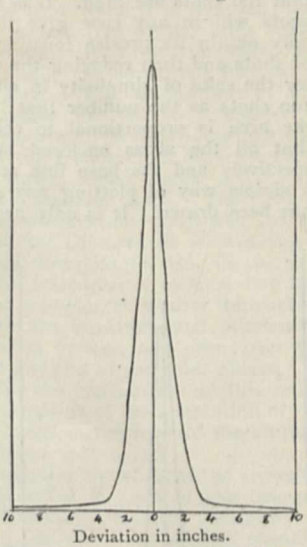
Of course, it will be understood that there are good as well as bad examiners. If the methods of good examiners are compared together, it will be found that they tend to uniformity, and that their results have certain characteristics in common. Whereas the methods and results of bad examiners differ from one another in every conceivable way.

But how are these results to be shown? It is not possible to obtain such information by running the eye down the totals awarded to candidates in the mark-sheets. Patient study will no doubt do something, but, where figures occur irregularly, it is hard to appreciate their import without definite classification.

In these days of the almost universal use of "squared" paper, all that is required is to find the percentages of candidates obtaining marks between the limits named, and to mark them off by counting the squares, say five candidates to a square. If the maximum in the subject is not 100, then it is only necessary to reduce the marks to that scale. By joining the top points of the vertical lines, which we call ordinates, the characteristic curve of the examiner is obtained, or, what is even more satisfactory, if black columns are raised on the bases 0 to 10, 11 to 20, &c., to show the number of candidates within these limits of marks, the result is a number of stepping-stones, shown in silhouette, and rising and falling in general harmony with the curve.

Difficulties presented themselves to me as soon as I began to plot the results of examiners from their mark-sheets. Until this had been done it was impossible to analyse the character of the marking, even after hours of study of the mark-sheets themselves. But as soon as the graphical representation had been arrived at, the whole matter was simplified. It was only necessary to determine whether there was any special form of curve to which the many varieties that have been placed before you ought to tend, or whether each subject, and even each examiner, might be properly represented by a different curve. I very soon became convinced that there was a tendency among the best examiners in many subjects to obtain results which gave the graphical form of a gendarme's hat (Fig. 2).

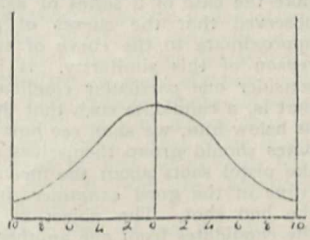
This form is one which is recognised by mathematicians as belonging to the so-called curve of "errors." I can best illustrate what is meant by this curve by supposing that some person in this room, experienced in the use of fire-arms, were asked to fire shots at a paper target on which a vertical straight line had been drawn as the mark to be aimed at. After a large number of shots had been fired, you would find that the holes in the target were arranged in about equal numbers on either side of the line, and that very few had actually hit the mark. If the distance of each shot from the centre line were measured and entered on a table, we should find so many falling within one inch of the line, so many between one inch and two inches, and so on. The curve now placed before you (Fig. 1) is produced by showing the number of shots falling within one inch on one side as a column of proportionate height erected on a base reaching one inch from the centre line. Similarly the column showing the number between one and two inches is drawn on a base between one and two inches from the centre line, and so on.



Deviation in inches.

FIG. 1.—Curve showing Pistol Practice at Vertical Line (good shot).

Now I show you a second curve (Fig. 2), in which the pistol has been put into the hands of an inexperienced person. You will at once perceive that these two curves are familiar to you. The curve of the good shot resembles the curve of the bad examiner, and the curve of the bad shot the curve of the good examiner. I think you will spare me giving you the mathematical equation of this curve, although many of the theorems and problems connected with it are extremely interesting. In preparing my paper to-day I have had to consider some of these questions from a mathematical point of view, and in doing so I have had the inestimable assistance of Miss Fawcett. I do not, however, propose to weary you with the mathematical treatment of the subject, but one result deserves consideration, because it is at the root of all the properties of this curve. If we allow the two sets of shots to be fired at one target, and classify them as before (dividing each total by two, since the number of shots is doubled), we shall obtain a curve of the same family as the component curves. However many times the process is repeated, each marksman will repeat his identical curve—on the supposition that he does not improve owing to practice—and of course the resultant curve due to both sets will be repeated.



Deviation in inches.

FIG. 2.—Curve showing Pistol Practice at Vertical Line (inexperienced shot).

Instead of taking only two performers with the pistol of unequal merit, we may bring within our view a considerable number in an ascending or descending scale of accuracy, and trace upon one sheet a series of these curves. Here is such a series (Fig. 3).

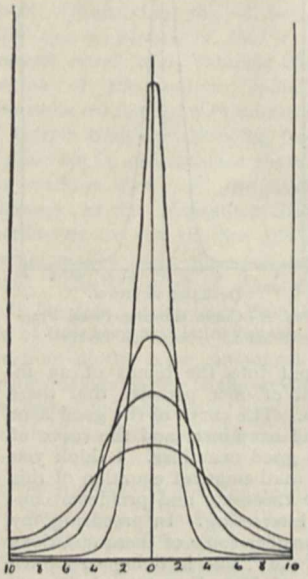
In each of these curves it should be noticed that the extreme portions never touch the base line, but they approach closer and closer to that line, so that the area enclosed in each case between it and the curve in question

[1] Abridged from an address delivered before Section D of the South African Association for the Advancement of Science on April 5 by Mr. E. B. Sargant, Education Adviser to Lord Milner.

depends upon a portion on each side of the middle ordinate which is at a measurable distance from that ordinate. Where the practice is accurate, the portion of the whole figure that may be safely excluded in calculating the area is much larger than in the cases where the shooting is wild.

A measure of the accuracy of the marksmen is obtained by drawing an ordinate to divide into equal parts the half area to the right or left of the middle ordinate, and estimating the distance between these two ordinates.

The whole area under consideration represents the total number of shots, and is therefore the same in the case of each curve. For the sake of simplicity we may suppose that 100 shots are fired. It is not true that that number of shots will in any case give the exact curve. We should only obtain its precise form by firing an infinite number of shots and then reducing the whole to a percentage. But for the sake of simplicity in our argument we will talk of 100 shots as the number that has been fired, and say that the area is proportional to that number. We see, then, that all the areas enclosed by each of these curves respectively and the base line are equal; and this gives us a simple way of plotting any one series if a single curve has been drawn. It is only necessary to suppose the curve to be stretched to a certain extent in either the horizontal or vertical direction, and to be contracted to a proportionate extent in the other direction, in order to pass to another curve of the series. In fact, if one of the curves were painted on a stretched india-rubber sheet, all the other curves could be got from it by pulling the sheet in one direction and slacking it off in the other.



Deviation in inches.

FIG. 3.—Series of Curves of "Error."

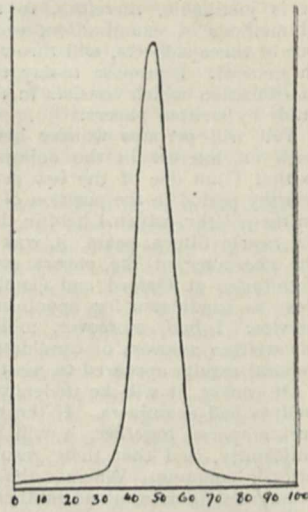
Another plan would be to bend a loop of wire into the form of one of the curves, and to place a lamp behind it so as to throw the shadow upon a screen. The loop and lamp might then be easily made to move in such a manner that the shadows in the successive positions gave the whole series of curves.

You will notice in the figure the points which show the intersection of neighbouring curves with one another. This is called, in mathematical language, the envelope of the family of curves. In this case it is a portion of two rectangular hyperbolæ.

Now, instead of our performers with the pistol, let us take the case of a series of examiners. As soon as I had observed that the curves of good examiners tended to approximate to the curve of errors, I cast about for the reason of this similarity. It is not far to seek. If we consider one particular candidate as the mean candidate, that is, a candidate such that there are as many above him as below him, we shall see how natural it is that the candidates should group themselves about this central figure as the pistol shots about the mean shot. It is clear that the curve of the good examiner should resemble the curve of the bad shot. The object of examination is to separate the candidates from one another as widely as is permissible under the given conditions, while the object of the target-practice is to get as many shots near the central line as possible.

Here we come to a most important limitation. You have already noticed that the curves we have been considering never touch the base line, that is to say, given a sufficient number of candidates, there will always be one or two removed to an extraordinary degree from the bulk of their fellows. But the examiner is obliged to give marks within certain limits, which he fixes arbitrarily as 0 and 100. If he were to place his zero point at a very great distance from the middle point, representing 50 marks, he would be able, no doubt, to make allowance for extraordinary candidates; on the other hand, the bulk of the candidates would be placed so close together that he would not be able to distinguish between them in any satisfactory manner. He is therefore bound to choose points such that the areas enclosed between the base line and the curve which lies beyond those points are very small compared with the areas up to the middle line. All the candidates beyond those points must be considered as having either nought or full marks.

Now you will see, I think, how an examiner in English composition, especially if he is a university man who has become acquainted with the finest examples of literature, tends to get a very steep form of curve (Fig. 4). He looks at some one paper, which differs to a considerable extent as regards both style and matter from the mean paper, and says, "This paper should have 80 marks at least." But then he thinks, perhaps unconsciously, "How do I know that, before finishing the pile of papers before me, I shall not find a budding Milton or Addison or Charles Lamb? If I give this candidate 80 marks, shall I be able to assign its true value to a composition of such extraordinary merit?" So he only awards 60 marks to the composition, and finds almost certainly, when he comes to the end of his pile, that no candidate has received any mark near 100. It is too late now to begin marking the papers all over again, and accordingly he sends in returns which do not serve to distinguish between the candidates in English composition to the same extent as they are distinguished in geometrical drawing, for example. The result is that a good candidate in the former subject is treated unfairly as compared with a good candidate in the latter subject.



Number of marks gained.

FIG. 4.—English Composition.

Again, we see why a curve (Fig. 5) based on marking dictation papers by the system of deductions is so abnormal. In this case, the examiner, without considering minor defects, makes a certain deduction for each mistake in spelling. If 10 marks are taken off for each mistake, all candidates having more than ten errors receive no marks, whereas if we were to assign negative marks, the curve of errors would almost certainly be reproduced, the mean ordinate being below the zero point. The divergence which you perceive near the point representing full marks is due to there being a good many candidates who make no important mistakes. If minor defects, such as refinements of punctuation, were considered, and the scale stretched beyond 100, this divergence would also disappear.

The problem which presented itself was how to bring these very different results into some accord. In order to give equal weight to various subjects having the same maximum, it seemed to me necessary that the examiners should have a common standard to work up to. Accordingly, during the latter period of my service with the Civil Service Commission, I caused such a diagram as has been placed before you to be printed on the sheet containing the examiner's report of his work. On that diagram, also, was printed a curve resembling a moderate sized gendarme's hat. If, as often happened, the examiner had 1000 papers to mark, he was requested to go through a batch of 100 taken at hazard, and to plot his curve upon the diagram. After a few examinations an old hand would probably find that his curve for the first 100 resembled closely the standard curve before him, but a fresh examiner might find himself altogether beside the mark. In such a case he was asked

to put aside the first 100 papers and to begin marking the fresh papers on such different lines as would, in his judgment, produce an approximation to the normal curve. On the supposition that he had achieved that result for the second 100, and continued to find that his curve was pretty constant for the third 100, fourth 100, and so on, he was asked at the end of all the papers to re-mark the first 100.

You might imagine that many examiners disliked having to place themselves upon this bed of Procrustes, but in the generality of cases it was not so. They positively took a delight in examining themselves. The process became one of self-education in marking.

Before leaving this part of my subject I should like to warn you that certain causes, which an examiner cannot always control, may make it difficult to obtain such an ideal curve as I have shown. It is not possible for me to enter fully into this part of the subject, but I will point out one cause at least that he can control—I mean the examination paper.

Good marking will not compensate for a bad paper. Every candidate must have his chance, in some question or other. Otherwise the examination is like a hurdle-race in which the hurdles are so high that a considerable number of candidates find themselves stopped from reaching the goal at all. The curve, in such a case, tends to assume a shape of this kind, mounting very rapidly to the zero line (Fig. 5)—just the curve, in fact, which we have already seen in connection with a dictation paper. In this case it is not the marking which is wrong, but the examination paper.

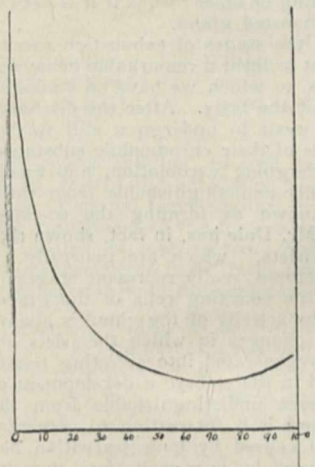


FIG. 5.—Dictation Paper.

Accordingly, I found in practice that it was necessary to point out to examiners, before ever their papers were proposed in manuscript, that they ought to divide their questions roughly into (say) three portions, of which one portion could be answered by candidates of inferior power, a second should be within the range of mediocre candidates, and a third only possible to candidates who might be classed as good to excellent. The result of these directions was that examiners soon found little difficulty in spreading out their candidates in the desired way. In setting their questions they had before their eyes the little gendarme's hat.

Among the causes, beyond the control of the examiner, which may interfere with the formation of this curve, we must reckon as in the first rank:—(1) such a small number of candidates as does not give fair play to the law of probabilities; (2) any selection of candidates by a preliminary examination or other means.

With regard to the causes just named, I will only say that it has been found that the method can be applied successfully when there are not less than one hundred candidates, and that, even below this number, the curve, though irregular in formation, gives us very useful information as to an examiner's capacities. With regard to the second cause, a great deal can be done to produce a satisfactory curve by setting such questions in the further papers as are only addressed to the candidates who remain after the preliminary sifting.

I trust that I have now fulfilled the promise with which I started, namely, to show you how examiners themselves may be examined; and not only this, but you will understand that it is possible to educate examiners so as to enable them to form a much more accurate and sustained judgment of a large number of candidates than would have been within their power without such preliminary guidance.

THE CHEMICAL REGULATION OF THE SECRETORY PROCESS.[1]

THE researches which we wish to bring briefly before the Royal Society deal with the mechanism of adaptation to changes in the food and the chemical correlation of the activities of different organs engaged in the digestion and assimilation of the food.

According to Pawlow, the secretion of the pancreatic juice is exactly comparable to the secretion of saliva, and is effected by a nervous reflex. The starting point of this reflex is the stimulation of the duodenal mucous membrane by the chyme, or by substances such as oil, ether, or oil of mustard. Not only is the pancreatic juice turned out into the intestine just at the time when it is required, but, according to Pawlow, the composition of the juice varies according to the food, the proteolytic ferment being increased by a diet of meat, while the amylolytic ferment is increased by a starchy diet. This adaptation of the glandular activity was ascribed by him to a species of "taste" in the mucous membrane. It was imagined that the different constituents of the food excited different nerve endings, which, in their turn, caused reflex activity of different mechanisms in the pancreas itself. The field of these assumed reflexes was considerably narrowed by the researches of Popielski (*Gazette Clinique de Botkin*, 1900) and Wertheimer (*Journal de Physiologie*, vol. iii. p. 335, 1901), who showed that the introduction of acid into the duodenum was productive of secretion even after destruction of all nerve connections of the pancreas and alimentary canal with the central nervous system, and even after extirpation of the sympathetic ganglia of the solar plexus. It was with a view to determine the mechanisms of this reflex secretion of the pancreas, as well as of the adaptation of the pancreatic secretion to variations in the food of the animal, that we began our researches.

The last named authors had also shown that the secretion occurred, but in smaller quantities, if the acid was inserted in any part of the small intestine, with the exception of the lower end of the ileum. It was thus easy to examine the effects of the introduction of acid into a loop of ileum in which all nerve connections with the pancreas, or with the rest of the body, had been destroyed. This crucial experiment had, curiously, not been performed by previous workers in the subject. On carrying it out, we found that destruction of all nerve connections made no difference to the result of introducing the acid. The pancreatic secretion occurred as in a normal animal. It was therefore evident that we had to do here with a chemical rather than a nervous mechanism. Previous work had narrowed the question down to such a degree that the further steps were obvious. We knew already that the introduction of acid into the blood-stream had no influence on the pancreas; hence the acid introduced into the intestine must be changed in its passage to the blood-vessels through the epithelial cells, or must produce in these cells some substance which, on access to the blood stream, evoked in the pancreas a secretion. This was found to be the case. On rubbing up the mucous membrane with acid, and injecting the mixture into the blood-stream, a copious secretion of pancreatic juice was produced. It was then found that the active substance, which we call *secretin*, was produced by the action of acid from a precursor in the mucous membrane, probably in the epithelial cells themselves. Once formed by the action of acid, it could be boiled, neutralised, or made alkaline, without undergoing destruction. The precursor of the substance (*pro-secretin*) cannot be extracted by any means that we have tried from the mucous membrane. Even after coagulation of the mucous membrane by heat or alcohol, however, secretin can still be extracted from the coagulated mass by the action of warm dilute acid.

We have not yet succeeded in determining the chemical nature of secretin, though we have obtained chemical evidence which will serve to exclude certain classes of substances. Thus the fact that it will stand boiling shows that it is neither a coagulable proteid nor a ferment. It is soluble in 90 per cent. alcohol in the presence of ether, but it is insoluble in absolute alcohol and ether. It is slightly diffusible through animal membranes. It can be

[1] Abstract of the Croonian Lecture. By Dr. W. M. Bayliss, F.R.S., and Prof. E. H. Starling, F.R.S. Read before the Royal Society, March 24.

filtered through a gelatinised Chamberland filter. It is not precipitated by tannic acid, thus excluding bodies of alkaloid nature as well as diamido-compounds. This evidence, slight though it is, points to secretin being a body of relatively small molecular weight and not a colloid. It may be compared to the active principle of the suprarenal glands, adrenalin, which has been obtained in a crystalline form and the chemical constitution of which has been approximately determined. This is, indeed, what one would expect of a substance which has to be turned out into the blood at repeated intervals in order to produce in some distant organ or organs a physiological response proportional to the dose. The bodies of higher molecular weight, such as the toxins, which owe their activity, according to Ehrlich, to the fact that they can be directly assimilated by the cells of the body, and built up into the protoplasmic molecule, always give rise to the production of anti-bodies, a process which, while not preventing necessarily their utilisation in the body, would prevent their acting as a physiological stimulus to certain definite cells. Adrenalin and secretin on the other hand belong to the class of drugs which act by their physicochemical properties, and the physiological effect of which is determined by the total configuration of their molecule. It was suggested to us early in our experiments that the secretion of pancreatic juice, evoked by secretin, was essentially a sudden production of an anti-body; such a sudden production is unknown in the animal body, and the anti-character of the secretion is at once negatived by the fact that secretin can be mixed with a freshly secreted juice without in any way destroying its efficiency.

Like adrenalin, secretin is extremely easily oxidised, and it is probable that it is got rid of in this way from the body, since, even after repeated injections of secretin, it is impossible to find this substance or any precursor of it either in the pancreas, the urine, or other tissues of the body. Just as in the case of adrenalin, so we find that secretin is not specific for the individual or species. An extract of the mucous membrane of the dog will evoke secretion in the pancreas of the frog, the bird, rabbit, cat, or monkey. In the same way the pancreatic secretion of the dog can be excited by injection of secretin prepared from the intestine of man, cat, monkey, rabbit, fowl, salmon, skate, frog, or tortoise. The evolution of this mechanism is, therefore, to be sought at some time anterior to the development of vertebrates.

The action of secretin is not confined to the pancreas. It has long been known that the pancreatic juice, in order to exert its full activity on the food stuffs, needs the simultaneous presence of bile, and the fact that in many cases the two fluids are poured into the duodenum by a common orifice shows the close connection which must exist between them. Digestion of fats is impossible unless both fluids have access to the gut, and even in the digestion of carbohydrates, as was shown by S. Martin and Dawson Williams many years ago, the presence of bile greatly hastens the digestive powers of the pancreatic juice. Whenever, therefore, a secretion of pancreatic juice is required, a simultaneous secretion of bile is also necessary. It is interesting to note that this simultaneous secretion is provided for by the same mechanism by which the secretion of pancreatic juice is evoked. If the flow of bile be determined by measuring the outflow from a cannula placed in the bile duct, it will be found that introduction of acid into the duodenum causes a quickened secretion of this fluid. The same increase in the secretion of bile can be produced by injecting solutions of secretin into the blood stream. This influence of secretin on the liver has been fully confirmed by Falloise. This observer has shown that acid extracts of the intestinal mucous membrane cause an increase in the bile secretion most marked when the extract is made from the duodenum and diminishing as the extract is taken from the lower parts of the gut, that from the lower section of the ileum being quite ineffective.

The discovery of secretin has placed in the hands of physiologists the power of controlling the activity of a gland by purely physiological means, and we have taken opportunity of the control thus acquired to investigate the exact character of the changes induced in the pancreas under this physiological stimulus. So far as we can tell secretin has no specific influence on any one constituent of the pancreatic juice. When injected it causes secretion of a juice which is normal in that it resembles the juice secreted on entry of food into duodenum, and contains a precursor of trypsin, amylopsin, and steapsin. Secretin, in fact, appears to cause the pancreatic cells to turn out the whole of the mesostates which they have accumulated during rest in preparation for the act of secretion. If secretin be injected at repeated intervals until the gland will no longer respond to the injection, it is found on microscopic examination that the cells have discharged the whole of their granules. In sections stained with toluidine blue and eosin the whole of the cells stain blue in marked contrast to the normal resting gland, where one-half or two-thirds of the inner margin of the cells is taken up with brilliantly stained red granules. This effect is not produced in all cases. In some animals we have injected secretin at frequent intervals over a period of eight hours, and obtained at the end of the experiment a secretion as vigorous as after the first injection. The pancreas in this case was evidently not fatigued, and on killing the animal and examining this organ microscopically it was found to give the typical picture of a resting pancreas. One may say, therefore, that under healthy conditions the activity of the pancreas is two-fold in character, and that the normal stimulus of secretin excites not only a breaking down of the protoplasm and a discharge of granules, but also a building up of the protoplasm and a new formation of granules. So marked, in fact, is this power of self-restitution that it is often advisable to diminish the resistance of the animal by bleeding or other means if it is desired to obtain a specimen of exhausted gland.

A study by Mr. Dale of the stages of exhaustion carried out in this way has brought to light a remarkable behaviour in the cells of the pancreas, to which we have no analogies in other secreting glands of the body. After the discharge of the granules the cells seem to undergo a still further involution, losing the whole of their chromophile substance, diminishing in size or undergoing vacuolation, and finally being transformed into cells undistinguishable from those which have long been known as forming the so-called "islets of Langerhans." Mr. Dale has, in fact, shown that in all probability these "islets," which are generally regarded as pre-formed structures, really represent stages in the functional activity of the secreting cells of the gland, and he is of opinion that the activity of the gland is always associated with a cycle of changes in which the islets are formed, to be afterwards regenerated into secreting tissue. Other observers have noted in the embryo a development of secreting tubules from tissue undistinguishable from the "islets of Langerhans," and it is interesting to note that the depletion of the gland caused by long starvation has a similar effect to that caused by over-excitation, namely, the conversion of a large proportion of the gland tissue into "islet" tissue.

So far we have dealt only with the correlation of the activities of the cells lining the intestinal tube with those forming the masses of the pancreas and liver, and have seen that a very large part in this correlation is played by a chemical substance which acts, so to speak, as a chemical messenger between these various organs. A striking feature, however, of the pancreas is its alleged power of adapting its secretion to the nature of the food taken in by the animal. It has been stated by Pawlow that according as the food consists chiefly of proteids, carbohydrates, or fats, so do we find a relative preponderance of the ferments acting respectively on each of these three classes of foods. The evidence on which this statement is based, although lending to it considerable support, is not absolutely convincing. Vasilieff (*Archives des Sciences Biologiques*, St. Petersburg, 1893) examined the pancreatic juice of dogs which were fed on meat, or bread and milk alternately for periods extending over several weeks for each kind of diet. This observer found that the transition from bread and milk diet to a meat diet caused a rapid rise in the proteolytic power of the juice, which reached its maximum after several days of meat feeding. A return to a diet of bread and milk caused a slower fall in the proteolytic power of the juice, but a rise in the amylolytic power. Similar results were obtained by another pupil of Pawlow—Jablonsky (*ibid.*, 1896)—who also extended his observations to the fat-splitting ferment. At the time that these observations were made the function of enterokinase was unknown, and it is there-

fore impossible to say what proportion of the trypsinogen of the juice secreted in these experiments had been converted into trypsin by the small amount of intestinal mucous membrane at the mouth of the duct. While, therefore, we are unable to ascribe much importance to the results as regards the proteolytic power of the juice, there seems no reason to doubt the results obtained by these workers as regards the starch-digesting power of the juice. In 1899 Walther (*ibid.*, 1899, vol. vii. p. 1) made a series of observations on a dog with pancreatic fistula in order to determine whether the amounts of ferments secreted were determined by the nature of the food at any given meal. He was satisfied that his results showed that, even without prolonged adherence to one diet, the composition of pancreatic juice was adapted to the nature of the meal taken. His results do not entirely bear out his contentions, as is seen by the following table, in which it will be noticed that although milk contains no starch, it evokes the secretion of a large amount of amylopsin, and that meat causes a secretion of more steapsin than does milk, although this latter contains much more fat than the meat diet.

TABLE I.—*Results of Walther's Experiments.*

Diet	Total amount of enzyme secreted		
	Proteolytic	Amylolytic	Fat-splitting
600 c.c. milk ...	1044	2310	4125
250 grams bread ...	2360	6343	1218
100 grams meat ...	1720	2498	4410

Of course Walther, as well as the other observers mentioned, regard the adaptation as determined by the stimulation of special nerve endings in the mucous membrane by each constituent of the food, a conclusion hardly borne out by the results just quoted. Another disturbing factor in these experiments is the large variation in total quantity of juice secreted with different food-stuffs.

TABLE II.—*Amount of Pancreatic Juice Secreted for different Food-stuffs (Walther).*

Food	Hours of secretion									Total amount
	1	2	3	4	5	6	7	8	9	
600 c.c. milk	8·2	6·0	23·0	6·2	1·75	—	—	—	—	45 c.c.
250 grams bread ...	35·5	47·0	20·5	16·5	10·0	12·0	6·5	3·0	—	151 ,,
100 grams meat ...	45·0	52·0	35·0	9·75	—	—	—	—	—	142 ,,

The quantity of juice secreted will depend on the amount of secretin turned into the circulation, and this, in its turn, on the amount of acid entering the duodenum from the stomach. The amount of juice will, therefore, be measured by the stay and resistance to digestion of the substance in the stomach rather than to any direct nervous or other influence of the duodenal contents on the pancreas. A repetition of Walther's experiments by Popielski (*Centralblatt f. Physiologie*, vol. xvii., 1903), working independently, has in fact led the latter to deny altogether the adaptation of the pancreatic juice to the nature of the food. Popielski concludes from his experiments that variations in the juice depend only on the intensity and duration of the stimulus, the intensity of the stimulus determining the amount of enzymes, whilst its duration determines the total quantity of juice.

In the meantime the question had been attacked from another side. It had been shown by Fischer and Niebel (*Sitzungsberichte der K. Preuss. Akad. d. Wiss.*, 1895, p. 73), as well as by Portier (*C. R. Soc. de Biologie*, 1898, p. 387), that watery extracts of the pancreas of the cow, horse, and dog had no influence on lactose. Weinland in 1899 confirmed these results so far as concerns the pancreas of dogs on an ordinary diet free from milk. On the other hand, he found that extracts of the pancreas of dogs, which had been fed for several days on milk, sometimes with the addition of lactose, invariably contained lactase in considerable amount, and these results have been confirmed lately by Bainbridge working in our laboratory. Here then we have a definite instance of adaptation of the pancreas, the pancreatic juice or pancreatic extracts of dogs on normal diet containing no lactase, while the administration of lactose to these animals causes the appearance of lactase in both cases. Since in this case we have to determine, not simply an increase or diminution in the amounts of ferments always present in the juice, but the presence or absence of a definite substance, this was evidently the best starting point for an investigation of the mechanism by which the pancreas can adapt itself to the nature of the food, an investigation which has been carried out and completed by Dr. Bainbridge.

What are the limiting conditions? In the first place the reaction is absolutely specific. Unless the animal is taking lactose in its diet no lactase is ever found in the pancreas or in its secretion. The pancreas of new-born animals, for instance, is quite free from lactase, which, however, makes its appearance two or three days after birth as the result of the milk diet. The production of lactase is not a direct reaction of the pancreas to the presence of lactose in the blood, since subcutaneous or intravenous injection of lactose does not cause the appearance of lactase in the pancreas. The intestinal mucous membrane of all animals, whether on a milk diet or not, contains lactase and has an inverting action on lactose. It might be thought therefore that the production of lactase by the pancreas was a reaction to the presence of the products of inversion of lactose in the blood. This was found not to be the case. Subcutaneous injection of galactose for several days was not followed by any appearance of lactase in the pancreas or its juice. Nor was the appearance of lactase due to the increased production of this ferment in the mucous membrane, and its escape into the blood. Injection of an extract of mucous membrane rich in lactase, repeated several days in succession, was not followed by any appearance of lactase in the pancreas. Injection of lactose into the duodenum, and the subsequent injection of secretin after an interval of one hour, was inefficacious in causing the appearance of lactase in the pancreatic juice. For the production of lactase in the pancreas, or its juice, it is therefore necessary that lactose should act on the intestinal mucous membrane for some time. The reaction is a slow one, like the adaptation in Vasilieff's experiments, and is certainly not due to the stimulation of certain nerve endings in the mucous membrane by the lactose.

The problem was somewhat similar to that presented by the action of acid in the duodenum, since this introduced into the duodenum produces secretion of juice, whereas, when introduced into the blood stream, it has no effect whatever on the pancreas. The question suggested itself whether, under the influence of lactose, a special secretin was formed in the intestinal mucous membrane which, on access to general circulation, evoked the formation and secretion of lactase by the pancreas. Secretin was therefore made in the usual way (*i.e.* acidification, boiling, neutralisation, and filtering) from the mucous membrane of milk-fed dogs. The secretion evoked by the injection of this liquid resembled that obtained from the injection of ordinary secretin, and contained no lactase.

Yet it was evident from the results already obtained that lactose must act on the pancreas through the mucous membrane of the intestine. An extract was therefore made from the mucous membrane of the whole small intestine of a milk-fed dog. This was filtered through muslin, and about 10 c.c. injected subcutaneously into a biscuit-fed dog once a day for three days. The dog was then anæsthetised, a cannula placed in its pancreatic duct, and ordinary secretin injected. A flow of pancreatic juice was obtained, and this juice was found to contain lactase. This experiment was performed eight times, and in each case the juice obtained from a biscuit-fed dog which had been injected with an extract of the mucous membrane of a milk-fed dog contained lactase.

TABLE III.—*Effect on Milk Sugar of Pancreatic Juice from "Biscuit-fed" dogs, which had received Subcutaneous Injections during three days of Extracts of the Mucous Membrane of "Milk-fed" dogs.*

The figures represent c.c. of lactose solution which reduced 50 c.c. Pavy's solution.

Exp.	Controls		Lactose + pancreatic juice	Percentage of inversion
	Solution of lactose	Lactose + pancreatic juice (boiled)		
1 ...	7·4	...	6·8	18·1
2 ...	8·2	8·2	7·6	16·5
3 ...	8·2	8·15	7·85	9·7
4 ...	7·95	7·9	7·65	8·5
5 ...	7·8	..	7·5	8·8
6 ...	7·0	7·05	6·75	8·1
7 ...	4·1	...	3·75	20·8
8 ...	9·25	...	8·2	25·9

Here then at last we have some glimpse into the mechanism of the adaptation of the pancreas to the nature of the food. As the result of injection of lactose some substance which we may call x is produced in the mucous membrane of the small intestine. This substance is carried by the blood to the pancreas, and there slowly gives rise to the formation of lactase which is turned out in the juice when secretion is excited by the entry of acid chyme into the duodenum. We have no knowledge as yet as to the nature of this substance x. All we can say is that it is destroyed at a boiling temperature, since boiled extracts of the mucous membrane of milk-fed dogs do not, when subcutaneously injected, cause the appearance of any lactase in the pancreatic juice of biscuit-fed dogs.

Whether the qualitative adaptation of the juice in respect of its trypsin, amylopsin, and steapsin is carried out in a similar fashion we cannot as yet say. We hope that an investigation of the mechanism of this adaptation, which is now proceeding, may throw light, not only on the factors involved, but also on the nature of the substance which is formed in the mucous membrane, and has this marked effect on the activity of the pancreatic cells. Involving, as it does, two distinct sets of cells, this chemical adaptation is more complex than any yet investigated, and shows the intimate relation which must exist between the chemical activities of very different organs of the body.

THE ROYAL SOCIETY CONVERSAZIONE.

THE Royal Society conversazione was held in the rooms of the Society at Burlington House on Friday last, May 13. Many exhibits illustrating methods and results of recent scientific progress were on view, and are briefly described in the following abstract of the official catalogue. So far as possible the exhibits representing related subjects are here grouped together.

In the course of the evening, lantern demonstrations were given in the meeting room of the society. Prof. W. A. Herdman gave an account of the recent investigation of the Ceylon pearl fisheries; Mr. Francis Fox showed lantern slides, illustrative of (1) operations at the Simplon Tunnel; (2) the Victoria Falls and gorge of the River Zambesi, and proposed bridge; and the Hon. C. A. Parsons, F.R.S., gave a demonstration of the auxetophone. This instrument is an air operated valve which is used for a reproducer in gramophones and phonographs, and replaces the usual reproducing diaphragm in such machines. The application of this valve to the violin was shown, selections of music, vocal and instrumental, being played on the auxetophone.

The following is a classified list of the other exhibits:—

The differentiator, a machine recording as a curve the values of the rate of change of any variable quantity which can be represented by a curve: Dr. J. Erskine-Murray. When the machine is guided along any curve it automatically traces another which represents the rate of change of the quantity represented by the first curve. Thus, if the population of a country at various dates be plotted on paper the derived curve shows the rate at which the population is increasing or decreasing at every date during the period chosen.—Twin-elliptic figures showing change of phase in one or both ellipses: Mr. Joseph Goold.—A radial area-scale: Mr. R. W. K. Edwards. A contrivance for finding the area of a plane figure by means of a transparency.

Sensitive barograph, for the study of minor variations of atmospheric pressure: Dr. W. N. Shaw, F.R.S. The instrument shows the details of comparatively rapid fluctuations of pressure such as are often indicated in the barometric diagram of the *Times*.—(1) Traces obtained from self-recording instruments sent up by means of kites, (2) self-recording instruments from which the traces were obtained: Mr. W. H. Dines. In the recording instruments designed by M. Teisserenc de Bort, the height is obtained from an exhausted aneroid box, and the temperature from a Bourdon tube. In the recording instruments designed by the exhibitor, the height is obtained from a fair sized aneroid box of thin metal containing air. A temperature correction is necessary, but the position of the pen is dependent on the elasticity of the enclosed air.—Photographs of clouds: Commander D. Wilson-Barker.—Models and photographs of large hailstones: the Royal Meteorological Society.

Photographs and diagrams illustrating solar and meteorological changes, and a series of photographs to determine the relative temperatures of the stars: Sir J. Norman Lockyer, K.C.B., F.R.S. The exhibit illustrated (1) enlarged pictures of the sun in "K" light taken with the spectroheliograph of the Solar Physics Observatory. (2) The results of a discussion of sun-spot distribution. (3) The relationship between the positions of solar prominences and the different forms of the corona. (4) The different types, and their distribution, of the short period barometric pressure variation over the earth's surface. (5) The close connection between the change of barometric pressure and rainfall. (6) Series of photographs taken with a quartz-calcite prismatic camera of 2 inches aperture and 18 inches focal length to determine the relative temperatures of stars.—The Narraburra siderite, New South Wales: Prof. A. Liversidge, F.R.S. This exhibit included photographs of the siderite, and photographs of etched sections to show the changes in the internal structure. The composition of the siderite was:—iron 88·605, nickel 9·741, cobalt 0·474, copper 0·009, phosphorus 0·429, sulphur traces, resinous matter 0·008, insoluble in HCl. 0·720 = 99·906. Traces of gold and of the platinum metals appeared also to be present.—Transparencies and prints in illustration of a photographic atlas of the heavens; photographed at the Royal Observatory, Cape Town, 1903–4: Mr. J. Franklin-Adams.—Ten transparencies from negatives taken with the Rumford spectroheliograph of the Yerkes Observatory by Prof. G. E. Hale and Mr. F. Ellerman: the Royal Astronomical Society.

Examples showing the application of natural colour photography to the production of lantern slides of spectra for lecture and educational purposes: Mr. E. Sanger-Shepherd. Negatives are taken through three colour filters, admitting light of the three primary colour sensations—red, green and blue-violet, in accordance with the power of the respective sensations to excite the eye. From these negatives gelatin relief prints are made upon a special film, each relief being soaked in a water-colour ink of the complementary colour to the sensation which it represents. These reliefs whilst still wet are successively applied to a mordanted gelatinised glass plate. The inks transfer to the mordanted gelatin film, and the result is a natural colour photograph, consisting of nothing but the colouring matter securely locked up in a single film of gelatin.—Colour photographs shown by spectrum colours: Sir W. de W. Abney, K.C.B., F.R.S. The ordinary three-colour photographs are shown in a triple lantern, one image being tinted by the light coming through red glass, another by that through green glass, and the third by that through blue glass. The new method substitutes spectrum colours for the three glasses, with the result that the colours on the screen are much purer and truer.—High power microscopy: Mr. J. W. Gordon. The apparatus consists of a compounding drawtube and oscillating screen, as proposed in Mr. J. W. Gordon's paper on the Helmholtz

theory of the microscope, recently read before the Royal Microscopical Society. The object exhibited was a diatom (*Pleurosigma angulatum*) magnified about 10,000 diameters. —A cylindrical telescope for the rotation of images: Dr. G. J. Burch, F.R.S. This instrument consists of two cylindrical lenses with their axes of curvature parallel, fixed the sum of their focal lengths apart. Objects seen through it are not magnified, but reversed as by reflection in a mirror. If the telescope is rotated it causes the image to rotate with double the angular velocity.—Large direct vision spectroscope, with ten prisms, automatically adjustable: Mr. P. Heele.—Experiments with non-homocentric pencils: Mr. W. Bennett.—Optical testing bench: Messrs. R. and J. Beck. The bench is so designed that the optical constants of a lens and its various aberrations (chromatic, spherical, astigmatic, &c.) can be rapidly and accurately measured, and is specially adapted for using the new Hartmann system of testing either by direct vision or by photography.—Examples of photomicrography: Mr. Arthur E. Smith and Mr. Richard Kerr.

Some new phosphorescent materials: Mr. H. Jackson. Examples were shown of phosphorescent compounds of zinc, strontium, aluminium, calcium, &c., prepared to illustrate varying degrees of response to such exciting influences as violet and ultra-violet light, electric discharge, heat and friction. By varying the constitution of the compounds in the direction of increasing or diminishing their basic or acidic character the length of time during which the phosphorescent glow lasts can be increased or lessened considerably, and the property of glowing, when heated, can be made to persist apparently indefinitely.—Photographs illustrative of induced radio-activity of bacteria: Dr. Alan B. Green. Small masses of bacterial growth were exposed to the β and γ rays of 10 mg. of virtually pure radium bromide. In a large number of instances such masses when removed from the influence of the radium and placed between two thin sheets of glass, themselves not radio-active, were capable of so affecting the sensitised film of a photographic plate with which they were brought in contact, that on development in the ordinary way, the plate showed a dark area corresponding to the shape of the bacterial mass. The photo-actinic rays proceeding from the bacteria which had been exposed to radium were capable of affecting a photographic plate through a double layer of lead foil.

A method of mechanically reinforcing sounds: Mr. T. C. Porter. An ordinary "Home" Edison-Bell phonograph with the "reproducer" is used as the source of the sounds. In this instrument the roughness of the record makes a rod vibrate, and these vibrations are communicated mechanically to a thin disc of glass or mica, which in turn transmits them to the air on the side of the disc remote from the rod; the aërial disturbances are then conducted by a tube usually to a trumpet, but in this experiment the reinforcement of the sounds is obtained by the combustion of coal-gas and air. The mixed gases are led over the disc of the "reproducer" and conveyed by tubing to two convergent jets and then ignited. A further reinforcement is obtained by placing platinum foil in the flame.—Experiments on lubrication showing cavitation: Mr. S. Skinner. The lubricating fluid in the space, between a bearing and the axle working in it, is subject to conditions in which cavitation, *i.e.* the formation of vacuous spaces in the fluid, can occur. This was shown by a series of experiments, in which the deeply coloured lubricating fluid is contained between glass surfaces, and light is transmitted through the cavities.—(1) Microphone-buzzer (with partially tuned telephone) giving a nearly pure note of 2000 vibrations per second; (2) apparatus used to investigate the distribution of temperature in the field coils of electric machinery; (3) apparatus for rapid electric thermometry: the National Physical Laboratory.—(1) Vibrograph for recording vibrations photographically; (2) micro-manometer: the Cambridge Scientific Instrument Company, Ltd.—Stream gauge for indicating the rate of delivery of air or gas by a pipe: Mr. R. Threlfall, F.R.S.—(1) Stereoscopic views and specimens illustrating the construction of the Simplon Tunnel; (2) stereoscopic and other views of the Victoria Falls of the River Zambesi: Mr. Francis Fox.

Apparatus for the metrical study of stationary electric waves on spiral wires: Prof. J. A. Fleming, F.R.S. The apparatus exhibited consists of a long solenoid of silk-covered wire having 5000 turns and a total length of 643 metres. This solenoid has parallel to it an adjustable earth wire and a divided scale. The solenoid is connected to one point on an oscillatory electric circuit consisting of a couple of Leydens having a capacity of 0·00068 mfd. and an adjustable inductance of 0 to 230 microhenrys and a silent discharger. When oscillations are set up in this circuit by induction coil discharges and the frequency adjusted, stationary electric waves are set up in the solenoid. The position of the loops and nodes is ascertained by the use of a series of carbonic dioxide vacuum tubes.—Edison's secondary battery (or accumulator) for automobiles: Mr. W. Hibbert and Mr. H. E. Dick.—Electrical instruments of precision: Colonel R. E. Crompton, C.B.—Improved muffle and melting furnaces for use in laboratories or art studios: Mr. H. H. Cunynghame, C.B. The plan on which these furnaces are constructed is to jacket them thickly with non-conducting material, in such a way that heat cannot escape as fast as it is developed, until a high temperature has been attained.—Electric resistance furnaces for laboratory use: Mr. Bertram Blount.

Specimens illustrating the action that occurs between metals at a temperature many hundreds of degrees below their melting point: Mr. Sherard Cowper-Coles.—Apparatus for determining the ignition point of gases: Prof. H. B. Dixon, F.R.S., and Mr. G. W. A. Foster.—Specimens of methyl and other derivatives of sulphur, selenium and tellurium: Dr. A. Scott, F.R.S.

(1) A new natural order of plants, the Amphipterygiaceæ, Hemsley and Rose; (2) fruits of *Melocanna bambusoides*, an exalbuminous, viviparous bamboo; (3) *Hydnophytum longifolium* (Rubiaceæ), Fiji Islands; (4) *Dischidia rafflesiana* (Asclepiadaceæ), Malaya; (5) *Aspidium anomalum*, Ceylon: the Director, Royal Botanic Gardens, Kew.—(1) Specimens illustrative of cotton cultivation in British colonies and dependencies; (2) map showing the "cotton belt" and the British and foreign areas in which cotton is now commercially or experimentally cultivated (from Prof. Dunstan's report on cotton cultivation in the British Empire and Egypt); (3) mineral and rock specimens from Ceylon and southern Nigeria; (4) specimens of the seeds of *Hevea brasiliensis* (Para rubber tree) from the Straits Settlements: Prof. Wyndham R. Dunstan, F.R.S., director of the Imperial Institute.—Microscopic slides illustrating nuclear division in cells of malignant growths of man: Prof. J. B. Farmer, F.R.S., Mr. J. E. S. Moore and Mr. C. E. Walker.—Microscopic preparations illustrating the parasitism of the rust fungi or Uredineæ: Prof. H. Marshall Ward, F.R.S.—Microscopical preparations to show the fertilisation and alternation of generations in the Uredineæ: Mr. V. H. Blackman.—Plants and photographs from the High Andes of Bolivia and Peru: Mr. A. W. Hill. —A series of hybrid wheats illustrating Mendel's laws: Mr. R. H. Biffen.

The pearl-oyster fisheries of Ceylon: Prof. W. A. Herdman, F.R.S.—Microscopical preparations and diagrams of the chromatophores of the higher Crustacea: Mr. Frederick Keeble and Mr. F. W. Gamble. The coloration of such Crustacea as *Hippolyte varians* is due to pigments contained in chromatophores. The chromatophores consist of several compartments, in each of which a single pigment is present. When contracted to the centre of the chromatophore, a pigment plays no part in the coloration of the animal; when expanded into the superficial network which communicates with the centre, the pigment takes a share in the coloration.—Ticks and tick-transmitted diseases: Dr. G. H. F. Nuttall, F.R.S. The exhibit included specimens of ticks which transmit several diseases; also specimens of the parasites and figures.—Nematocysts of Æolids: Mr. G. H. Grosvenor.—International North Sea investigations. Results of work during 1903, from the Plymouth and Lowestoft laboratories: the Marine Biological Association.

A photographic study of the English skull, 1600–1850: Prof. Karl Pearson, F.R.S. The photographs of English skulls illustrated normal and abnormal types. There were two series, numbering upwards of 500 altogether, from old plague pits or graveyards in the City of London. Both series were of great interest, and the nearest related group to one of them appears to be long barrow British.—Apparatus and methods employed for measuring, in the

case of human blood, its content in agglutinating substances, bactericidal substances, red blood corpuscles, albuminous substances, calcium salts, and salts generally: Dr. A. E. Wright.—(1) Wax model of the marmoset's brain; (2) sections from which the wax model was constructed: Mr. Gustav Mann.

(1) Colour printed geological maps; (2) geological model of the Isle of Purbeck: the director of the Geological Survey and Museum.—Models illustrative of mountain building: Lord Avebury, F.R.S.—(1) A set of lantern slides of microscopic sections of igneous rocks, &c.; (2) portable sounding machine for mountain lakes: Prof. E. J. Garwood.—Series of geological and other drawings and plans: Prof. J. P. O'Reilly.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—In connection with the approaching international assembly of representatives of academies, it is proposed to confer the degree of Doctor of Science *honoris causa* on Prof. Bakhuyzen, of Leyden; Dr. Faminstyn, of St. Petersburg; Dr. Mojsisovics von Mojsvár, of Vienna; Prof. Retzius, of Stockholm; Prof. Riecke, of Göttingen; and Prof. Waldeyer, of Berlin; and the degree of Doctor of Letters *honoris causa* on Count de Franqueville, of Paris; Prof. Goldziher, of Budapest; Prof. Gomperz, of Vienna; Prof. Krumbacher, of Munich; Prof. Leroy-Beaulieu, of Paris; and Dr. Perrot, of Paris.

Mr. W. J. Sell, F.R.S., and Mr. H. J. H. Fenton, F.R.S., are to be appointed university lecturers in chemistry, and Mr. A. Harker, F.R.S., a university lecturer in petrology.

THE Senate of the Royal University of Ireland has resolved to confer, *honoris causa*, the degree of Doctor of Science on Sir William Crookes and on Prof. J. Dewar.

Science states that the New York University has received an anonymous gift of 2500*l.* for the Medical College, and that the American Geographical Society has received a bequest of 6000*l.* from Sarah M. de Vaugrigneuse.

IN a paper on "Local Expenditure and Local Indebtedness in England and Wales," read by Mr. R. J. Thompson at the Royal Statistical Society on Tuesday, it was stated that education showed an increase of expenditure from 4,806,000*l.* in 1889 to a sum of nearly 11,000,000*l.* in 1902. The cost of erecting school buildings had during the same time—1889 onwards—augmented the outstanding loans from 9,937,000*l.* to 33,564,000*l.* London incurred 29 per cent. of the total expenditure, while it contributed only one-fifth of the total number of pupils.

THE inauguration on February 10 of an information bureau in connection with the University of Paris is an excellent innovation. The bureau will afford information on all matters connected with higher education in Paris, whether in Government or private institutions. Those who in this country are contemplating entering a university, and who have spent hours in trying to derive some tangible ideas from calendars and class syllabuses, will appreciate the useful purpose which would be served by a bureau of this character. If such a bureau would go a little further, and furnish to candidates for chairs and lectureships some idea of the duties they would have to perform, its value will be still greater.

THE President of the Board of Education, the Marquess of Londonderry, K.G., has appointed a departmental committee to inquire into the present working of the Royal College of Science, including the School of Mines, to consider in what manner the staff, together with the buildings and appliances now in occupation or in course of construction, may be utilised to the fullest extent for the promotion of higher scientific studies in connection with the work of existing or projected institutions for instruction of the same character in the metropolis or elsewhere, and to report on any changes which may be desirable in order to carry out such recommendations as they may make. Sir Francis Mowatt, G.C.B., is chairman of the committee, and Mr. J. C. G. Sykes, assistant secretary in the branch of the board which deals with evening schools, technology, and higher education in science and art, has been appointed secretary to the committee. The London County Council is represented on the committee.

A DEPUTATION consisting of representatives of various county councils was received by Sir William Anson on May 13 with reference to the abrogation of the arrangements which were in vogue under what was known as Clause 7 of the Directory of the Science and Art Department. The deputation explained that county councils had hoped when the Education Act became law that it would be recognised more fully than before that these councils were the authorities for all grades of education, including particularly higher education. But the new regulations taking the place of Clause 7 have reduced their powers, and county councils are hampered in the performance of the duties expected of them. In reply, Sir William Anson explained that Clause 7 was an attempt to bring local authorities into relations with the efforts being made to give science and art and technical teaching, assisted by the Board of Education, and limited in the first instance to institutions of a very different character from ordinary secondary schools. Local authorities are now in a position to deal with the whole of secondary education, and not merely with the subject-matter which was contemplated in Regulation 7. Sir William Anson, in conclusion, asked the deputation to consider the wider question which they should have in view in dealing with secondary education, and not merely from the point of view of exercising their own authority and the speedy transaction of their own business. What he deprecated was that at that early stage in the working of the Act, the Board of Education should be asked to stereotype the relations of local authorities for the secondary schools within their area.

AT the annual conversazione of the Medical Society of London on Monday, Sir Isambard Owen delivered the annual oration, taking for his subject "The Future of London Medical Education." After contrasting the interest displayed by Continental States in scientific research and public education with the indifference evinced towards them by the generality of Englishmen, and pointing out that this indifference could only be a passing phase, due to patent historical causes, he expressed the hope that the reports of the Mosely Commissioners, with their marvellous tale of recent educational progress in America and the fabulous amounts of public and private money freely lavished upon it, would at last awaken attention here to the backward state of things at the heart of the British Empire. Of all forms of higher education, he submitted, none could lay greater claim to public support than medical education. The unendowed London schools had still to carry the entire burden of the preliminary academic training of their students—a task which elsewhere was now undertaken by endowed universities and university colleges. Until the reconstitution of the University of London, no practicable way out of the difficulty could be seen. Sir Isambard Owen then detailed the plan which the university had adopted of establishing a public institute within its bounds and under its direct control to undertake teaching in physics, chemistry, biology, anatomy, and physiology for the purposes of medical students. Including buildings, the institute would cost about 375,000*l.* to establish. As the State declined all responsibility for professional education in England, the university could only look to enlightened private liberality. Wealthy men in London capable of being fired by emulation of Transatlantic gifts to education should make this modest benefaction their peculiar care.

SOCIETIES AND ACADEMIES.

LONDON.

Anthropological Institute, April 26.—Sir Thomas Holdich, K.C.M.G., &c., in the chair.—Prof. W. **Ridgeway** delivered a lecture on the origin of jewellery. Prof. Ridgeway holds that the objects employed in modern jewellery had their origin in magical properties attributed to them and not in æsthetic, although the æsthetic reason for wearing them undoubtedly influenced the wearers at an early stage (see NATURE, October 29, 1903, vol. lxviii. p. 636).

Challenger Society, April 27.—Sir John Murray in the chair.—Prof. **Minchin** exhibited specimens of the new sporozoan, *Lymphocystis johnstoni*.—Mr. E. T. **Browne** showed Medusæ from Valencia.—Dr. G. H. **Fowler** explained some graphic diagrams of the distribution of Biscayan Chætognatha, and announced that he had detected *Krohnia hamata* among specimens obtained at the Falkland Islands by Mr. Vallentin within six fathoms from the surface.—Mr. V. H. **Blackman** read a paper on the metabolism of the ocean, dealing with the close analogy between the circulation of nitrogen on land and that in the sea; this was followed by an interesting discussion.—Mr. G. P. **Farran** described the copepods of the north-east Atlantic slope; of these rather less than half present a wide and often tropical distribution, occurring also in the Indian or Pacific Oceans. The remainder are only known as Atlantic or Atlanto-Mediterranean species, many being bottom haunting forms, the recorded range of which is likely to be extended. About 12 per cent. of the total copepod fauna extends north to the Arctic regions.

British Academy, April 27.—Lord Reay, president, in the chair.—Prof. I. **Gollancz** read a paper on Shakespeariana, 1598–1602. A theory was put forward explanatory of Shakespeare's use of the name Polonius for the counsellor of the King of Denmark in place of Corambis, or Corambus, found in the first quarto, evidently the name of the character in the old play, which belonged to about the year 1587. Corambus, being discarded by Shakespeare, was used by him as a passing name in the play of "All's Well."

Physical Society, May 6.—Mr. J. Swinburne, vice-president, in the chair.—Some instruments for the measurement of large and small alternating currents: W. **Duddell.** The author, after some preliminary remarks on the available means for measuring alternating currents, proceeded to describe three thermal instruments which he has constructed for this purpose. The first instrument is essentially a sensitive Ayrton-Perry twisted strip ammeter which is very quick in action for a thermal instrument, and has been used for observing and recording P.D.'s and currents which varied as rapidly as one per second. The second instrument exhibited was a very sensitive thermal galvanometer called in the paper a "thermogalvanometer." It consists of the combination of a radio-micrometer of the "Boys" type with a very small resistance which is heated by the current to be measured, and in turn heats the thermo-junction of the radio-micrometer by radiation and convection. The third instrument described was a switchboard instrument which works on the same principle as the last.—Mr. F. E. **Smith** exhibited and described the following instruments from the National Physical Laboratory:—(1) a mercury-resistance standard; (2) a 10-ohm build-up resistance-box; (3) an astatic galvanometer.

Mathematical Society, May 12.—Dr. E. W. Hobson, vice-president, in the chair.—The following papers were communicated:—On the evaluation of certain definite integrals by means of Gamma functions, and generalisations of Legendre's formula $KE'-(K-E)K'=\frac{1}{2}\pi$: A. L. **Dixon.** It has been shown by E. B. Elliott that Legendre's relation may be regarded as a particular case of a relation by which a certain sum of products of what are really hypergeometric functions can be expressed in terms of Gamma functions. In the Weierstrassian form of Legendre's relation, a certain determinant of the second order having elliptic integrals as its elements is shown to be a constant. In the generalisation the determinant is of order higher than the second, the elements are hyperelliptic integrals, and the constant is expressed as a product of Gamma functions. The ratio of two such determinants, of suitable orders, is expressed in a similar form. Weierstrass's relations between hyperelliptic integrals of the first and second kinds are deduced. The results are extended to include a certain class of integrals which are not integrals of algebraic functions.—Perpetuant syzygies: A. **Young** and P. W. **Wood.** The perpetuants considered are linear in the coefficients of each quantic concerned, that is to say, they are "perpetuant types." All possible products of irreducible forms of a given degree and weight are arranged in a predetermined sequence so that any product may be identified by its place in the sequence. A syzygy expresses one of the products that enters into it, viz. the one that comes earliest in the sequence, in terms of others which come later in the sequence. In consequence of the existence of the syzygy this earliest product is "reducible." It is possible to enumerate the actually irreducible forms for degree δ by means of a generating function. When the irreducible products have been identified for any degree, all the independent syzygies of this degree will have been identified, there being one such syzygy for each reducible product of irreducible forms. The work can be completed as far as degree 8, but a large class of products have been discussed in general. A generating function for all irreducible products and types of degree δ is suggested in the form

$$\frac{x^{\binom{\delta}{1}+\binom{\delta}{2}+\ldots+\binom{\delta}{\kappa}}}{(1-x)^{\delta-1}}$$

and this form is proved to hold for $\kappa=1$, $\kappa=2$ and $\kappa\geqslant\frac{1}{3}\delta$.—Note on the integration of linear differential equations: Dr. H. F. **Baker.**—Some properties of the function Γ_p: **Rev.** F. H. **Jackson.**—Informal communications were made as follows:—On the geometrical representation of imaginaries: G. B. **Mathews.**—A collation of Kessler's and Hertzer's tables of the residue-index (ν) of 10 (mod p) with Shanks's table of the Haupt exponent (ξ) of 10 (mod p): Lieut.-Colonel A. **Cunningham.** The numbers ν and ξ are defined by the congruence $10^{\xi}\equiv 1 \pmod{p=\nu\xi+1}$. Twenty-nine errors were found in Kessler's table, 3 in Hertzer's, 107 in Shanks's.

CAMBRIDGE.

Philosophical Society, May 2.—Dr. Baker, president, in the chair.—Early development of the unfertilised egg of the sawfly *Nematus ribesii*: L. **Doncaster.** In the unfertilised egg the two maturation divisions give rise to four nuclei, the outer two of which are the halves of the first polar body, the third is the second polar nucleus, and the innermost the egg-nucleus. The second polar nucleus unites with the inner half of the first, giving the "copulation nucleus." This divides into two groups of chromosomes, which persist without important change until the blastoderm begins to form, beyond which stage their fate has not yet been followed. The egg-nucleus soon begins to divide, and gives rise to the embryo, the chromosomes remaining at the reduced number. The outer nucleus of the first polar body rapidly disappears. These results are very similar to those obtained by Petrunkewitsch in the bee, where, as in this case, virgin eggs produce males, and fertilised eggs females. It was pointed out that a comparative study of the development of sawflies which produce males and females respectively from virgin eggs would provide a test of Castle's hypothesis of sex-determination.—Metallic "passivity" in relation to time and temperature: Dr. W. A. **Hollis.**—(1) On partial fractions; (2) note on plane unicursal curves; (3) on the order of certain systems of conditions: Dr. A. C. **Dixon.**

PARIS.

Academy of Sciences, May 9.—M. Mascart in the chair.—The president announced to the academy the death of M. Duclaux, member of the section of rural economy, and gave a short account of his life work.—Remarks on the use of alternating currents in chemistry and on the theory of reactions which they set up: M. **Berthelot.** Remarks on the recent work of MM. Brochet and Petit concerning the solution of platinum in a solution of potassium cyanide by the action of an alternating current. The author directs attention to a similar reaction with glucose studied by him in 1879. The bearing of these experiments on the action of the silent discharge is also discussed.—The cooling power of a feebly conducting liquid current on an indefinite cylinder, the axis of which is normal to the current: J. **Boussinesq.**—On a new method of preparation of alkyl and alkylidene derivatives of cyclic ketones. The application to the preparation of alkyl-menthones: A. **Haller.** By treating certain cyclic ketones, such as menthone, with sodium, the corresponding alcohol is formed besides the sodium derivative, and in preparing alkyl derivatives this leads to undesirable secondary products. The formation of the alcohol is avoided if sodium amide is used instead of sodium, and the

alkyl iodide can be added directly to the reaction product. The physical properties of several homologues of menthone which have been prepared in this way are described.—An arrangement allowing identical results to be obtained with X-ray tubes on different occasions: M. **d'Arsonval.** The current passing through the tube is measured by means of a milliammeter of the d'Arsonval type. For a tube with a given vacuum, the amount of X-rays given off, as measured by their photographic effect, is proportional to the intensity of the current passing through the tube, and this appears to be true of various makes of tube.—M. Barrois was elected a member in the section of mineralogy in the place of the late M. Fouqué.—Observations of the Brooks comet (1904 *a*) made at the Observatory of Algiers with the 31·8 cm. bent equatorial: MM. **Rambaud** and **Sy.**—The linear *connexe* in space of $n-1$ dimensions: Léon **Autonne.**—On the radio-activity of gases given off from the water of thermal springs: P. **Curie** and A. **Laborde.** The radio-activity of samples of gas from various mineral waters was measured and its rate of decay determined, the results being compared with the radio-activity of air which had been in contact with a known amount of radium bromide. The radio-activity was in all cases very small, and it hardly appears possible to draw any conclusion as to the action the radio-activity may play in the physiological actions of mineral waters.—On the melting point of gold: Daniel **Berthelot.** It is pointed out that all the recent values for the melting point of gold fall between 1064° and 1067°.—On the fixity of the solar rays: Maurice **Hamy.** The author has previously shown that there is a slight variation in the wave-length of the λ 508 cadmium ray according as a tube with or without electrodes is employed. Since the physical conditions in the sun are liable to considerable variation at times, the question is raised as to how far the solar lines can be regarded as possessing absolutely fixed wave-lengths.—The proof of a radio-activity induced on all bodies by the emanation from incandescent metallic wires: Th. **Tommasina.**—The action of anæsthetics on the sources of the *n*-rays: Jean **Becquerel.**—On some points of technique for the examination of organs by means of the *n*-rays. First results relating to a study of the brain: André **Broca.**—On the mode of propagation of nervous oscillations: Augustin **Charpentier.**—Electrical osmosis in methyl alcohol: A. **Baudouin.**—On the atomic weight of samarium: G. **Urbain** and H. **Lacombe.** The samarium salts were obtained from three different sources, and atomic weight determinations of the various fractions, together with the spectroscopical examination, showed that the oxide was homogeneous. The final value for the atomic weight of samarium (O=16) is 150·34.—The formation of hydrogen silicide by direct synthesis from its elements: Ém. **Vigouroux.** Remarks on a recent paper by M. Dufour on the same subject.—The apparent volatilisation of silicon in hydrogen: A. **Dufour.** In Geissler tubes filled with hydrogen arsenide, the arsenic deposited by the discharge is displaced by distillation pure and simple; in tubes filled with hydrogen silicide, the displacement of the silicon under similar conditions is explained by the formation of hydrogen silicide in the warm parts of the tube and its decomposition in the dark space.—On a property of tin-aluminium alloys: Hector **Pécheux.**—The differentiation of the primary, secondary and tertiary alcohols of the fatty series: André **Kling** and Marcel **Viard.** The method adopted is based on the fact that tertiary alcohols are decomposed at the temperature of boiling naphthaline, whilst at the temperature of boiling anthracene only primary alcohols resist decomposition. The vapour density of the alcohol under examination is taken in a Victor Meyer apparatus with the above two liquids as vapour jackets, the deviation from the theoretical density showing to which class the alcohol belongs. About 250 determinations have been made by this method, a summary of which is given.—On the formation of the chloroanilines: Eyvind **Bœdtker.**—On the saponifying power of the castor oil seed: Maurice **Nicloux.**—On the structure of the heart in Cephalopods: F. **Marceau.**—The resistance of certain seeds to the action of absolute alcohol: Paul **Becquerel.** The tegument of the moist grain allowing of osmosis is permeable to absolute alcohol, but when dried to a certain extent, osmosis no longer takes place, and the skin is now absolutely impermeable to alcohol.

DIARY OF SOCIETIES.

THURSDAY, MAY 19.

ROYAL SOCIETY, at 4.30.—The Bakerian Lecture will be delivered by Prof. E. Rutherford, F.R.S., on the Succession of Changes in Radio-active Bodies.—The following papers will be read in title:—The Spectrum of the Emanation of Radium: Sir William Ramsay, K.C.B., F.R.S.—On Saturated Solutions: Earl of Berkeley.—On the Liquefied Hydrides of Phosphorus, Sulphur, and the Halogens, as Conducting Solvents. Part i.: B. D. Steele and D. McIntosh.—On the Liquefied Hydrides of Phosphorus, Sulphur, and the Halogens, as Conducting Solvents. Part ii.: D. McIntosh and E. H. Archibald.—On the General Theory of Integration: Dr. W. H. Young.

INSTITUTION OF MINING AND METALLURGY, at 8.—Miners' Phthisis—its Causes and Prevention: Dr. J. S. Haldane and R. A. Thomas.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Discussion on Messrs. Parsons, Stoney and Martin's paper, entitled The Steam Turbine as applied to Electrical Engineering.

FRIDAY, MAY 20.

ROYAL INSTITUTION, at 9.—The Radiation and Emanation from Radium: Prof. E. Rutherford, F.R.S.

TUESDAY, MAY 24.

ROYAL INSTITUTION, at 5.—The Solar Corona: H. F. Newall, F.R.S.

LINNEAN SOCIETY, at 8.—Anniversary Meeting.

WEDNESDAY, MAY 25.

GEOLOGICAL SOCIETY, at 8.—Occurrence of a Limestone with Upper Gault Fossils at Barnwell, near Cambridge: W. G. Fearnsides.—Age of the Llyn-Padarn Dykes: J. V. Elsden.

VICTORIA INSTITUTE, at 4.30.—The Tanganyika Problem: W. H. Hudleston, F.R.S.

THURSDAY, MAY 26.

ROYAL INSTITUTION, at 5.—Literature and the State: H. G. Wells.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Annual General Meeting.

FRIDAY, MAY 27.

ROYAL INSTITUTION, at 9.—The Progress of Oceanography: H.S.H. Albert Prince of Monaco.

PHYSICAL SOCIETY, at 5.—The Law of Action between Magnets and its bearing on the Determination of the Horizontal Component of the Earth's Magnetic Field with Unifilar Magnetometers: Dr. C. Chree, F.R.S.—On the Ascertained Absence of Effects of Motion through the Ether in Relation to the Constitution of Matter on the FitzGerald-Lorentz Hypothesis: Prof. J. Larmor, Sec.R.S.—On Coherence and Recoherence: Dr. P. E. Shaw and C. A. B. Garrett.

SATURDAY, MAY 28.

ROYAL INSTITUTION, at 3.—Spitsbergen in the 17th Century: Sir W. Martin Conway.

CONTENTS.