THURSDAY, MARCH 14, 1907.

MODERN MOTOR VEHICLES.

Motor Vehicles and Motors: their Design, Construction and Working by Steam, Oil and Electricity. By W. Worby Beaumont. Vol. ii. Pp. xvi+677. (London: Archibald Constable and Co., Ltd., 1906.) Price 42*s.* net.

WHEN we reviewed the first volume of this work on the motor vehicle, we pointed out how difficult it is adequately to review encyclopædic matter, which in this instance occupies 660 pages of letterpress, accompanied by upwards of 400 illustrations. Mr. Beaumont has, in this second volume, supplied many of the omissions and corrected some of the mistakes which existed in his first volume, so that now the two volumes, taken together, form a valuable work of reference, not only for the general public interested in the motor movement, but of considerable value to professional engineers.

In this second instalment, after a short introduction pointing out the rapid development of motor engineering during the last two years, Mr. Beaumont devotes the first half of the work to descriptive matter dealing with motor vehicles of all kinds, commencing with the lighter motor-cars and going on to the heavier vehicles and electrically-propelled cars. We do not propose to say much on this portion of the book. No doubt those who are interested in any particular make of car will turn to the description of that car, but to the general reader the whole of this portion of the work savours of a dealers' catalogue, and is somewhat wearisome to read. The few pages dealing with modern American vehicles show that these vehicles are interesting, as they depart rather more widely from the conventional types than is the case with the Continental and British-made cars.

With chapter xxi. the really interesting part of the book commences. In this and the following chapters the author summarises the advances that have been made in the design and in the various components which are now accepted as the necessary features of a petrol-driven vehicle. In chapter xxiii. he gives us in a compendious form his methods of computing the h.p absorbed in propelling motor vehicles, but we notice that on p. 349 he repeats the coefficient for air resistance which he originally gave on p. 49 of the first volume, namely, that the total air resistance of a vehicle varies as the velocity squared in miles per hour multiplied by the exposed cross-section of the car, multiplied by the coefficient 0·0017. It must be noted that this coefficient is only about two-thirds of the value of that which was obtained after careful experimental work at the National Physical Laboratory by Dr. Stanton as that of flat-fronted solid bodies moving through columns of air the cross-section of which is very large in relation to the solid body that moves through them. We think that although Mr. Beaumont explains this low figure by the fact that it works in very fairly with his computations as to the actual h.p. exerted by cars of all classes, both in hill-climbing competitions and on speed trials up to 60 miles an hour, it must be admitted that far more accurate experimental measurements must be made to ascertain whether this extremely low figure of 0·0017 has ever been approached by any form of solid moving through a column of air even in cases where great attention has been paid to the form of the solid, especially to the stern lines, to use nautical nomenclature. It appears probable, therefore, that the table vi. on p. 350 is likely to need considerable correction.

The author in chapter xxiv. gives us very valuable and interesting notes on the influence of the vibration and even turning effort of the propelling engine on the stability of the car when it is driven rapidly round sharp bends of the road. We think that in this chapter he is substantially correct in his views, and the matter is of great importance, and has hitherto not received sufficient attention from the designers of these vehicles.

With chapter xxv. he commences his descriptions of the heavier class of modern self-propelled vehicles applied to commercial purposes, such as the carriage of goods, omnibuses, and other public-service passenger vehicles. This part of the descriptive matter is very full, but from the nature of the subject is incomplete, as in no branch of the industry have there recently occurred such great changes, and these changes are likely to continue to occur as the type of public-service vehicle is yet very far from perfect, and is likely to be greatly modified in the immediate future; in fact, it is not too much to say that most of the vehicles described in chapters xxv. to xxviii. will be obsolete in a few years' time, particularly when we consider the extraordinary results which are now expected from the adaptation to these vehicles of highly superheated steam produced in flash or semi-flash boilers, for although in chapters xxix. to xxxi. the author gives descriptions of the various forms of steam-driven cars made by Serpollet, White, Turner-Miesse and Clarkson, and others, these really relate to the smaller class of pleasure car, and not to the public-service vehicle.

Chapter xxxii., which deals with the highly important and dangerous question of the skidding of self-propelled vehicles on our greasy streets, is disappointing, as the author gives no indication of the direction in which improvement is to be expected. He does not even touch on the highly interesting matter of how much depends on the skill of the drivers and of the power rapidly acquired by them of controlling the side-slip or skidding by a certain rapidity of action and correlation of hand and eye correcting the tendency to skid at the earliest stage, long before the brain has had time to consider the matter and to apply a corrective effort.

The chapter devoted to carburetters is interesting, as it shows that much ingenuity has been applied to this most important organ of the internal combustion engine, yet little or nothing has been done on the question of the day, namely, the utilisation of the heavier oils for these engines. Until this is done

everyone who uses the petrol-driven motor-car is at the mercy of the kings of oil finance, who at present are masters of the situation.

Another important matter, that of electrical motor vehicles, is dismissed in a single chapter, although, on account of the recent reductions in the cost of electrical energy, the prospects of this class of vehicle are increasingly good.

In the chapter devoted to the consideration of the efficiency of transmission gear, the matter is dealt with in an ingenious manner, and it is probable that the rough-and-ready method adopted by the author of calculating the transmission losses is within a narrow percentage of being correct. The objects of the tourist trophy race initiated by the Automobile Club are clearly explained, and the cars taking part in the first of these races are tabulated and their performances usefully compared.

Altogether, the author, in this second volume, has been very reasonably successful in dealing with the difficult task of getting together sufficient descriptive matter to satisfy any reasonable inquirer, and has made his matter as short as was possible, considering that he has been compelled to describe a mass of vehicles the bulk of which resemble one another very closely, as most of the designers have copied the main features of two or three Continental models, and only vary in certain details or special methods of cheapening or facilitating manufacture.

THE SOLAR RESEARCH UNION.

Transactions of the International Union for Co-operation in Solar Research. Vol. i. (First and Second Conferences.) Pp. 257. (Manchester: University Press, 1906.) Price 7*s.* 6*d.* net.

IN a previous number of this Journal a brief summary was given of the proceedings of this International Union at its second conference, held at Oxford in September, 1905. The volume before us gives a complete historical account of the union from its origin in 1904 up to the end of the work completed at the Oxford meeting, and its appearance is due to the energy of the chairman, Prof. Schuster, who has brought all this useful material under one cover.

The subject is dealt with under seven heads. The first shows that the origin of this union was due to Prof. George E. Hale, who issued a circular letter to a number of men of science interested in solar physics. The receipt of favourable answers led him to approach various societies and academies, with the result that a meeting was arranged and held in connection with the International Congress of Science at the St. Louis Exhibition.

Part ii. deals with the proceedings of the first conference, which took place in September, 1904, and is followed by part iii., which contains *in extenso* the papers submitted to the conference. They include introductory remarks by Prof. Hale on the importance of international cooperation in solar research, and valuable reports by Henry Crew, A. Pérot, C. Fabry, H. Kayser, and Lewis Jewell on the importance of establishing a new system of standard wave-lengths.

In part iv. we are made acquainted with the preparations for the second conference. A portion of this consisted in sending out circular letters to members of the union and others, relative to such subjects as the fixing of standards of wave-length, measurement of the intensity of solar radiation, work done with the spectroheliograph, and the spectra of sun-spots. In response to these, numerous valuable replies were received, and these are all included in the volume.

At the Oxford conference some important papers were communicated (part vi.), among which may be mentioned the compensating pyrheliometer, by K. Ångström. At this conference the constitution of the union also was discussed, and we have in this volume (part viii.) the text in English, French, and German of the constitution as finally adopted, and the resolutions, also in the three languages, concerning the various important questions discussed.

An important result of the Oxford conference was the appointment of committees to take in hand the work of preparation and organisation of investigations which have not yet been collected and co-ordinated.

In connection with these, the present volume contains a very valuable memoir, drawn up by Prof. Fowler, on the observations of the spectra of sun-spots in the region *b* to E (part vii.). This paper brings together in a very admirable manner the main features of the spectrum-analysis of sun-spots, and will serve as a valuable guide to those observers who take up this part of solar physics.

The next meeting of the union will take place at Meudon in May of the present year. There is every probability, therefore, that a second volume of these transactions will make its appearance during the next twelve months.

AGRICULTURAL ANALYSIS.

The Principles and Practice of Agricultural Analysis. By Dr. H. W. Wiley. Vol. i. Soils. Second edition, revised and enlarged. Pp. xii+636. (Easton, Pa.: Chemical Publishing Co.; London: Williams and Norgate.) Price 18*s.* net.

DR. WILEY'S treatise on agricultural analysis has long been the chief resource of every worker in that domain, because it contained not merely the particular method in vogue, but to a large degree all the methods that had been proposed or were in use in either American or Continental laboratories, very often in the words of the original. This did not make the book easy to use by the tyro, for Dr. Wiley rarely attempted any criticism or recommended one method beyond another, but the collection was extremely useful to the investigator, and saved him much labour in trying over things which had been tested before. The gain is particularly apparent in dealing with soils, the subject of the present volume, for the analysis of a soil is not like that of a manure, where there is a definite element or elements to be

determined and a result in sight the correctness of which is only limited by the imperfections of the method. Instead, the methods are often conventional, depending upon such factors as the method of preparing the sample or the solvent employed, or they may be determinations like the absorptive power of the soil for water, which have no absolute meaning at all, but are merely attempts in the laboratory to get a number which shall represent the behaviour of the soil in the field. With regard to so many of these determinations of a physical nature the difficulty lies, not in carrying out the process, but in interpreting it afterwards, and correlating it with some practical aspect of the soil. The present volume of Dr. Wiley's book becomes, in consequence, something more than a collection of analytical methods; it is in many respects a treatise on soil chemistry and soil physics, so full are the introductory discussions dealing with each of the various means of investigating the soil, and as such it is indispensable to all serious students of agricultural chemistry.

Dr. Wiley has cut out some of the matter of the earlier edition, though retaining processes which have a historical interest or are necessary in tracing the development of the more modern method; he has further incorporated methods and investigations which have been published in the twelve years that have elapsed since the appearance of the first edition. The present volume is dated October, 1906; we miss, however, one or two methods which appeared before that date, *e.g.* Mitscherlich's interesting determination of the heat evolved when a soil is moistened (benetzungwärme), which is correlated with the active surface of the soil particles. In one or two other respects also we think later work might have modified some of the conclusions expressed, but of course the subject is in a constant state of progress, and the time occupied in writing a book of this magnitude is sufficient to bring about a revision of some of the points of view. We notice, indeed, but scant reference to the more recent developments in soil investigation which have issued from the Division of Soils in the United States Department of Agriculture; perhaps we may take this negative attitude of Dr. Wiley's as a critical one.

In conclusion, we can only express our thanks for what must always be one of the most useful books in the library of any agricultural laboratory.

A. D. H.

OUR BOOK SHELF.

Introduction to the Theory of Fourier's Series and Integrals and the Mathematical Theory of the Conduction of Heat. By H. S. Carslaw. Pp. xvii+434. (London: Macmillan and Co., Ltd.) Price 14*s.* net.

THIS book is an interesting sign of the times. The gulf between pure and applied mathematics, in this country at any rate, has of recent years become more and more complete. Indeed there is no one who so heartily detests and despises mathematics proper as the ordinary physicist. He is often compelled to use elaborate mathematical analysis, but he does not feel or profess any interest in anything but the result, and questions as to the mathematical basis of his arguments seem to him merely trifling and vexatious.

Prof. Carslaw has therefore shown a good deal of courage in offering to English readers a book on the theory of conduction of heat which includes a serious account of the mathematical difficulties of the theory and may expose him to unsympathetic criticism from different points of view which have little in common. However, the experiment is a distinct success, and it is to be hoped that it will lead to similar and equally successful experiments with other and more difficult branches of mathematical physics.

The book is divided into two parts. Part i. is entirely mathematical, and it is this part which contains most that is novel in an English book and is, therefore, most interesting to the critic. A short but well-written historical introduction is an attractive feature. In the first two chapters, which deal with irrational numbers and infinite sequences in general, the author mostly follows Dedekind and Tannery, and he could not have chosen better guides. The chapters on uniform convergence are also good, though here the arrangement and method of presentation do not seem to us in every respect the best. The author, we are glad to see, speaks of "*infinite* definite integrals," and discards the barbarous "improper." He might perhaps have brought out more clearly the fact that the infinite integral is essentially a repeated limit—as it is, he rather exaggerates the analogy between the integral and the infinite series; and it is a pity that he should have omitted to prove the fundamental inversion theorems for finite integrals. But the chapters dealing especially with Fourier's series seem to us the best; we are particularly glad to see Fejér's theorem included. Part ii. contains a clear account of the principal problems of conduction, and requires no special comment here.

This book shows very clearly how much of the Continental spirit of rigour English mathematics has absorbed in recent years. It also shows how much the heaviness of the Continental δ and ϵ can be lightened by a bright and attractive style, interesting illustrations, numerous examples, and other touches of the Cambridge tradition.

G. H. H.

Museu Paraense de Historia e Ethnographia: Arboretum Amazonicum. By Dr. J. Huber. Pp. 40; with 40 plates. Decades i. to iv. (Para, 1900 and 1906.)

FOR a development of moist equatorial vegetation no region surpasses that bordering the Amazon and its tributaries, which Dr. Huber, in the course of his long association with Para, has had unique opportunities of visiting. The form in which Dr. Huber presents his information is similar to the "Vegetationsbilder," where the illustrations are the chief feature and the notes are explanatory thereto, but it should be stated that the first two parts of the "Arboretum Amazonicum" were issued in 1900, previous to the first numbers of the "Vegetationsbilder." Two additional parts appeared last year, and it is proposed to complete the work in ten numbers. The publication of the work has been undertaken by the Polygraphisches Institut of Zürich, and the photogravures afford a criterion of the excellence of their work.

Palms generally rank among the most important tropical plants, and along the Amazon and its tributaries, especially near the embouchure, they form such prominent objects in the landscape that all voyagers make special mention of their luxuriance and variety. Dr. Huber devotes a number of plates to different species. *Phytelephas microcarpa*, that yields vegetable ivory, the Tucuma and Mumbaca palms, both species of Astrocaryum, the Javary, another species of the same genus, bearing spines on the young trunks, and the Bussu, *Manicaria saccifera*, producing huge, almost entire, leaves, are illustrated in the first two parts. No less interesting are *Cocos inajas*, with pinnæ arranged in bundles on the leaves, the Baccaba or wine-palm, *Oenocarpus distichus*, remarkable for the distichous arrangement of the leaves, and the Urucury, *Attalea excelsa*, which provides the *Seringueiro*, or rubber collector, with nuts used in smoking the rubber. Of trees other than palms, the famous Para rubber tree, *Hevea brasiliensis*, *Dipteryx odorata*, the source of the Tonca bean of commerce, *Bertholletic excelsa*, the superb tree yielding brazil-nuts, and the magnificent *Caryocar villosum* are selected for representation.

Dr. Huber has also chosen some illustrations of typical plant formations, including the littoral vegetation on the river Couany, where the Aninga, *Montrichardia aborescens*, is growing on the shore; scenes from some of the tidal creeks or channels known as "igarapés"; plant formations occurring in inundated localities, showing in one case a fine development of *Ipomoea fistulosa*, in another a wide expanse of *Panicum amplexicaule*; and a view of an Indian plantation with manioc and sugar-cane in the foreground, and the characteristic Imbauba, *Cecropia peltata*, beyond.

The illustrations are admirable, owing to the care that has been exercised in selecting fine specimens and suitable situations from which the characteristic features of the plants can be brought into the photographs.

Cams, and the Principles of their Construction. By George Jepson. Pp. 60. (New York: D. van Nostrand Co.) Price 8*s.* net.

In this work examples are given of the design of cams of various types, including cylindrical, conical, face, and spherical cams, and of different degrees of complexity, from the simple heart-shaped cam employed in winding bobbins to the writing cam with the differential motions of paper and style. The illustrative drawings are accurately and beautifully executed, the construction lines being printed in red ink for the sake of extra clearness. It is shown how to design the profile of a cam so as to give a simple harmonic motion or a uniform acceleration and retardation to the follower, thereby effecting a change of position of the latter with a minimum wear and tear. The book is a welcome addition to the somewhat scanty literature on the subject.

Rivetage. By M. Fricker. Pp. 168. (Paris: Gauthier-Villars and Masson et Cie., n.d.)

This little volume belongs to the "Encyclopédie scientifique des Aide-mémoire" series, to which attention has often been directed in these columns. It is divided into two parts; the first passes in review the rules—for the most part empirical—which are adopted in determining the dimensions of rivets and in riveting generally, and the second describes the methods which are employed in the actual processes of riveting.

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.]*

A New Mud-Volcano Island.

Admiral Field's letter in Nature of February 28, embodying Commander Beauchamp's description of a new island recently discovered by him about nine miles north-west of Cheduba (not Chebuda) Island, off the coast of Arakan, leaves no room for doubt that the island in question was due to the eruption of a submarine mud volcano.

Ramri and Cheduba, together with the adjacent subordinate islands, are composed mainly of shale and sandstone (probably of Tertiary age), containing some coal, and also very considerable quantities of petroleum, accompanied by inflammable gas. There is evidence of a certain degree of abnormal subterranean heat, although such is far lower than that associated with true volcanoes, which do not exist, nor have any volcanic rocks been observed. Mud volcanoes are fairly numerous, which, besides emissions of a quieter character, are subject, at uncertain intervals, to violent paroxysmal eruptions. At such times mud and stones are shot out with great force and noise, accompanied by large quantities of inflammable gas, which in many cases catches fire, and gives rise to a volume of flame that lights up the country for miles around. There are numerous well-authenticated descriptions of such occurrences, more than one of which were submarine. The stones ejected are all derived from the stratified rocks mentioned above, the shales furnishing the source of the mud. Electric sparks, produced by the friction of the ejecta amongst themselves, probably cause the ignition of the gas. Some of the recorded paroxysms were synchronous with earthquakes.

A somewhat detailed account of the mud volcanoes may be found in the "Records of the Geological Survey of India," vol. xi. (1878), pp. 188–207, and descriptions of several later eruptions in subsequent volumes.

Ealing. F. R. Mallet.

A New Chemical Test for Strength in Wheat.

The principle of the test for strength in wheat flour described as new by Mr. T. B. Wood in a recent issue of Nature (February 21), and further claimed by Dr. E. Frankland Armstrong (Nature, March 7) as having been in regular use in his laboratory during the past year, was employed by me more than four years ago, and still forms an important factor in my physicochemical method of gauging the baking qualities of wheat flour.

I can fully corroborate Mr. Wood's opinion that no single factor is capable of measuring the strength value of wheat, and Dr. Armstrong's statement that the problem is one in which no small number of variables must be dealt with.

In 1905 Mr. A. E. Humphries supplied me with five samples as tests of the accuracy of my system as then elaborated. I was, however, not successful; but, on receiving Mr. Humphries' views of their baking qualities, the cause of my failure was at once apparent. When investigating the relation of chemical composition to baking qualities, I had relied for the latter data upon loaves baked in tins, whilst Mr. Humphries based his opinions upon self-supporting loaves of the "cottage" type. It thus became evident that it was necessary to view the analytical data from a standpoint suited to a definite system or method of baking. That different systems of baking require different types of flour explains why millers occasionally receive both commendatory and condemnatory remarks from their customers on the quality of the same blend of flours.

I hope soon to have an opportunity of publishing some of the results of my investigations of the correlated factors determining the blending qualities, strength, and texture properties of wheat flour.

After a very lengthy investigation of the biochemical changes which occur in the natural ripening of the wheat berry, its preparation or "conditioning" in the mill, and the influence of variations in the treatment of the resulting flour in the bakehouse, I am fully convinced that it is no longer the bakehouse that has to give the final verdict on the qualities of flour, as laboratory methods can now provide all the data necessary for inferring the antecedent conditions, defining the present qualities, and anticipating the future evolution of wheat or its product, flour.

A. J. BANKS.

Waterloo, Liverpool, March 11.

Ionisation and Anomalous Dispersion.

IN NATURE of February 21, Prof. Wood, referring to my letter of January 17, says that the effects observed were probably due to disturbance of the density gradient of the sodium vapour caused by "local heating by the wire." I am afraid that in my letter I cannot have described the experimental arrangement sufficiently clearly; at any rate, Prof. Wood seems to be under a mistaken impression.

The wire was merely an electrode insulated from the tube containing the sodium vapour, but connected to one pole of a battery, the other being connected to the tube. A current passed through the sodium vapour, or the nitrogen left in the tube after exhaustion and heating, presumably an ionisation current; and this was of the order of one microampere, and could hardly produce much local heating.

Be this as it may, since I left Aberystwyth my pupil, Mr. Needham, noticed an effect which, if confirmed, appears to me to be decisive in favour of a connection between ionisation and dispersion. While the tube was heated, by a flame as usual, with 10 volts there was a current of 4 divisions and an anomalous dispersion of 9 divisions. On raising the voltage to 58 volts, the current rose to 10 divisions, but the *anomalous dispersion immediately fell to zero*, and thereafter slowly increased to a value somewhat greater than before.

That an increase of current, and presumably of local heating, if there be any, should diminish the dispersion temporarily can hardly be understood, unless the systems producing the dispersion are themselves electrically charged and swept away to the electrode. I hope shortly to investigate the whole question fully, so as to decide definitely what connection, if any, exists between ionisation and dispersion.

G. A. SCHOTT.

Physical Institute, Bonn, February 26.

The Rusting of Iron.

IN NATURE of February 21 (p. 390) Prof. W. R. Dunstan states that rusting of iron takes place in the presence of water and oxygen when every trace of carbonic acid has been removed. To a certain extent this is the result obtained by our chemist, but his experiments proved conclusively that rusting must be due to an admixture of carbonic acid, for with improved precautions against its presence rusting was enormously reduced, and, this is important, confined to one or two spots. In some cases this local rusting took place where the steel samples rested on the glass vessels, and it was but natural to suppose that this local corrosion was brought about by silicic acid of the glass. The obvious precaution was to arrange an iron bowl in the centre of the glass vessel into which water could be distilled, but although this apparatus was constructed, it was not used, because if corrosion can be caused by the silica of the glass, then it may also be caused by specks of exposed slag in the iron or by the oxidised specks of manganese sulphite which can be seen with the microscope, or by other impurities. Corrosion may even be brought about by carbonic acid occluded in the iron. In order to settle the question, the experiment should be repeated with a piece of iron of absolute purity.

C. E. STROMEYER.

Manchester, March 5.

A Problem in Chance.

THE law of probability is often illustrated by the simple method of supposing a bag filled with an equal number of white and black balls, which are presumably uniformly distributed within the bag. It is stated that the chances are equal that any extracted ball will be black or white.

I am desirous of ascertaining how this equality of extraction of either colour would be disturbed if it be assumed that the balls are not merely inert, but that there is an inherent tendency for like-coloured balls to cluster together. Two subsidiary and mutually alternative conditions may be further assumed: either the tendency of the black balls to cluster together is greater than that existing between the white balls, or it is equal. It is the former of these two subsidiary conditions that interests me.

Perhaps I may state the problem in more definite form. Assume 2000 balls, of which half shall be black and half white, placed in a bag. The intensity with which the latter tend to cluster $=d$, and that of the former is greater, but to a less degree than half as much again. The balls are extracted in groups of eight. In four separate extractions, what will be the probable proportion of black and white balls at each extraction? And how many extractions will have to be made before it is probable that an equal number of black and white balls will have been withdrawn?

GEO. P. MUDGE.

London Hospital Medical College.

THE UNIVERSITY OF THE CAPE OF GOOD HOPE.

ON the invitation of Sir Lauder Brunton, a meeting took place at his residence on January 21 of gentlemen interested in university education. Among those present were Sir Arthur Rücker (of the London University), Dr. Donald MacAlister (then of Cambridge University, and president of the General Medical Council), Prof. Perry (Royal College of Science), Sir W. Arbuckle (Agent-General of Natal), Sir David Gill, Sir John Buchanan, and Mr. Howard d'Egville, honorary secretary Imperial Federation (Defence) Committee. Prof. Osler (of Oxford University), Sir Norman Lockyer, K.C.B., Sir Thomas Fuller (Agent-General for Cape Colony), and Prof. Stirling, dean of the medical faculty of the Victoria University, were unfortunately prevented from attending. Copies of the proposals provisionally agreed to by the committee of University of the Cape of Good Hope, relative to the re-organisation of that University, had been circulated before the meeting, and formed the basis of the evening's discussion. The result was a consensus of opinion on several leading issues, which may be summarised as under:—

(1) That in the existing condition of South Africa the interests of the higher education of the country would best be served by the continuance of only one examining and degree-conferring university.

(2) That the conferring on single colleges in the country the power of granting degrees to their own students would be detrimental to higher education, and specially injurious to the status of all such South African graduates. Such degrees would be depreciated, not only in the estimation of the people of the country itself, but also outside the colony, and would not have the same value or consideration given them which degrees granted by one general University would receive. The tendency of multiplying degree-granting institutions in the circumstances such as those existing in South Africa would be in the direction of unhealthy competition, which would inevitably lower, and not raise, the worth of degrees so obtained.

(3) That sound education would be promoted by associating in examinations the teacher with independent examiners, but the University should control all

examinations, and alone determine the granting of degrees. The appointment of examiners outside the influence of local institutions is desirable, so as to secure confidence in the impartiality of the examination; examiners of experience in teaching the subjects in which they examine should be employed. Efficiency, as well as confidence, would further be secured by obtaining as presiding members of each board of studies examiners experienced in teaching in institutions in the older centres of education.

(4) That all colleges should be affiliated with the University, and should be directly represented on the University council, if necessary, larger representation being given to the larger institutions.

(5) That in any new Act of Incorporation or new charter provision should be made so as to leave the University free to expand, and to include new teaching bodies, as well as to develop in any direction in which the progress and prosperity of the country might in the future indicate.

AN ANTHROPOLOGIST AMONG THE TODAS.[1]

DR. RIVERS has re-discovered the Todas. This curious little nation, long known to us as an isolated social abnormality, in which the dairy industry takes the place of religion and matrimonial safety is found in a plurality of—husbands, now appears to be both much more and much less than this. As a descriptive monograph in ethnology the book is a remarkable achievement, but it is, perhaps, most significant on account of its method. The social sciences are at a disadvantage in that they are not exact, as physical and mathematical sciences are exact; but the present work is a proof that anthropology is attaining such exactness as the nature of the subject allows. This means a good deal, as anyone may see who compares the present monograph with the earlier accounts of the Todas. The testing of the evidence and the verification of fact have been carried out in the most pertinacious and patient manner, and the general method followed is new enough in its application to deserve the epithet original. To the superficial reader little trace of this laborious preliminary process may be revealed, but the work will justify itself by remaining unsuperseded. It struck me as interesting that the account is compiled in such a way as to show itself in the making, that it is an organism, revealing its own evolution.

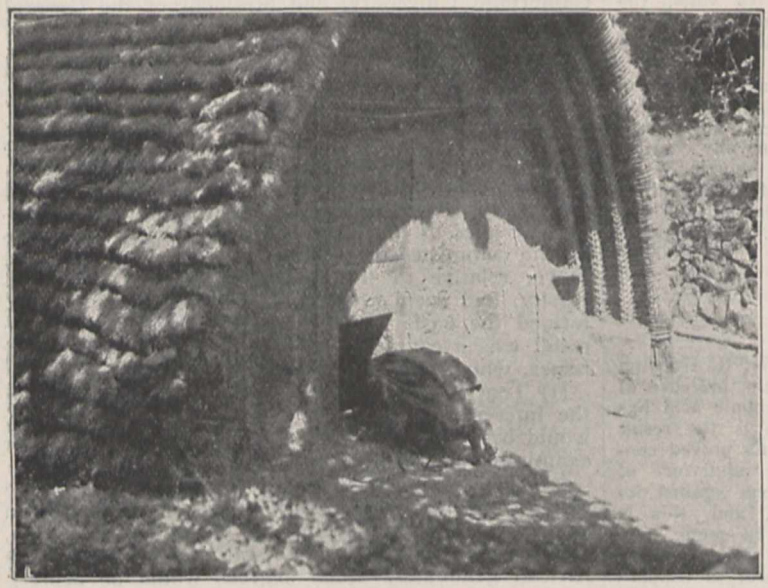


FIG. 1.—The "Palikartmokh" saluting the threshold of the dairy at Kiudr "Pavnersatiti." From "The Todas."

The Todas are sufficiently isolated as to render the problem of their origin more or less insoluble. Dr. Rivers makes a very good case, of the cumulative sort, for their *provenance* from the Malabar races. There are some interesting clues leading us back to the Christianising of South India more than a thousand years ago.

In their social organisation, the new facts collected by Dr. Rivers make our knowledge of the Todas practically free from lacunæ. To the comparative student this very full and detailed account will serve, among other things, to connect the sociology of India with that of the rest of mankind. The polyandrous character of marriage, and the customs of *tererstthi* and the like, deserve studying in these pages by anyone who takes an interest in the marriage problems of Western civilisation. The Toda view of morality in this sphere merits consideration, especially in connection with the altruistic emotions. Something similar has been recently observed by Messrs. Spencer and Gillen among the natives of Central Australia. Not least remarkable is the way in which their form of marriage seems actually to make for efficiency and—righteousness.

The chief regulations of the marriage system are in brief:—Prohibition of intermarriage between the two "castes" *Tartharol* and *Teivaliol*; exogamy among the clans which compose these "castes"; certain kinship prohibitions; polyandry, the typical form of marital association, the extra husbands being generally brothers of the husband proper; polygyny, now on the increase, either in the ordinary form, or two men having two wives in common; the transference of wives from one group of husbands to another, *tererstthi*; a sort of concubinage, as between members of the two great "castes," *mokhthoditi*.

We are supplied with a wealth of detail, practically new, in all the spheres of social life and religious practice. The economic sources of religion are more clearly laid bare in the full description of the dairy-religion of the Todas than would have ever appeared possible to the *a priori* speculator in anthropological theory. To quote Dr. Rivers:—"The sacred animals are attended by men especially set apart who form the Toda priesthood, and the milk of the sacred animals is churned in dairies which may be regarded as the Toda temples, and are so regarded by the people themselves. The ordinary operations of the dairy have become a religious ritual, and ceremonies of a religious character accompany nearly every important incident in the lives of the buffaloes." It would be a pity to attempt to skim the cream from the rich supply presented here; the reader will find it deeply interesting, and the student of religious origins will be well advised to ponder the whole subject. The best photographs in a well-illustrated book represent the operations of these milkmen, priests and

[1] "The Todas." By W. H. R. Rivers, Fellow of St. John's College, Cambridge. Pp. xviii+755; with illustrations and tables. (London: Macmillan and Co., Ltd., 1906.) Price 21*s.* net.

acolytes, the shrines and the divinity thereto attached. It is interesting to note that the people would talk about an important *ti* "in exactly the same kind of way that an Englishman talks about a benefice."

FIG. 2.—Toda man. From "The Todas."

The European cleric and the Toda *palol* thus meet after a journey commenced at what widely separated points. Thanks to Dr. Rivers's energy and care we have a complete and scientific account of one of the most significant phenomena in the history of that varied organism, religion.

The author is of opinion that the division of the people into *Teivaliol* and *Tartharol* is due to the coalescence of two tribes, coming to the hills at different times. There are marked dialectical differences between them. The Toda language as a whole is very difficult. The philologist will find it well worth study, and the data are both extensive and rendered more valuable in a way because the collector was himself ignorant of any other Dravidian tongue, and had therefore no expert prejudices. The secret and sacred languages are rather conspicuous in the life of the Todas.

The book—Dr. Rivers' first book, if I mistake not, in this subject—is a monument of industry and care, not without insight and the results of comparative study, and is an invaluable record of which Cambridge and the new anthropology may be proud.

A. E. CRAWLEY.

A LAW OF RECORD TIMES IN RACING.

A REMARKABLE article on "An Approximate Law of Fatigue in the Speeds of Racing Animals," by Mr. A. E. Kennelly, appears in the Proceedings of the American Academy (vol. xlii., p. 275) for December, 1906. We cannot help speculating as to the causes which led the author to choose such a subject for investigation. To the man of science, even to the omnivorous statistician, the subject sounds so unpromising—one may almost say undignified or improper; the sort of subject with which no civil servant, no permanent official, should ever deal, even in secret. Once the investigation was commenced, it was naturally extended from one series of records to another; but what accident prompted the commencement? Mr. Kennelly is provokingly silent on the point. He opens, it is true, by telling us that "Olympia and Epsom Downs are known to fame by the races they have witnessed. Olympian races, recently revived, are of international interest. . . . A reduction of either of the records [for the 100 yards or the mile] by even one per cent. would be a matter of world-wide importance, and the hero of the new record would be famous among the inhabitants of the temperate zones." Yet we find it hard to believe that the investigation was undertaken simply as a definite matter of urgent public importance, even though the results, as it turns out, may have the gravest social consequences. They may lead to the advertising of mathematical tables and squared paper in the sporting press. They may even influence the teaching of mathematics in our public schools, our universities, and other haunts of ancient peace.

Put briefly and in its simplest possible form, the approximate law relating distances with record times which Mr. Kennelly has discovered is as follows:—For all pairs of distances in the same proportion the record times are in constant ratio, and this ratio is independent of the animal and of the mode of progression. The observed ratios fluctuate, as one might expect, but the fluctuation seems to be of a casual kind over a very wide range of distances, and the ratios for different animals or modes of progress show little more divergence than the ratios for the same animal and the same mode of progress. Thus, taking merely a few instances in the ratio 2·1, we have:—

HORSES TROTTING.

Distance (miles)	Time (seconds)	Ratio of times
1	118·5	—
2	257·0	2·16
4	598·0	2·33
5	750·75	—
10	1575·0	2·10
20	3505·0	2·22
Average ratio		2·202

MEN SWIMMING.

Distance (yards)	Time (seconds)	Ratio of times
25	12·2	—
50	24·6	2·02
100	58·0	2·36
200	140·0	2·42
400	297·0	2·12
800	628·0	2·12
Average ratio		2·208

The law has been tested and found to hold good for horses running, trotting, and pacing, and for men walking, running, rowing, swimming, and skating. It does not hold, on the other hand, for bicycling—a not unnatural result, when the importance of the machine as well as the rider is considered.[1]

If T denote the record time and L the distance, the law may evidently be put in the form

$$T = A.L^n \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

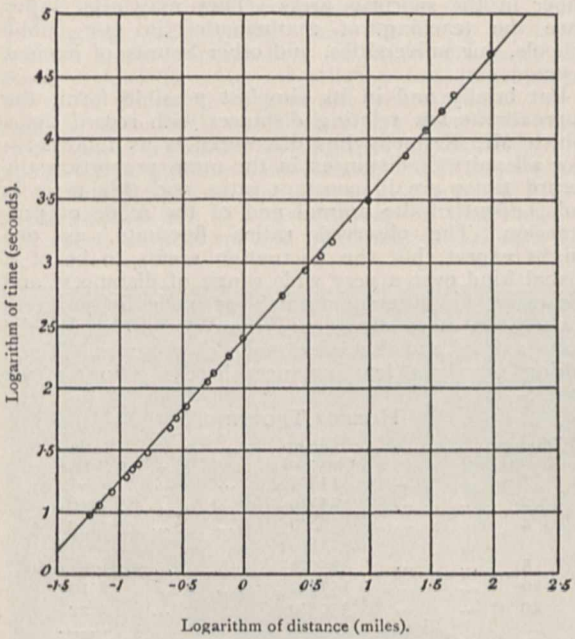
[1] Cf. the work of M. Bouny (Paris Academy of Sciences, and NATURE, vol. liv., 1896), and R. E. Crompton (NATURE, vol. lxi., 1899).

where n is a constant and A varies with the animal and the mode of progress. That is, in terms of logarithms,

$$\log T = \log A + n.\log L \quad . \quad . \quad . \quad . \quad (2)$$

Hence, if T and L are plotted on logarithmic paper, or their logarithms plotted on ordinary scale paper, the points obtained will lie more or less closely round a straight line. If a line be run as near as may be through the points, its slope will give the value of n. This is the procedure adopted by Mr. Kennelly, and he finds an average value of n equal to 9/8, corresponding to a ratio of the times for double distances 2·181. To illustrate the closeness of the logarithmic law from data that are readily accessible in England, we have plotted a diagram from the table of running records in "Whitaker's Almanack" (p. 415), taking, like Mr. Kennelly, the lowest record, whether amateur or professional, in each case. We must refer the reader to the original paper for numerous diagrams, on a somewhat larger scale, illustrating the records in the other cases.

The author concludes, we think correctly, that a



Men running: logarithmic graph of record time and distance, 100 yards to 100 miles.

record is more likely to be lowered if it correspond to a point lying above the time-distance line than if it correspond to a point lying below it, and hence the graph may be of service to the athlete. He also argues that, as a consequence of the law, an athlete should adopt such a speed in running that he can just maintain it constant to the end of the course and is then completely exhausted. But the energy of the individual is not exhausted suddenly in this way, and, although the conclusion may concur with practice, we do not think that it follows from the given law of record speeds. We agree with the author that more information is wanted on this head. It seems doubtful, in fact, if the observed rule should be termed a "law of fatigue" at all; it is not a law of the variation of speed, with time or distance, for the same individual running his fastest continuously, nor even of the average speeds of the same runner over different distances when he knew in advance the distance to be run. It is a law relating times to distances when the best possible runner is selected for each particular distance. This involves the adaptation of the individual as well as fatigue. How much it involves adaptation or selection is illustrated by the complete disagreement of the older with the more recent records for the case of trotting horses. For the longer distances only old records are available, and these fit much better with the older records for short distances (cf. *Encycl. Brit.*, xii., 205) than with the more recent records given by Mr. Kennelly.

We cannot help hoping that a knowledge of "Kennelly's Law" will soon be widely diffused; the possibilities of its educational influence seem almost unbounded. The bookmakers will take to studying "Chambers' Tables"; betting books will be bound up with a few pages of logarithmic paper for the purpose of entering, shall we say, "recordograms"; and Jones Minor, callous to the beauties of logarithmic graphs when illustrated by the laws of steam or the behaviour of purely symbolic barges on non-existent canals, may awaken into something resembling life when racing records are in question. Schoolmasters need not hesitate for fear of corrupting youth; the necessary data can be taken from either of those most respectable publications, "Whitaker's Almanac" and the "Encyclopædia Britannica."

G. U. Y.

PROF. H. W. BAKHUIS-ROOZEBOOM.

CHEMISTS have received with great sorrow the news of the death of Prof. H. W. Bakhuis-Roozeboom on February 8. Roozeboom was struck down in full activity, and science might have hoped to have been enriched by his work for years to come. At the beginning of February, however, he was attacked by influenza; apparent recovery was followed by pneumonia, which in three days proved fatal. He leaves a widow and five children.

Hendrik Willem Bakhuis-Roozeboom was born on October 24, 1854, at Alkmaar, a little town some twenty miles north of Haarlem, noted in history for the first successful resistance made against the Spaniards in the struggle for Dutch independence. He was educated in his native town at one of the higher burgher schools where so excellent an education on modern lines is given. Even during his school career his unusual ability gave promise of a notable future. After leaving school he assisted his chemistry master, Dr. Boeke, for some time in making a number of soil analyses in connection with the plan which is still under discussion of draining the neighbouring Zuider Zee. Not thinking at first of an academic career, he accepted a position in the butter factory of Dr. Mouton at the Hague, and it was the circumstance of the factory being burnt down in 1878 which decided his future. Hearing of the fire, a brother-in-law of Dr. Boeke, van Bemmelen, professor of chemistry at Leyden, offered Roozeboom the post of assistant. This he decided to accept, and while thus occupied he carried on his studies in the University of Leyden, and graduated in 1884. He remained at Leyden as docent, and later as lecturer, supplementing his small university stipend by teaching in the girls' higher burgher school and by translating English books into Dutch, until on the removal of van 't Hoff to Berlin in 1896 he succeeded him as professor of general chemistry in the Uni-

versity of Amsterdam, and this chair he held until the time of his death.

In the Dutch universities seven years is the minimum period of study required for graduation, and the last of these is devoted to original research. The work undertaken by Roozeboom on the hydrates of the halogens and their hydrides led him at once to the problems with which his name will always be associated.

In the course of his experiments he came upon phenomena which he was unable to explain. At that time the conditions which determine equilibrium in chemical systems were little understood by chemists. About ten years before, the American physicist, Willard Gibbs, had developed a theory of equilibrium between materials in contact which was completely independent of all assumptions as to the nature of matter or as to molecular structure. Given a system constituted of homogeneous portions (phases, as they are called, P in number) separated from each other by definite surfaces of contact, and made up of constituents (components, as they are termed, C in number) the amounts of which present in the system can alter independently of the others, Gibbs had shown that, considering only the temperature and pressure under which the system exists and the concentration of the components, the number F of the latter conditions (degrees of freedom, as they are called) to which arbitrary values must be assigned to describe the system perfectly are given by the expression $F=C-P+2$, this numerical relationship being known as the "phase rule."

Gibbs had published his results in a journal not widely circulated—the Transactions of the Connecticut Academy. They were, moreover, presented in a mathematical form unfamiliar to chemists, and had consequently remained scarcely noticed all these years. Prof. van der Waals, to whom Gibbs's work was known, hearing of Roozeboom's difficulty, suggested to him that this mode of regarding equilibrium might throw light upon it. Roozeboom's philosophical mind at once grasped the immense possibilities of this new method of regarding problems of equilibrium, and from that time he occupied himself with brilliant success in working out its application to chemistry.

The investigations of Roozeboom and of those whom he interested in this branch of physical chemistry have cleared up our ideas in a surprising way, and opened out fresh paths of inquiry in the attractive region which connects chemistry and physics. The great merit of first applying the phase rule in chemistry must be attributed to Roozeboom, and gives him a high place among the founders of the new chemistry.

An account of the many applications of the phase rule to chemical problems was written by Roozeboom in his well-known book "Die heterogenen Gleichgewichte vom Standpunkte der Phasenlehre," of which two parts only have yet appeared. He had prepared all the necessary material, and was about to begin writing the third and concluding part at the time of his death.

Apart from scientific work his life was uneventful. His simplicity of character and extreme desire to do justice to every fellow-worker won him the affection of all who came to know him well. In 1890 he was made a member of the Royal Academy of Science of Amsterdam. Totally devoid of any trace of the advertising spirit, he received fewer public honours than might have been expected to follow his notable achievements, and everyone must feel regret that the scientific world did not in his lifetime more adequately recognise his services. F. D. CHATTAWAY.

NOTES.

THERE is every likelihood that Lord Lister's eightieth birthday, on April 4, will be suitably celebrated by his friends and admirers. A committee is being formed, consisting of representatives of medicine and science, with a view to carry into effect a suggestion made, we learn from the *British Medical Journal*, by Dr. C. J. Martin, F.R.S., the director of the Lister Institute. Dr. Martin has proposed that the best form in which to convey to Lord Lister the admiration and regard of his fellow-workers and followers would be the re-publication of all his scientific papers, prefaced by a biography of Lister containing an account of the part he took in the development of present knowledge of infectious processes, and of his efforts to avoid wound infection, the successful result of which revolutionised surgery. Dr. Martin will be glad to receive at the Lister Institute, Chelsea Gardens, S.W., the names of persons who desire to participate in this happy idea.

Science announces that the Rumford medal of the American Academy of Arts and Sciences "for discoveries in light and heat" has been awarded to Prof. E. F. Nichols, of Columbia University.

THE death is announced, in his seventy-fifth year, of Sir Thomas Hanbury, K.C.V.O., at one time of Shanghai, the founder of the Hanbury Botanical Institute at the Royal University, Genoa, and of the Museum Præhistoricum, near Mentone.

WE learn from the *Athenaeum* that the third congress of the Prehistoric Society of France will be held at Autun on August 13–18. Excursions will be made to Mâcon, to Mont-Auxois (the ancient Alesia), to Mont-Beuvray (the ancient Bibracte), and to Solutré. Dr. Marcel Baudouin, 21 rue Linné, Paris, is the secretary.

PETITIONS in support of the Metric Weights and Measures Bill, which is down for second reading on March 22, are being signed by many public bodies and institutions throughout the country. Among the petitions already received by the Decimal Association for presentation to the House of Commons is one signed by the headmaster and the whole teaching staff of Eton College.

THE model of the Channel Tunnel which was on view at Caxton Hall, Westminster, during last week was well patronised, and the voting of those who have inspected it has resulted in a large majority in favour of the scheme. The model is well made in sections, which show clearly the positions of the proposed tunnels in the chalk and the direction of the strata. An interesting point is the very slight variation of level which occurs at this part of the Channel bed.

THE death is announced of Prof. Y. Y. Tswetkoff, of the Moscow Petroffsky Forestry Institute. Soon after finishing his studies at the St. Petersburg University he obtained the degree of Master of Mathematics by a dissertation on surfaces subject to change without rupture or bend of their component parts. In 1864 he was commissioned by the Department of Agriculture abroad, and on his return he became extraordinary professor of the Moscow Institute of Forestry and Agriculture. In 1873 he became professor of mathematics at the Lycée. He read lectures also on physics and meteorology, and his auditorium was always crowded. In 1885 he retired owing to illness. He was most generous in helping poor students and others, and only after his death was it found that he had given away several thousand roubles in this way.

IN the House of Commons on March 7 the President of the Board of Agriculture was asked whether, in view of the loss now sustained by fruit growers, it is the intention of the Government at an early date to propose legislation which will enable insect and other pests which infect fruit to be dealt with effectually; and, if it is intended to propose legislation, whether the Government will use every endeavour to bring it into force by May, in view of the fact that the disease will, during that month, begin to spread from the affected gooseberry plantations. In reply to the question, it was stated that the President of the Board of Agriculture hopes very shortly to be in a position to introduce legislation to confer on the Board and on local authorities further powers to deal with insect and other destructive pests.

AMONG the lecture arrangements at the Royal Institution after Easter we notice the following:—Prof. G. H. Bryan, two lectures on wings and aëroplanes; Prof. W. Stirling, three lectures on stimulation, luminous and chemical; Prof. G. H. F. Nuttall, two lectures on malaria, sleeping sickness, tick fever, and allied diseases; Prof. H. A. Miers, two lectures on the birth and affinities of crystals; Mr. H. F. Newall, two lectures on spectroscopic phenomena in stars, (1) chemistry, (2) motion; Sir James Dewar, three lectures on chemical progress—work of Mendeléeff and Moissan; Prof. S. P. Thompson, three lectures on studies in magnetism (the Tyndall lectures); Prof. W. C. McIntosh, two lectures on scientific work in the sea fisheries; and Sir Wm. H. White, two lectures on the contest between guns and armour. The Friday evening meetings will be resumed on April 12, when a discourse will be given by Prof. A. H. Church on conservation of historic buildings and frescoes; succeeding discourses will probably be given by Prof. C. S. Sherrington, Sir James Crichton-Browne, Prof. G. Chrystal, Prof. J. A. Fleming, Mr. A. H. Savage Landor, Sir James Dewar, and others.

A REUTER telegram from Rome on March 4, published in the *Times*, supplies information as to the programme of the Italian Government in the matter of the excavations at Herculaneum and other archæological schemes in Italy. It has been decided that the work shall be undertaken by the Italian Government, and the archæologists in charge of the Herculaneum excavations will probably be Profs. Dall'Osso and Pellegrini, of the University of Naples; Prof. Gabrici, of the Naples Museum; and Profs. Savignoni and Mariani. The Minister of Instruction, Prof. Rava, is making antiquities his special care, and has obtained the funds necessary to carry out an extensive programme. The yearly sum to be expended for antiquities and fine arts has been raised to nearly a quarter of a million pounds, and the appropriation for excavations has been doubled. The Minister has ordered the beginning on a large scale within a year of excavations at Ostia, the port of ancient Rome; excavations at Pæstum to find the remains of the great edifices of which Greek and Roman historians have spoken; he has obtained permission to expropriate all the houses surrounding the baths of Diocletian, and is spending 20,000*l.* to free those grand remains; and, finally, he has obtained 240,000*l.* for the construction of the proposed archæological promenade, which is to be finished within three years. It will start from the Roman Forum, and will pass by the Colosseum, going so far as the Baths of Caracalla on one side and the Baths of Titus and Trajan on the other.

SIR W. H. PERKIN, F.R.S., presided at the annual dinner of the Society of Dyers and Colourists on March 8. Prof. Meldola, F.R.S., proposed the toast of "The Society," and said the dinner was fittingly held on the 100th anniversary of the introduction of coal gas as an illuminant in the streets of London. The society was, therefore, doubly pleased to welcome as its president the founder of the coal-tar colour industry. The introduction of the scientific spirit into this industry is largely due to the work of Sir W. Perkin. The society is doing a great work in the particular industry represented by it, especially in bringing together representatives of the industry and of science bearing upon the industry. Good work which the society is developing is, said Prof. Meldola, the system of giving prizes for the solution of technical problems. It is a departure which can only be commended, and it is to be hoped it will be imitated by many other technical societies. The president, in reply, referred to the great advances made in other countries in the coal-tar industry during recent years, and urged manufacturers in this country, in order to maintain their supremacy in this industry, to employ in their works the services of the best scientific men. Sir W. Perkin declared that the time for energetic research is while business is prosperous. If that is done there is very little probability of decline. In commemoration of the connection of Sir W. Perkin with the society, the council has decided to found a Perkin medal, which will be conferred for inventions of striking scientific and industrial merit connected with the tinctorial industry.

THE Commercial Motor Vehicle and Motor Boat Exhibition, which was opened last week at Olympia by the Lord Mayor, is likely to prove a great success, as every kind of commercial interest is well catered for. The exhibits shown include various new forms of motor 'buses, lorries, chars-à-bancs, a motor police ambulance for London, numerous forms of trade vans, and a motor horse-box. Not the least interesting of the exhibits from an Imperial point of view is the motor van which is shortly to tour the country showing Canadian products. Tyres of all descriptions, and non-slip bands and devices occupy the gallery, and various new oils for motor lubrication are also much in evidence. Some well-finished motor boats are shown, the largest being a launch about 40 feet in length, made and fitted for the use of the Plymouth Port medical officer. A notable feature in this section is the increase in the number of boats which are propelled without the use of petrol, the paraffin engine being largely installed instead, thus obliterating one of the greatest objections to the motor boat, *i.e.* the danger of the petrol exploding. The boats are in some cases fitted with a seat for the driver similar to that in a car, and are provided with a brake. From a business point of view the exhibition should prove of great value, and is also of great interest as showing the progress made recently in heavy motor traction.

A MEETING was held on March 7 to aid the work of the National League for Physical Education and Improvement at Londonderry House. The aims of the league are to stimulate public interest in the physical improvement of the people, to coordinate and extend the work of existing agencies, to make known the legal powers already possessed by public authorities, and to promote fresh legislation where necessary. Lord Londonderry presided, and in his opening remarks said there are few persons who are studying the condition of the people of this country who do not recognise the importance of hygiene and physical education. In dealing with the question of the teaching of hygiene in the schools, he said that medical inspection

of the children should be periodically carried out; children should not be worried by over-inspection, and discretion should be exercised. As to the instruction of the children in the rules of health, care should be taken to use language which the child understands. Sir Lauder Brunton, in the course of an address, said that, in spite of all the charitable organisations and benevolent institutions in the country, infants are dying in millions, children are starved by thousands, they become weak, they are growing up burdens to themselves and useless to others, and, instead of being a strength to the country, they weaken it. The great weakness, misery, and crime in this country can only be attacked successfully by means of cooperation. The National League is endeavouring to effect the cooperation which is so much needed by bringing together all the individuals and corporations who are interested in the welfare of the coming generation.

A DISCUSSION on the best types of cases (combining economy with suitability) for exhibition purposes occupies a large portion of the February number of the *Museums Journal*. An article, illustrated by an excellent photograph, is also devoted to the new wing recently added to the Liverpool Museum.

IT appears from a paper by Dr. D. Woolacott in vol. ii., part vi., of the Proceedings of the University of Durham Philosophical Society, that a raised beach in the Cleadon Hills has been unusually well exposed during the last two years. The beach is 100 feet above sea-level, but caverns and a sea-cliff indicate that the most recent depression of the country was as much as 150 feet.

THE combined January and February numbers of the *Irish Naturalist* are devoted to an account of the natural history and geology of Lambay Island, county Dublin, now in the occupation of the Hon. Cecil Baring, under whose auspices the investigation has been undertaken, and who has himself contributed notes on the seals and other mammals. A number of naturalists have contributed to the work, which has resulted in the discovery of five new species of invertebrates, and has likewise added several forms to the British fauna and a much larger number to the fauna of Ireland.

WE have been favoured with a copy of a paper from the *Jenaischen Zeitschrift* (vol. xxxix.), by Prof. Hubrecht, on the origin of annelids and chordates, and the systematic position of the Ctenophora and Platyhelminthes. As the "trophocœle" and "hæmocœle" theories are discussed at length, especially from the point of view of Prof. Lang, it is scarcely necessary to mention that the paper is of an extremely abstruse nature. Much importance is attached to the view that the Ctenophora are pelagic worms rather than cœlenterates, and that the Platyhelminthes are likewise an aberrant type.

TO the fourth part of vol. xxxvi. of Gegenbaur's *Morphologisches Jahrbuch*, Augusta Ärnbäck-Christie-Linde contributes the first portion of a paper on the shrew-mice (Soricidæ) and their relationship to other mammals. This section of the paper is devoted to the anatomical part of the subject. It is mentioned that a lateral gland occurs in the males of the common shrew-mouse (Sorex) and water-shrew (Crossopus). Although the occurrence of such glands in the musk-shrews (Crocidura), generally in both sexes, is well known, no reference is made to their presence in the British species in such text-books as we have been able to consult.

REFERENCE in these columns was recently made to Prof. Baldwin Spencer's description of emeu-bones from King Island, Bass Strait. To the January issue of the *Emu* Colonel Legge contributes notes on the extinct emeus of both that island and Tasmania. The author recalls having seen a pair of Tasmanian emeus in his boyhood, and states that they were slightly smaller than the mainland species. As this bird also lays a larger egg, it is regarded as distinct, although it does not appear to have received a scientific name. Colonel Legge withdraws, in a postscript, a name he proposed in the text for the King Island bird, owing to it having been already christened by Prof. Spencer.

"PARENTAL Care among Fresh-water Fishes" is the title of a very interesting article, by Mr. Theodore Gill, published in the Smithsonian Report for 1905 (art. No. 1688). Despite Aristotle's account of the care displayed by the Macedonian glanis in the preparation of a breeding-site, it was long an axiom among naturalists that fishes displayed no parental care for their eggs and offspring. How erroneous was this idea is sufficiently exemplified by the present account, although it deals only with species inhabiting fresh waters. Representatives of a very large number of groups exhibit some degree of parental care, although this may be limited to clearing a space to receive the spawn. The highest development in this respect occurs in the sticklebacks, in which the kidneys and their adjuncts are specially modified to yield a thread employed in the construction of the nest.

IN the shell-gallery of the Natural History Museum have been placed full-sized *papier-maché* models of two giant cephalopods, an Architeuthis and an Octopus or Polypus. Being suspended from the roof, they show to great advantage, and convey a good idea of the huge size attained by certain members of the class, although much larger forms are known. The giant squid, or Architeuthis, measures 40 feet in total length, although 30 feet of this are accounted for by the pair of attenuated tentacular "arms," the length of the body being only 10 feet. An additional interest attaches to this cephalopod on account of its constituting a large portion of the food of the cachalot. The models were obtained from Ward's Natural Science Establishment, Rochester, U.S.A. Another important addition to the collection is formed by two caribou, shot and presented by Mr. F. C. Selous, one representing the Yukon and the other the Newfoundland race. The former has antlers measuring just above 58 inches along the curve.

THE report of the Botanical Club of Canada for 1905–6, prepared by the secretary, Dr. A. H. Mackay, has been received. It contains, as usual, a summary of the phenochrons or observations on the flowering of plants and other natural phenomena recorded from several hundred schools throughout Nova Scotia, and a table of general Canadian phenological observations. Dr. Mackay has also published a handy bibliography of Canadian botany for the year 1905.

IN the *Lyttelton Times* (December 19, 1906) Dr. L. Cockayne pays a tribute to the work of the late Mr. Robert Brown, of Christchurch, New Zealand. By profession a shoemaker, he was at the same time an enthusiastic naturalist, keenly interested in the fauna and flora of the country. He devoted his energies primarily to the collection and identification of the New Zealand mosses, and contributed numerous papers during the last fourteen years that will be found in the Transactions of the New Zealand Institute.

AN insidious disease of the cocoa-nut palm, known as "bud-rot," has been recognised for a considerable time, but the primary cause was not determined. The view is now held that decay is due to bacteria developing in the slimy coating found on the young protected organs. Although certainly existent in the East Indies, there was no record of its occurrence in Ceylon until last year a case was brought to the notice of the Government mycologist, Mr. T. Petch. The disease and its treatment are noted in vol. iii., No. 15, of the Circulars and Agricultural Journal of the Royal Botanic Gardens, Ceylon. In No. 17 of the same series Mr. Petch describes the root disease of the Para rubber tree caused by the bracket fungus, *Fomes semicostatus*.

IN the course of an article in vol. i., No. 10, of the *Philippine Journal of Science*, on the active constituents of certain medicinal plants, Mr. R. F. Bacon refers to the substances used by the Filipinos for stupefying or poisoning fish. The fibre of *Entada scandens*, the bark of *Ganophyllum obliquum*, and the fruit of *Croton Tiglium* are commonly employed for the purpose. The two former contain saponin, the latter a poison allied to ricin, but it is not considered dangerous to eat fish poisoned by these substances. On the other hand, there is risk attending the consumption of fish poisoned with the fruits of *Anamirta cocculus* on account of the picrotoxin contained. The fruits of *Derris polyantha* and *Diospyros canomoi* are also used.

THE Local Government Board has just issued a report on the micrococcus of epidemic cerebro-spinal meningitis (spotted fever), a disease which recently appeared in Glasgow, Belfast, Liverpool, and other places in the British Isles. The report is compiled by Dr. M. H. Gordon, and contains full details of the characters of the microorganism and its recognition.

THE *Journal of Hygiene* for January (vii., No. 1, just issued) contains a number of interesting and important papers. Dr. Castellani describes certain cases of tropical fever associated with apparently new species of bacilli; Messrs. Dudgeon and Dunkley discuss the *M. neoformans*, found in cancer by Doyen; Prof. Hewlett and Mr. Barton outline the results of a chemical, microscopical, and bacteriological examination of twenty-six samples of London milk; and Dr. Arkwright describes the *M. catarrhalis*, met with in nasal catarrh, and its differentiation. Fleet-Surgeon Bassett-Smith, R.N., contributes an important paper on the treatment of Mediterranean fever by means of vaccines. Although a few cases did well, on the whole the results were disappointing.

WE have received the first number of the "Annals of Tropical Medicine and Parasitology," edited by Prof. Ronald Ross, F.R.S., and issued by the Liverpool School of Tropical Medicine. It is intended to take the place of the separate memoirs on tropical medicine which have hitherto been issued by the school, and is to be issued at the subscription price of 10*s*. 6*d*. per volume of probably not less than four numbers. The present number, of 161 pages, contains an elaborate memoir, by Messrs. Newstead, Dutton, and Todd, on insects and other arthropods collected in the Congo Free State, illustrated with six plates; descriptions of two new species of African ticks, by Prof. Neumann, and of parasites in the Liverpool School Museum, by Prof. Looss; a paper on the presence of *S. duttoni* in the ova of the tick, *Ornithodoros moubata*, by Captain Carter, I.M.S.; and a note on the therapeutics of trypanosomiasis, by Messrs. Moore, Nierenstein, and Todd. The number is excellently printed and illustrated, and the general "get-up" all that can be desired. It bids fair to be one of the most important journals on tropical medicine in its scientific aspects.

IN the *Naturwissenschaftliche Wochenschrift* (vol. vi., No. 8) Prof. H. Potonié gives an interesting historical summary of the various theories that have been propounded to explain the genesis of coal.

A PAPER contributed by Mr. W. R. Thomas to the Institution of Mining and Metallurgy, and published in the Bulletin (No. 29) of the institution, strikingly illustrates the manner in which modern mining appliances and methods are now being adopted in Cornwall. It describes the electrically-driven centrifugal pumping plant at the Tywarnhaile mine. Special interest is attached to the installation from the fact that Dowson gas is used to run the electric plant. The results obtained have proved eminently successful.

ADVANCE statistics, subject to correction, issued by the Home Office, show that the British output of coal in 1906 was 251,050,809 tons, or 6·33 per cent. more than in 1905. The number of persons employed at the coal mines in 1906 was 882,345. The mineral production also included 2,971,173 tons of fireclay, 8,209,880 tons of ironstone, 2,546,113 tons of oil-shale, 1,824,415 tons of iron ore, 230,558 tons of rock salt, 151,915 tons of salt from brine, and 126,699 tons of slate. The number of persons employed at mines under the Metalliferous Mines Regulation Acts was 29,969.

IN a paper read before the Society of Arts, published in the Journal of the society of March 8, Prof. W. Boyd Dawkins gives a summary of the results obtained in the investigation of the south-eastern coalfield. The paper contains a map of the coalfield between Dover and Canterbury, and sections of the strata in the borings at Dover, Penshurst, Ellinge, Brabourne, Waldershare, and Fredville. At present, the seams proved are at Dover, thirteen seams with an aggregate thickness of 22½ feet; at Waldershare, four seams 10 feet 3 inches thick; and at Fredville, three seams 7 feet thick. At Dover the coalfield is about 1000 feet below Ordnance datum. At Ropersole the Coal-measures were struck at a depth of 1180 feet, and at Ellinge at 1815 feet. Prof. Boyd Dawkins takes an optimistic view of the future of the coalfield, which he regards as an important national asset and a striking instance of the value of scientific research to the nation.

VERY high temperatures are required in tempering the modern special tool-steels, and care has to be taken that contact with carbon or air is avoided lest the composition of the steel should be altered. A novel type of electric tempering furnace designed by Körting Brothers is described in *Engineering* of March 1. The steel is placed in a fused salt, which must have a high melting point, and should not evaporate to any great extent at high temperatures. With barium chloride a temperature of 1300° C. can be maintained in such a furnace. The furnace forms a square box built up of iron, asbestos, and fire-bricks, leaving in its interior a cubical crucible chamber. This space is filled with the salt, and two plates of iron attached to opposite walls serve as electrodes for the alternating currents, supplied by an oil transformer. When the salt is fused, the object is lowered into the molten mass, and the temperature controlled by means of a pyrometer and rheostats. The tools may be pre-

heated up to red glow before being placed in the furnace. Primary currents of 50 or 100 periods and 200 volts are used. When keeping the furnace at its maximum temperature of 1300° C. for ten hours a day, about 2 lb. of barium chloride have to be replenished every day. The furnace lining is said to last about a year; the iron electrodes do not last so long. Barium chloride seems, so far, to be the best material for the extreme temperatures. For lower temperatures mixtures of barium chloride and potassium chloride are used. The crust of fused salt which adheres to the steel peels off at once when the steel is dropped into the cooling liquid. Local superheating is not to be feared in this kind of furnace, and the application of fused salts is attracting much attention.

AN interesting discussion on the advantages and disadvantages of heating buildings with gas stoves of various types, which was held at the meeting of the Royal Sanitary Institute on December 12 of last year, is printed in the March number of the Journal of the institute. Dr. Rideal, in opening the discussion, considered that as soot, carbon monoxide, and hydrogen sulphide are never present in the products of the combustion of coal gas in modern gas stoves, and as the proportion of oxygen in the air of a room is little changed when the heating is effected by a flueless gas stove, the use of flueless stoves was in several cases an advantage, especially when the economy of the heating effect was considered. The amount of carbon dioxide produced was not sufficient to be deleterious, and instead of causing defective ventilation, flueless stoves, especially those of a condensing type, seemed actually to remedy it. Several speakers took part in the discussion, many of them dissenting from the views expressed by Dr. Rideal. In particular, the passage of sulphur acids into the air when a flueless stove is used appears to present difficulties.

MESSRS. JOHN J. GRIFFIN AND SONS, LTD., yesterday entertained a number of visitors at their new premises in Kingsway. New physical and other apparatus were exhibited, and there were demonstrations of the properties of vessels made of silica glass; of the oil-pigment process, velox printing, among modern processes in photography; the wireless transmission of signals, the musical arc, and other physical phenomena. This opportunity of seeing instruments and processes in operation is likely to be appreciated by teachers and others, and Messrs. Griffin and Sons, Ltd., will probably be repaid for their enterprise.

OUR ASTRONOMICAL COLUMN.

DISCOVERY OF A COMET (1907*a*).—A telegram from the Kiel Centralstelle announces the discovery of a new comet by Prof. Giacobini at the Nice Observatory. The object was of the eleventh magnitude, and its position at March 9d. 10h. 10·9m. (M.T. Nice) was

R.A. = 7h. 4m. 31·4s., dec. = 18° 21′ 17″ S.

The daily motion is westward at the rate of 47′, and northward at the rate of 57′, per day. The above position lies in the constellation Canis Major, about 20′ E. and 1½° S. of Sirius.

SOLAR RESEARCH AT MEUDON.—In No. 5 (1907) of the *Comptes rendus*, MM. Deslandres and d'Azambuja describe, and give some of the preliminary results of, the solar researches carried out at Meudon, with several forms of spectrographs, during the year 1906. One of the principal difficulties encountered by M. Deslandres in his previous experiments has been to obtain a satisfactory slit so narrow that the finer dark lines of the spectrum might be completely isolated, and this difficulty was, to a great extent, overcome during the recent research by drawing a very fine clear line on the surface of a piece of chemically-silvered optical glass. By having a clear space above and below the slit, the solar spectrum was simultaneously photographed on each plate, thereby enabling the parallelism of the slit and the line, and the exactitude of the setting on the line, to be tested for each exposure.

Photographs taken on the centres of the fine iron lines at λ 4045 and λ 4385 are found to differ considerably from those taken on the degraded edges of the lines, for whilst the latter show simply the bright faculic areas, the former show a net-work of bright inequalities of very different form; the photograph with the setting on the centre of the line is supposed to represent the upper layers of the iron vapours. The differences between the images obtained with the K_3 and K_2 lines are not so marked as was expected, although many of the bright areas obtained with the latter are not to be found on the K_3 images. No relation between the K_3 images and the dark calcium flocculi of Prof. Hale's photographs could be established, nor could the similarity of the former with the dark areas produced by photographs on the dark hydrogen lines be recognised.

THE MARKINGS AND ROTATION PERIOD OF VENUS.—Mr. Denning, in continuing his series of articles on the planets in the March number (No. 381) of the *Observatory*, discusses the contradictory results which have been derived from observations of Venus concerning the existence of permanent markings on the planet's surface, and the time it takes the planet to perform one rotation on its axis. He points out that whilst Mr. Lowell records that he has seen the markings when their contours have "had the look of a steel engraving," numerous other very careful observers have failed to distinguish anything which might be recognised as permanent. Similarly, a large number of observers have arrived at the conclusion that the rotation period is about 23h.–24h., whilst others, including Schiaparelli, have concluded that it is about equal to the period of the planet's revolution in its orbit. The spectroscopic results are similarly in opposition.

Summing up the results of the discussion, Mr. Denning concludes that after the earnest application of observers during three centuries, the problems of the configurations and of the axial rotation remain unsolved, the difficulties having, as yet, proved insuperable.

THE ELECTRICAL INFLUENCE OF THE SUN.—No. 8, vol. vii. (February 23), of the *Revue Scientifique* contains an interesting discussion, by Dr. A. Nodon, of the electrical influence of the sun on the earth.

After giving a historical account of the subject, the author proceeds to describe the experimental results obtained by M. Brunhes and by himself, from which follows the deduction that the sun produces, at the earth's surface, a positive electrical induction of variable magnitude. The amount of this induction is far greater than that attributable to the actino-electric action of the luminous radiations, whilst the interposition of clouds before the sun arrests the induction effect. Other possible causes are discussed, and it is shown that, independently of these, there still remains an effective induction directly due to the sun's charge alone.

In a second part of the discussion, published in No. 9 of the same journal, Dr. Nodon considers the effect of the solar influence on the planets, on comets, and on the earth in particular, and in conclusion he urges the fundamental importance of the study of solar physics on the grounds that a large number of meteorological phenomena appear to be directly connected with the solar changes.

RECENTLY DISCOVERED ASTEROIDS.—The provisional elements of the orbits of twenty-five recently discovered asteroids are published in No. 4156 (February 21) of the *Astronomische Nachrichten* by Herr J. Bauschinger, of the Astron. Rechen-Institut, Berlin. These asteroids were discovered between August, 1905, and April, 1906, and their designatory numbers range from 570 to 598.

SURVEY OF SCOTTISH LAKES.

DURING the past three or four years the bathymetrical survey of 554 of the fresh-water lochs of Scotland has been completed under the direction of Sir John Murray and Mr. Laurence Pullar. This practically means that all the Scottish fresh-water lochs have now been surveyed, except some small ones on which no boats could be found. A large staff has been employed during the course of the work—about forty voluntary and paid assistants, in addition to a great many boatmen and other workmen. Up to the present time, the charts of 180 lochs, with descriptions, have been published in the *Geographical Journal*, and arrangements have now been made for the publication in the same journal during the present year of the descriptions and charts of the thirty-three lochs in the Ness basin. This will complete the publication of the observations made in the more important lochs. The results obtained in the case of the remaining 340 lochs will be published, as a special volume, by the Royal Geographical Society in about eighteen months from this date, the charts being at present in the course of printing by Mr. J. G. Bartholomew.

Besides the purely bathymetrical aspect of the survey, papers have been published by Prof. Chrystal on seiches, by Mr. E. M. Wedderburn on the temperature of Loch Ness, by Mr. E. R. Watson on ionisation of air in vessels immersed in deep water, by Dr. Wesenberg-Lund on a comparative study of Scottish and Danish lakes, by Prof. Bachmann on phytoplankton of Scottish and Swiss lakes, by Mr. G. West on aquatic plants, by Mr. James Murray on fresh-water animals, by Drs. Peach and Horne on the geological surroundings of the lochs, and other papers.[1]

The last published paper[2] treats of the lochs within the basin of the Lochy, the relative positions of which are shown in the little index map of the district (Fig. 1). The total area of the basin exceeds 400 square miles, the diameter from east to west exceeding forty miles, and from north to south exceeding twenty miles. Of the ten lochs within the basin, five exceed three miles in length and four exceed five miles in length, while Loch Lochy is nearly ten miles, and Loch Arkaig twelve miles, in length; five of the lochs exceed 100 feet in depth, and three exceed 300 feet in depth, while Loch Lochy exceeds 500 feet in depth; five of the lochs cover a superficial area in each case exceeding a square mile, and four exceeding two square miles, while Loch Arkaig and Loch Lochy each cover an area of about six square miles. The two largest lochs (Arkaig and Lochy) drain into the River Lochy, while the remaining lochs within the basin (Pattack, East and West na h-Earba, Laggan, Ossian, Ghuilbinn, Treig, and an Dubh Lochan) drain into the River Spean, which joins the River Lochy shortly after its exit from Loch Lochy; the little Loch nan Gabhar and Lochan Lùnn dà-Bhrà drain by independent streams into Loch Linnhe. In these twelve lochs, which cover an area of about twenty square miles, nearly 2600 soundings were taken, or an average of 214 soundings per loch, and 129 soundings per square mile of surface; the aggregate volume of water contained in the lochs is about 85,855 millions of cubic feet, or more than one-half of a cubic mile, and the area draining into them is more than 270 square miles, or fourteen times the area of the lochs.

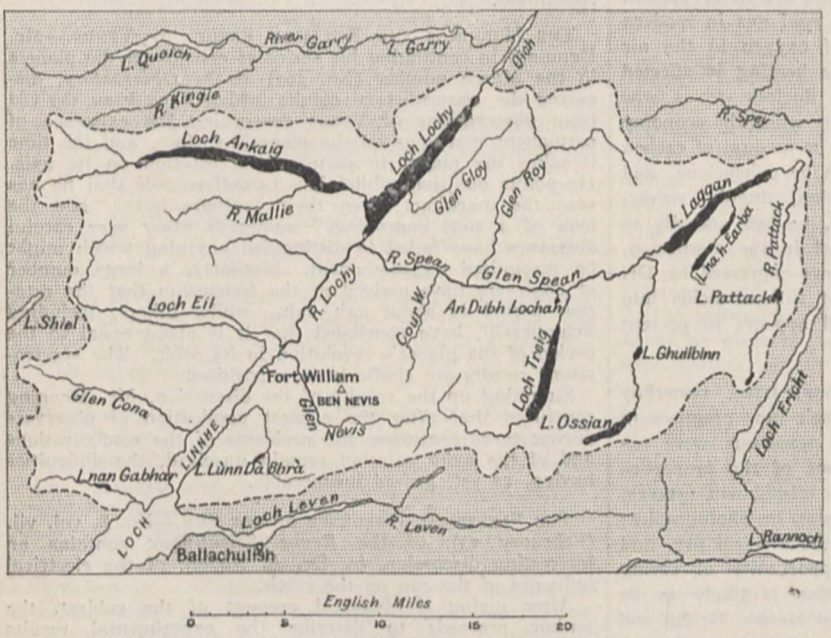


FIG. 1.—Index Map of the Lochy District.

Loch Lochy (see Fig. 2), the southernmost of the chain of lochs occupying the Great Glen, utilised in forming the Caledonian Canal, is a straight loch, having the form of a narrow triangle with the apex at the north-east end, whence it widens gradually southward to Bunarkaig, where the maximum breadth of a mile and a quarter is found, the average breadth of the whole loch being three-fifths of a mile. The superficial area is nearly 3800 acres, and the volume of water about 37,726 millions of cubic feet, the maximum depth being 531 feet and the mean depth 229 feet. All the contour lines are continuous, the 100-feet contour enclosing an area little less than the total length of the loch, while the areas enclosed by the 200-feet, 300-feet, and 400-feet contours are respectively 6½, 4¾, and 3 miles in length. The 500-feet contour encloses a very small area, one-third by one-eighth of a mile, just about the middle of the loch.

Loch Arkaig (see Fig. 3), a long, narrow, curved loch, trending nearly east and west, lying about a mile to the west of Loch Lochy, is of somewhat irregular outline, broadest in the middle parts, where the loch is nearly a mile wide, and tapering towards each end, the mean breadth being half a mile. The superficial area is about 4000 acres, and the volume of water about 26,573 millions of cubic feet, the maximum depth being 359 feet and the mean depth 153 feet. The basin is nearly simple, the slight irregularities being doubtless correlated with the curving outline. The 100-feet contour is continuous, but the 200-feet contour is broken into two basins, and the 300-feet contour into three basins. The largest 300-feet area, just about the middle of the loch, is two miles in length, and includes the maximum depth of 359 feet.[1]

Loch Treig occupies a deep, narrow valley trending north and south among very high mountains in the region of Lochaber, the West Highland Railway running along the east side. It is more than five miles in length, with a maximum breadth of three-quarters of a

[1] See Trans. Roy. Soc. Edin., vol. xli. pp. 367, 599, 677, and 823; vol. xlv., p. 261; Proc. Roy. Soc. Edin., vol. xxv., pp. 1, 401, 593, 609, 637, 967; *Geogr. Journ.*, vol. xxiv., p. 429.

[2] "Bathymetrical Survey of the Fresh-water Lochs of Scotland." Under the direction of Sir John Murray, K.C.B., F.R.S., and Laurence Pullar. Part xii., The Lochs of the Lochy Basin (*Geogr. Journ.*, vol. xxviii., pp. 592–615; with 8 plates of maps).

[1] It is odd that surveys were apparently made of Lochs Arkaig, Lochy, and Ness about eighteen years ago by a German military officer named Sandler, who lived for some months in the district. The results of these surveys have never been published, but a copy of that of Loch Arkaig was obtained from Mr. Honeyman, factor to Cameron of Lochiel, which corresponded very closely with the results of the Lake Survey.

mile, and a mean breadth of half a mile, covering an area of 1540 acres, and containing 13,907 million cubic feet of water; the maximum depth is 436 feet, and the mean depth 207 feet. The loch forms a narrow triangle, broadest towards the south and tapering towards the outflow, the steep slope of the hills being continued under water. The basin is simple, all the contours approximately following the shore-line, but the line of greatest depth is nearer the western shore. The 400-feet area is about two miles in length, the two ends approaching very close to the west side, where the steepest slopes occur. The valley is so narrow relatively to the depth of the loch that, in the central parts, the steep slopes reach far towards the middle and leave comparatively little level bottom, but towards the south end, where the loch is broader and not quite so deep, there is a greater extent of nearly flat bottom. It is interesting to note that seiches were first observed by the staff of the Lake Survey in Loch Treig.

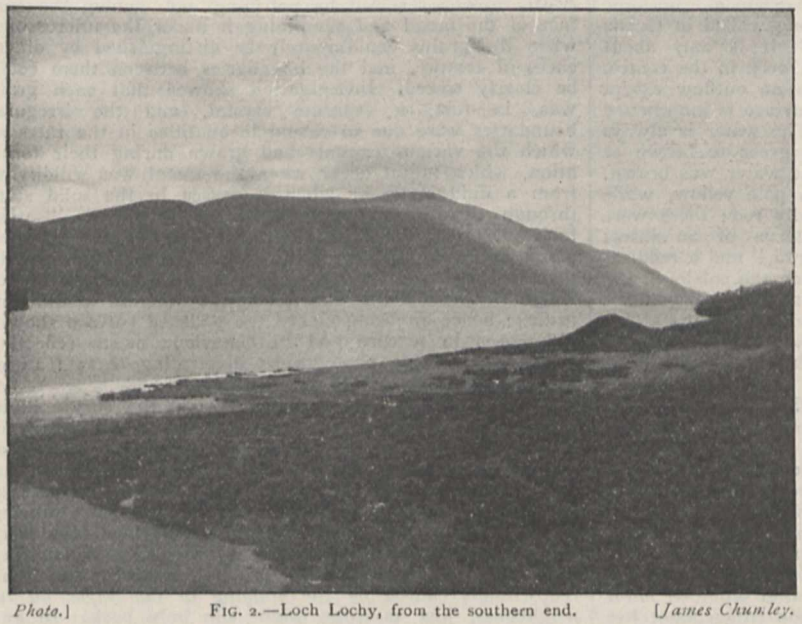


Photo.] FIG. 2.—Loch Lochy, from the southern end. [*James Chumley.*

Loch Ossian lies at an elevation of about 1270 feet above the sea to the north of Rannoch Moor, trending north-east and south-west, with its long axis slightly curved, and of nearly uniform breadth throughout. It is 3¼ miles long, and nearly half a mile in greatest breadth, the mean breadth being one-third of a mile. The superficial area is nearly 660 acres, and the volume of water about 1224 million cubic feet, the maximum depth 132 feet, and the mean depth 43 feet. The lake-floor is very uneven, both the transverse and longitudinal sections being undulate.

Loch Laggan, situated between the Highland and West Highland Railways, the coach road from Kingussie to Tulloch passing along the northern shore, trends north-east and south-west, and is of the usual elongate, narrow form of Scottish lochs, narrowest in the central parts and somewhat expanded towards each end, where deeper water occurs; the outline is very irregular, and the bottom correspondingly irregular, with a number of larger and smaller islands in the narrower parts. It is more than seven miles in length, two-thirds of a mile in maximum breadth, the mean breadth being nearly half a mile, and the superficial area about 1900 acres. The maximum depth is 174 feet, the mean depth 68 feet, and the volume of water about 5600 million cubic feet. The shallower contour lines are continuous, and follow approximately the outline of the shore, but all the deeper contours are much broken up. There are four 75-feet areas and six 100-feet areas, the largest and deepest approaching the west end.

Lochan na h-Earba is the name applied to two distinct lochs (now differing by nearly 10 feet in level, though they may once have formed a single loch) lying in a valley running nearly parallel to, and about a mile to the south of, that occupied by Loch Laggan. The *west loch* is the larger and deeper of the two, nearly two miles long by one-third of a mile in greatest breadth, covering an area of about 263 acres, and containing 408 million cubic feet of water, with a maximum depth of 81 feet and a mean depth of 35½ feet. The basin is simple, the contour lines being continuous, but narrowing more decidedly than the outline from the centre to each end, the slopes being much steeper towards the centre of the loch. The *east loch* is about half a mile distant from the west loch, the stream conveying the overflow from the west loch winding through the boggy flat between them. It is 1¼ miles long by a quarter of a mile in greatest breadth, covering an area of about 146 acres, and containing 191 million cubic feet of water, with a maximum depth of 69 feet and a mean depth of 31 feet. The deep water is all towards the upper end, the lower half being very shallow.

Besides the larger lochs thus briefly summarised, details are given in the paper of Loch Pattack, the highest loch surveyed in the basin, with a maximum depth of 58 feet and a mean depth of 14 feet; of Loch Ghuilbinn, with a maximum depth of 49 feet and a mean depth of 13 feet; of an Dubh Lochan, a very small but relatively deep loch near Loch Treig,

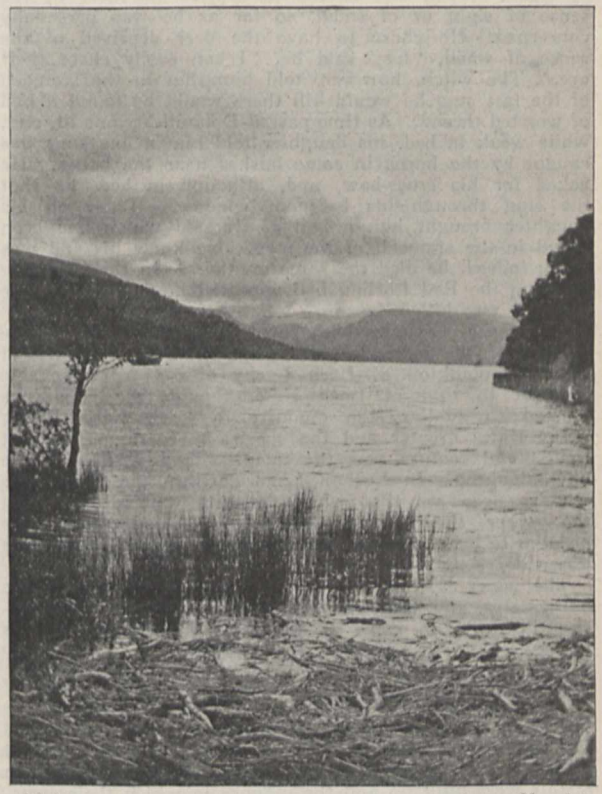


Photo. *James Chumley.*

FIG. 3.—Loch Arkaig, from the east end.

with a maximum depth of 40 feet and a mean depth of 15½ feet; of Lochan Lùnn dà-Bhrà, with a maximum depth of 25 feet and a mean depth of 8½ feet; and

of Loch nan Gabhar, a little weedy hollow only 5 feet deep, which is evidently being rapidly silted up. An interesting account is also given of the Red Lochan at Tulloch, a small pond lying in an extensive morainic terrace near the north end of Loch Treig, called in Gaelic by a name signifying "brown eye." It is only about 30 yards in longest diameter and 5 feet deep in the centre, fed only by rains, and, though it has no outflow except by percolation through the gravel, its surface is maintained almost constantly at the same level. The water is always turbid, and varies in colour from dull green to brown or red. When examined in May, 1902, the water was brown, the collection with the coarse net was pale yellow, while that taken by the fine net was decidedly red; there were only two abundant organisms, the larva of an insect (Corethra) known as the "phantom larva," and a reddish-coloured rotifer, *Anuraea valga*, to which the colour of the water was evidently due, for none of the other organisms were abundant enough to be held responsible for the colour of the water. On placing the collections in formalin, a blood-red sediment was deposited, which was found to consist chiefly of *Anuraea valga* and myriads of its red eggs. Examined subsequently at different seasons, the changes of colour were doubtless correlated with the predominance of one or other organism. None of the other ponds in close proximity shared the turbidity and reddish-brown colour of the Red Lochan, the peculiarity being probably due to its being more closely shut in, the surrounding rim of gravel being 14 feet or more above the pond, and there is besides a fringe of birch trees. The water is stagnant, which favours the growth of certain organisms, particularly *Anuraea valga*. It is said that wildfowl never settle on the pond, and that the common frog cannot live in it. The following legend was related to Sir John Murray concerning this Red Lochan:—"Many centuries ago there lived in these parts a noted hunter named Donnuil. In return for some services rendered to the witch of Ben-a-Vreich, she offered to deprive the deer of the sense of sight or of smell, so far as he was personally concerned. He chose to have the deer deprived of the sense of smell, 'for,' said he, 'I can easily cheat their eye.' The witch, however, told him that in the stomach of the last stag he would kill there would be found a ball of worsted thread. As time passed Donnuil became ill, and, while weak in bed, his daughter told him a fine stag was caught by the horns in some bushes near the house. He asked for his cross-bow, and, although in bed, he shot the stag through his bedroom window. Later on his daughter brought him a ball of worsted which had been found in the stomach of the stag. He knew his end was near; indeed, he died the same evening. On the following morning the Red Lochan had appeared at the place where the stag was killed."

The paper concludes with some interesting notes on the biology of the lochs by Mr. James Murray, who found that the plankton of Loch Lochy offered a remarkable contrast to that of Loch Ness, though the conditions seemed so similar, the quantity in Loch Lochy being many times greater and the species more numerous, but the special feature was the quantity and variety of the phytoplankton. In Lochan Lùnn dà-Bhrà the Diaptomus was so deep red that when the nets were drawn from the water they seemed to contain blood; the same peculiarity was observed in An Dubh Lochan, but in a lesser degree.

The paper is illustrated by coloured maps showing the bathymetry and orography, and there are several woodcuts in the text, some of which are reproduced in this notice.

THE STRUCTURE OF METALS.[1]

THE lecturer said that his purpose was to give some account of researches in which he had been engaged for a good many years, dealing with the manner in which metals were built up and the manner in which their structures allowed them to yield when they were compelled to change their shape by being overstrained. A piece of metal was not a homogeneous single thing; it was a collocation of grains or granules, which built it up just as granules of ice built up a glacier. The grains of metal were irregular in shape and unequal in size. Their existence was revealed by polishing and etching the surface of the metal and examining it under the microscope, when the grains could readily be distinguished by differences of texture, and the boundaries between them could be clearly traced. Investigation showed that each grain was, in fact, a separate crystal, and the irregular boundaries were due to casual inequalities in the rates at which the various crystals had grown during their formation, which might occur when the metal was solidifying from a fluid state, or when it passed in the solid state through certain temperatures at which re-crystallisation took place. Each grain might be regarded as composed of an immense number of molecular brickbats grouped in perfectly regular tactical formation, but the direction in which these brickbats were piled was different in different grains; hence on being etched the polished surface showed differences in texture and in behaviour as to reflecting light. Microscopic photographs illustrating these features in iron and other metals were exhibited.

When the metal was strained beyond the elastic limit, and thereby compelled to change its form, the change of form took place by slips occurring between the layers of molecular brickbats in the individual granules. The discovery of these slips had been made by the lecturer in conjunction with Mr. Walter Rosenhain, by noticing certain lines to appear on the polished surface of a piece when subjected to severe strain. These lines, which they called slip lines, looked like minute crevasses, but were really steps caused by the slipping of one layer on its neighbours, just as cards might slip in a pack. In any one crystal grain there were at least three sets of independent parallel planes in which such slips could take place, and these allowed the grain to undergo complete alteration of form as a result of the straining. Microscopic photographs were exhibited showing three systems of slip lines on the surface, corresponding to slips in three directions throughout the substance of the grain. The true nature of these slip lines was made apparent by means of obliquely incident light, which showed them as little steps in the surface. An interesting direct confirmation of this had been afforded by recent experiments of Mr. Rosenhain in which cross-sections of the stepped surface had been obtained.

Dr. Ewing next explained, by aid of models, a theory which he had recently advanced as to the structure of the crystal granule itself. This theory might be regarded as an extension of the views he put forward fifteen years ago to explain the phenomena of magnetic induction by the mutual actions of polarised magnetic molecules. Cohesion in the crystalline structure might similarly be regarded as due to the mutual forces between polarised molecules, the polar quality of which determined the regular tactical formation in which they grouped themselves to form the crystal. For this purpose he conceived of each molecule as possessing polarity along each of three rectangular axes; in other words, as having six poles exercising forces of attraction on the opposed poles of neighbouring molecules.

The lecturer proceeded, by aid of the model, to demonstrate the process of crystal-building with these polarised molecules for brickbats. He showed how, under certain conditions, a group of dissenting molecules might be formed within the crystal grain, possessing a certain degree of stability, though not in complete harmony with the molecules around them. Evidence for the existence of such groups was furnished by the microscope in the examination of iron and other metals. The process of straining was next considered, and it was shown that the conception of polarised molecules was in agreement with what was known of the actual behaviour of metals during, first, the elastic stage of straining, and, second, the stage where much greater yielding took place and permanent set was produced. The molecular theory explained how energy was dissipated in the process of straining, and also how elastic "fatigue" resulted. After any severe strain the piece was a long time in recovering its full amount of elastic quality, but the recovery could be accelerated by heating it. These phenomena were accounted for by

[1] Abstract of "Wilde" Lecture, delivered by Dr. J. A. Ewing, F.R.S., before the Manchester Literary and Philosophical Society on February 18.

the setting up of dissenting groups, as a result of straining, which resolved themselves after a time into the normal configuration. It further explained the fatigue of strength which was found to occur when a metal was subjected to repeated reversals of stress, a matter of great practical importance in the design of machines and engineering structures. The manner in which a piece broke, for example, after repeated bendings to and fro was discussed by aid of the molecular model. It was shown that the effects of slip are felt for some distance on either side of the plane of slip, a fatigued condition of the metal being established. This is especially the case when slip is many times repeated, backwards and forwards, and a condition is ultimately arrived at in which the cohesive bonds are broken and a crack results.

In conclusion, Dr. Ewing briefly referred to the relation between the molecular structure of the crystal grain, to which strength and elasticity were to be ascribed, and the finer structure which accounted in magnetic metals for the phenomena of magnetism. He had formerly shown that in the process of magnetisation in iron there was a turning round of a molecular axis possessing magnetic polarity. It was when the magnetically polar axes of all the molecules were turned round so as to face one way that the iron became "saturated." The polarity he was now concerned with was different in kind. It was not magnetic, and it existed in three directions, whereas the magnetic polarity with which the process of magnetisation was concerned was uniaxial. Moreover, the three-directional polarity concerned in crystal building did not suffer rotation when a magnetising force was applied. We had accordingly to think of the molecule as possessing polar axes which were non-magnetic and remained fixed under the control of forces of the same kind exerted by the poles of neighbouring molecules, and at the same time as possessing an inner structure characterised by uniaxial magnetic polarity, which was capable of rotation under the influence of an applied magnetising force while the non-magnetic polar axes remained fixed.

FORTHCOMING BOOKS OF SCIENCE.

MESSRS. BAILLIÈRE, TINDALL AND COX direct attention to:—"Practical Agricultural Chemistry," by F. Robertson; "Meat Inspection," by Dr. W. Robertson; "Blood Stains (a Medico-legal Book)," by Major Sutherland; "Trypanosomata and the Trypanosomiases," by A. Laveran and F. Mesnil, translated and edited by Dr. D. Nabarro; and a new edition of "The Röntgen Rays in Medical Work," by Dr. D. Walsh, with section on apparatus and methods by Dr. L. Jones.

Messrs. A. and C. Black announce:—"Notes upon the Island of Dominica (British West Indies)," by S. Grieve, illustrated; "Rudolf Eucken's Philosophy of Life," by W. R. B. Gibson; "The Sense of Touch in Mammals and Birds, with Special Reference to the Papillary Ridges," by Dr. W. Kidd; "How to Fish," by W. E. Hodgson; "Man, his Manners and Customs," by L. W. Lyde; and "Descriptive Geography of the British Isles," by F. D. Herbertson.

Messrs. William Blackwood and Sons promise:—"In the Footsteps of Marco Polo, being the Account of a Journey Overland from Simla to Pekin," by Major C. D. Bruce; "The Sovereignty of the Sea, an Historical Account of the Claims to the Exclusive Dominion of the British Seas and of the Evolution of the Territorial Waters, with Special Reference to the Rights of Fishing," by Dr. T. W. Fulton; "In Malay Forests," by G. Maxwell; and "Forest Entomology," by A. T. Gillanders.

In Messrs. Cassell and Co.'s list we find:—"Greenhouses and Conservatories, Constructing and Heating"; "Steel, its Varieties, Properties, and Manufacture"; "Domestic Hot Water Supply"; "Iron, its Sources, Properties, and Manufacture"; "Photographic Studios and Dark Rooms"; "Window Blinds"; "Tinplate Work"; "Rustic Carpentry"; "Pumps and Rams, their Action and Construction"; "Domestic Jobbing"; and "Zinc Working."

Messrs. Chatto and Windus give notice of:—"A History of Sumer and Akkad, being an Account of the Primitive Inhabitants of Babylonia, with Maps and Illustrations after all the Principal Monuments of the Period in the British Museum and Elsewhere, and a Special Binding Design after a Monument of the Period," by L. W. King; and "The Paradise or Garden of the Holy Fathers, being Histories of the Anchorites, Recluses, Cœnobites, Monks, and Ascetic Fathers of the Deserts of Egypt between A.D. CCL and A.D. CCCC circiter, compiled by Athanasius, Archbishop of Alexandria, Palladius, Bishop of Helenopolis, Saint Jerome, and others, now translated out of the Syriac, with Notes and Introduction," by Dr. E. A. W. Budge.

Messrs. Archibald Constable and Co., Ltd., announce:—"European Animals, their Geological History and Geographical Distribution," by Dr. R. S. Scharff; "Natives of Northern India," by W. Crooke; "Universal Dictionary of Mechanical Drawing," by G. H. Follows; "Railroad Curve Tables for the Field Engineer," by R. S. Henderson; "Cranes," by A. Bottcher, translated from the German, enlarged, and edited with a complete description of English and American practice by A. Tolhausen; "Searchlights," by F. Nerz, translated from the German by C. Rodgers; "Agglutinants and Adhesives," by H. C. Standage; "Irrigation, its Principles and Practice as a Branch of Engineering," by Sir H. Brown; "Design of Irrigation Works," by W. Bligh; "Experimental and Theoretical Applications of Thermodynamics to Chemistry," by Prof. W. Nernst; "The Elastic Arch, with Reference to the Reinforced Concrete Arch," by B. R. Leffler; "Machine Design," by C. H. Benjamin; "A Text-book of Hydraulics, including an Outline of the Theory of Turbines," by L. M. Hoskins; "Fuel, Water, and Gas Analysis," by J. B. Kershaw; "Gas, Oil, and Solid Fuel," by Prof. V. B. Lewes; "Gold and Precious Metals," by Dr. T. K. Rose; "Electrometallurgy," by J. B. C. Kershaw; "Electrical Distribution of Power," by J. H. Davis; "Gas Light and Heating," by W. H. Y. Webber; "Coal," by J. Tonge; "Iron and Steel," by J. H. Stansbie; "The Manufacture of Paper," by R. W. Sindall; "India-rubber and Guttapercha," by H. L. Terry; "Wood Pulp and its Applications," by C. F. Cross, E. J. Bevan, and R. W. Sindall; "Steam Engines," by J. T. Rossiter; "Glass," by W. Rosenhain; "Electric Lamps," by M. Solomon; "Steam Locomotives," by V. Pendred; "Patents, Trade Marks, and Designs," by K. R. Swan; and "Photography," by A. Watkins.

Messrs. J. M. Dent and Co.'s list includes:—"Nature-study," by Prof. J. R. A. Davis; "Trigonometry," by C. Hawkins; "Fly-fishing," by Sir E. Grey, illustrated; "Our Gardens," by the late Dean Hole and G. S. Elgood; and "Farming," by W. M. Tod, illustrated.

Messrs. Duckworth and Co. announce:—"The Interpretation of Nature in Earlier Greek Art," by E. Löwy, translated and illustrated; and a new edition of "A Text-book of Plant Diseases," by G. Massee.

In Messrs. Everett and Co.'s list appears:—"Charts of the Diseases of the Horse, with Explanatory Notes and Prescriptions," by C. Gresswell.

Mr. Gustav Fischer (Jena) will publish:—"Die Bakteriologie des Auges," by Prof. Axenfeld, illustrated; "Das Dysenterietoxin," by Dr. R. Doerr, illustrated; "Geologische und Palaeontologische Abhandlungen," edited by E. Koken, Band viii., Heft iii., illustrated; "Die Grosshirnrinde des Menschen in ihren Massen und in ihrem Fasergehalt," by Dr. T. Kaes, 1 Teil, text, 2 Teil, illustrations; "Praktikum der Bakteriologie und Protozoologie," by Drs. K. Kisskalt and M. Hartmann; "Jahresbericht der Literatur über physische Anthropologie im Jahre 1905," by Dr. E. Fischer, edited by Dr. G. Schwalbe; "Normentafeln zur Entwickelungsgeschichte der Wirbeltiere," edited by Prof. F. Keibel, Siebentes Heft, "Normentafel zur Entwickelungsgeschichte des Koboldmaki (Tarsius Spectrum) und des Plumplori (Nycticebus Tardigradus)," by Prof. A. A. W. Hubrecht and F. Keibel, illustrated; "Progressus rei Botanicae, Fortschritte der Botanik, Progrès de la Botanique, Progress of Botany," edited for the International Association of Botanists by Dr. J. P. Lotsy, Erster Band, Zweites Heft; "Verhandlungen der deutschen pathologischen Gesellschaft," Zehnte Tagung gehalten in Stuttgart vom September 17–21, 1906,

Jahrgang 1906, illustrated; "Wissenschaftliche Ergebnisse der deutschen Tiefsee-Expedition auf dem Dampfer *Valdivia* 1898–1899," Fünfzehnter Band, 1 Lieferung, die Tiefsee-Fische, by Prof. A. Brauer, Systematischer Teil, illustrated; "Zoologische Forschungsreisen in Australien und dem Malayischen Archipel," by Prof. R. Semon, Dritter Band, Monotremen und Marsupialier II., 2 Teil, 3 Lieferung, illustrated; and "Klinisches Jahrbuch," Sechzehnter Band, Zweites Heft, illustrated.

Mr. H. Frowde promises:—"Australasia," by J. D. Rogers, being the sixth volume of the "Historical Geography of the British Colonies"; "The Dillenian Herbaria: an Account of the Dillenian Collections in the Herbarium of the University, together with a Biographical Sketch of Dillenius, Selections from his Correspondence, Notes, &c.," by G. C. Druce, edited, with an introduction, by Prof. S. H. Vines, F.R.S.; "Ancient Khotan," detailed Report of Archæological Exploration in Chinese Turkestan, carried out and described under the Orders of H.M. Indian Government by M. A. Stein, 2 vols.; and "Surgical Instruments in Ancient Times," by J. S. Milne.

Messrs. Greening and Co., Ltd., promise:—"Practical Fruit Culture," by J. Whitehead; "Practical Glass Culture," by J. Cheal; and "Home Pets," by H. Compton.

The list of Messrs. Charles Griffin and Co., Ltd., includes:—"The Design and Construction of Ships," by Prof. J. H. Biles, 2 vols., illustrated; "The Problem of Flight," by H. Chatley, illustrated; "Practical Calculations for Engineers," by C. E. Larard and H. A. Golding, illustrated; "Shaft Sinking in Difficult Cases," by J. Riemer, translated from the German by J. W. Brough, illustrated; "The Analysis of Materials used in the Leather Industry," by S. R. Trotman, illustrated; "Soil Bacteria," by Dr. J. Clark, illustrated; "General Foundry Practice, a Practical Handbook for Iron, Steel and Brass Founders, Metallurgists, and Students of Metallurgy," by A. McWilliam and P. Longmuir, illustrated; "Physico-chemical Tables for the Use of Analysts, Physicists, Chemical Manufacturers, and Scientific Chemists," vol. i., "Chemical Engineering, Physical Chemistry," vol. ii., "Chemical Physics, Pure and Analytical Chemistry," by J. Castell-Evans, 2 vols.; "Medical Ethics," by Dr. R. Saundby; and new editions of "A Manual of Dyeing, for the Use of Practical Dyers, Manufacturers, Students, and all Interested in the Art of Dyeing," by Dr. E. Knecht, C. Rawson, and Dr. R. Loewenthal, 2 vols.; "Principles and Practice of Brewing, for the Use of Students and Practical Men," by W. J. Sykes, revised by A. R. Ling, illustrated; "The Work of the Digestive Glands," by Prof. Pavlov, translated into English by Dr. W. H. Thompson, illustrated.

Mr. W. Heinemann's list contains:—"A Handbook of Metabolism," by Prof. C. von Noorden, English translation, edited by Dr. I. W. Hall, 3 vols.; "The Nutrition of Man," by Prof. R. H. Chittenden, illustrated; "The World's History, a Survey of Man's Record," edited by Dr. R. F. Helmolt, vol. v., "Eastern Europe"; "Eclipse and O'Kelly," by T. A. Cook, illustrated; and "Wild Flowers of the British Isles," written by H. I. Adams, illustrated.

Messrs. Hodder and Stoughton promise:—"Brain and Personality, or the Physical Relations of the Brain to the Mind," by Dr. W. H. Thomson, illustrated; and "The Book of the Open Air," by E. Thomas, twelve monthly parts, illustrated.

The list of Messrs. Hutchinson and Co. contains:—"Extinct Birds," by the Hon. W. Rothschild, illustrated; "The World's Peoples," by Dr. A. H. Keane, illustrated; "In Wildest Africa," by C. G. Shillings, translated by F. Whyte, 2 vols., illustrated; "Nearest the Pole," by Commander R. E. Peary, illustrated; and "Maori and Polynesian," by J. M. Brown.

Messrs. P. S. King and Son direct attention to:—"The Infant, the Parent, and the State, a Social Study and Review," by H. L. Heath; and "Central Poor-law Conference, 1907, Report of the Proceedings of the Central Poor-law Conference held on February 19 and 20 at the Guildhall, London"; "Poor-law Conferences, 1906–7, Annual Volume containing the Reports of the Proceedings of the Central and District Conferences held from May, 1906, to February, 1907, with the Report of the Central Committee."

Mr. John Lane's list contains:—"Ornithological and other Oddities," by F. Finn, illustrated; "Forms of Paralysis," by Dr. J. S. Collier; "The Post-mortem Handbook," by Dr. C. R. Box; "Minor Operations," by E. M. Corner; "Book of Rock and Water Gardens," by C. Thonger; "The Book of the Chrysanthemum," by P. S. Follwill; "The Book of Fruit Bottling," by E. Bradley and M. Crooke; and a new edition of "The Tree Book," by M. R. Jarvis.

Messrs. Crosby Lockwood and Son give notice of:—"Modern American Lathe Practice," by O. E. Perrigo, illustrated; "Graphical Handbook for Reinforced Concrete Design," by J. Hawkesworth, with an appendix containing the requirements of the Building Code of New York City in regard to reinforced concrete, illustrated; "The Construction of Dynamos (Alternating and Direct Current), a Text-book for Students, Engineer-constructors, and Electricians-in-charge," by T. Sewell, illustrated; "A Handbook of Wireless Telegraphy: its Theory and Practice, for the Use of Electrical Engineers, Students, and Operators," by Dr. J. Erskine-Murray, illustrated; "The Twentieth Century Book of Recipes, Formulas, and Processes, containing nearly 10,000 Selected Scientific, Chemical, Technical, and Household Recipes, Formulas and Processes, for Use in the Laboratory, the Office, the Workshop, and the Home," edited by G. D. Hiscox, illustrated; and new editions of "Mechanical Engineer's Pocket-book of Tables, Formulæ, Rules, and Data, a Handy Book of Reference for Daily Use in Engineering Practice," by the late D. K. Clark, revised by H. H. P. Powles; and "A Handybook for Brewers, being a Practical Guide to the Art of Brewing and of Malting," by H. E. Wright, illustrated.

Messrs. Longmans and Co.'s announcements include:—"Design in Nature, illustrated by Spiral and other Arrangements in the Inorganic and Organic Kingdoms as exemplified in Matter, Force, Life, Growth, Rhythms, &c., especially in Crystals, Plants, and Animals," by Dr. J. B. Pettigrew, F.R.S., illustrated; "Nature Round the House, a Simple Natural History for Small Students," by P. Wilson, illustrated; "Hydraulics," by Prof. S. Dunkerley, 2 vols.; "Electro-physiology of Plants," by Prof. J. C. Bose, illustrated; "Investigation on the Theory of the Photographic Process," by Drs. S. E. Sheppard and C. E. K. Mees; "The Teaching of Mathematics in the Elementary and the Secondary School," by Dr. J. W. A. Young; and "Systematic Researches in Thermo-chemistry, Numerical and Theoretical Results," by J. Thomsen, translated by K. A. Burke.

In the list of Messrs. Macmillan and Co., Ltd., are to be found:—"Inflammation," by Prof. J. G. Adami, F.R.S.; "Mining Tables," by Hatch and Valentine; "Geometry Papers," by R. Deakin; "Steam and Other Engines," by J. Duncan; and new editions of "Modern Views of Electricity," by Sir Oliver Lodge, F.R.S.; "A Hunter's Wanderings in Africa," by F. C. Selous; and "Woolwich Mathematical Papers," edited by E. J. Brooksmith.

Mr. Elkin Mathews directs attention to:—"The Days of a Year, a Naturalist's notes from January 1 to December 31, 'the Harvest of a Quiet Eye.'"

Mr. Murray's list includes:—"Life and Adventures of Captain Cook, R.N., the Great Circumnavigator of the World," by A. Kitson, illustrated; "Cretan Excavations and their Bearing on Early History," by Prof. R. M. Burrows; "Heredity," by Prof. J. A. Thomson; "Recent Development in Biological Science," by W. B. Hardy, F.R.S.; "A Primer of Psychology," by L. Brackenbury; "Notes on the Teaching of Elementary Chemistry, with a Sequence of Experiments on Air and Combustion," by J. B. Russell (teacher's edition).

Messrs. A. Owen and Co. announce:—"The Moon in Modern Astronomy," by P. Fauth.

Messrs. George Philip and Son, Ltd., will publish:—"A New Physical Geography for Intermediate and Secondary Schools," by E. O. Williams; and "Builders of the Body," by E. Miles.

Sir Isaac Pitman and Sons, Ltd., give notice of new editions of "Great Astronomers," "In Starry Realms,"

and "In the High Heavens," three works by Sir R. S. Ball, F.R.S.; "Astronomy for Everybody," by Prof. S. Newcomb, with an introduction by Sir R. S. Ball; "By Land and Sky, the Record of a Balloonist," by Rev. J. M. Bacon; "Minute Marvels of Nature," by J. J. Ward; and "Peeps into Nature's Ways," by J. J. Ward.

Messrs. G. P. Putnam's Sons' list contains:—"The Family, an Ethnographical and Historical Outline, with Descriptive Notes, planned as a Text-book for the Use of College Lecturers and Directors of Home-reading Clubs," by Dr. E. L. Parsons; "Hunting Big Game with Gun and with Kodak: how Wild Animals Look and Live in their Haunts, from Personal Experiences in the United States, Dominion of Canada, and Old Mexico," by W. S. Thomas, illustrated; "On the Great American Plateau, Wanderings among Canyons and Buttes in the Land of the Cliff Dweller, and the Indian of To-day," by T. M. Prudden, illustrated; "Diagnosis of Organic Nervous Diseases," by Dr. C. A. Herter, revised by Dr. L. P. Clark, illustrated; "The Sporting Rifle," by W. Winans, illustrated; "Scientific Sanction for the Use of Alcohol," by Dr. J. Starke; "The Muscles of the Eye," by Dr. L. Howe, 2 vols.; "Philosophical Problems in the Light of Vital Organisation," by E. Montgomery; and a new edition of "A Manual of Prescription Writing, with a Full Explanation of the Methods of Correctly Writing Prescriptions, and Rules for avoiding Incompatibilities and for Combining Medicines," by Dr. M. D. Mann.

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Messrs. Scott, Greenwood and Son give notice of:—"Industrial Alcohol, a Practical Manual on the Production and Use of Alcohol for Industrial Purposes," by J. G. McIntosh; "Modern Flax, Hemp, and Jute Spinning," by H. R. Carter; "Celluloid, the Raw Material, Manufacture, and Uses," by Dr. F. Böckmann; "Paper Testing," by Dr. H. P. Stevens; "The Preparation of Paper for Special Purposes," by L. E. Andés; "Pottery Decorating," by R. Hainbach; "Grammar of Textile Design," by H. Nisbet; and new editions of "The Practical Compounding of Oils, Tallow, and Grease for Lubrication"; "A Manual of Agricultural Chemistry," by H. Ingle; "Cotton Spinning, for Honours Students," by T. Thornley; "Workshop Wrinkles," by W. N. Brown; "Recipes for Flint-glass Making."

Messrs. Smith, Elder and Co. give notice of:—"Animal Life," by Dr. F. W. Gamble, illustrated; and "The South Polar Times," reproduced in facsimile, the periodical brought out by the officers of the National Antarctic Expedition on board the *Discovery* during the Antarctic winters of 1902 and 1903, illustrated.

Messrs. Swan Sonnenschein and Co., Ltd., direct attention to:—"How to Study Geology," by E. Evans; and a new edition of "Life by the Sea-shore, an Introduction to Natural History," by Dr. M. Newbigin.

Messrs. E. and F. N. Spon, Ltd., announce:—"The Smith and Forgeman's Handbook of Practical Smithing and Forging," by T. Moore; "English Weights, and their Equivalents in Kilogrammes," by F. W. A. Logan; "The Stoker's Catechism," by W. J. Connor; "A Treatise on the Grouping of Electric Cells," by W. F. Dunton; "Experimenting with Induction Coils," by H. S. Norrie; "Mechanical Draft, a Practical Handbook for Engineers and Draftsmen," by J. H. Kenealy; "Types and Details of Bridge Construction," by F. W. Skinner, part ii., "Plate Girders"; "Designs for Small Dynamos and Motors," by C. P. Poole; and new editions of "A Treatise on Surveying," compiled by R. E. Middleton, O. Chadwick, and J. Du T. Bogle, part ii.; and "The Management of Electrical Machinery," by F. B. Crocker and Dr. S. S. Wheeler.

Mr. Edward Stanford announces:—Vol. i. of "Australasia" in Stanford's "Compendium of Geography and Travel," by Prof. J. W. Gregory, F.R.S., illustrated.

Mr. Elliot Stock promises:—"Natural History of the British Butterflies," by J. W. Tutt, vol. i., illustrated.

The University Tutorial Press, Ltd., will issue:—"Plant Biology," by Dr. F. Cavers; and a new edition of "Physiography," by Drs. R. W. Stewart and W. Briggs.

Mr. Fisher Unwin's list contains:—"Woodlanders and Field Folk," by J. Watson; "The Birds of Middlesex," by J. E. Harting, illustrated; "The Psychology and Training of the Horse," by Count E. M. Cesaresco; "The Principles and Practice of X-Ray Diagnosis and Therapy," by Dr. J. Rudis-Jicinsky, with the collaboration of C. H. Treadwell and Dr. J. Hoffman, illustrated; and "The Horse, a Pictorial Guide to its Anatomy," 110 drawings (reproduced by photolithography) by H. Dittrich, with explanatory notes by Profs. Ellenberger and Baum.

Messrs. Watts and Co. announce:—"An Essay Outline of Evolution," by D. Hird.

The following are Messrs. Whittaker and Co.'s announcements:—"Modern Practice of Coal Mining," by D. Burns and G. L. Kerr; "Armature Construction," by H. M. Hobart and A. G. Ellis; "Electricity in Mining," by P. R. Allen; "Electric Lamps and Photometry," by L. Gaster; "Motor-car Construction," by T. Gray; "The Care of Motor Cars," by T. Gray; and "An Advanced Text-book of Steam, Gas, and Oil Engines," by J. W. Hayward.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The master and fellows of University College have established a "Radcliffe prize" for the encouragement of research in medical science; it will be awarded every second year alternately with the Rolleston prize. Its value is 50*l.*, and it is open to all graduates who have not exceeded twelve years from the date of passing the last examination for the degree of Bachelor of Arts, and are not Radcliffe fellows at the date of application. Candidates must send in their memoirs to the secretary to the boards of faculties on or before June 1.

CAMBRIDGE.—The Master of Trinity Hall has consented to act, and will be formally appointed to act, as deputy for the Vice-Chancellor for the period from March 22 to April 24, when the Vice-Chancellor will be absent in America representing the University at the opening of the Carnegie Institute.

The subject selected for the Adams prize in 1908 is "The Radiation from Electric Systems or Ions in accelerated Motion and the Mechanical Reactions on their Motion which arise from it." The prize is open to the competition of all persons who have at any time been admitted to a degree in this University. The essays must be sent in to the Vice-Chancellor on or before December 16, 1908, privately. The successful candidate will receive about 225*l.*

A university lecturer in pathology will shortly be appointed. The stipend is 100*l.* per annum. Candidates are requested to send their names and testimonials to the Vice-Chancellor on or before April 19.

The next combined examination for sixty-six entrance scholarships and various exhibitions at Pembroke, Gonville and Caius, King's, Jesus, Christ's, St. John's, and Emmanuel Colleges will be held on December 3 and following days. Mathematics and natural sciences will be the subjects of examination at all the above-mentioned colleges. A candidate for a scholarship or exhibition at any of the seven colleges must not be more than nineteen years of age on October 1, 1907. Forms of application for admission to the examination at the respective colleges, and further information respecting the scholarships, may be obtained as follows:—Pembroke College, Mr. W. S. Hadley; Gonville and Caius College, the Master; King's College, Mr. W. H. Macaulay; Jesus College, Mr. A. Gray; Christ's College, Rev. J. W. Cartmell; St. John's College, Dr. J. R. Tanner; Emmanuel College, the Master.

DR. H. T. BARNES, assistant professor of physics in McGill University, Montreal, has been appointed professor of experimental physics in succession to Prof. E. Rutherford, F.R.S.

THE sixth annual students' soirée of the Sir John Cass Technical Institute will be held on Saturday, March 16. The programme includes special demonstrations and short addresses on scientific subjects in the laboratories and workshops of the institute.

ON April 23, the University of Glasgow will confer the honorary degree of Doctor of Laws upon Sir George Watt, author of the "Dictionary of the Economic Products of India"; Prof. E. Boutroux, Paris; Prof. J. Norman Collie, F.R.S.; Prof. U. Dini, Pisa; Prof. J. H. Poincaré, Paris; Prof. John G. McKendrick, F.R.S.; and Principal D. Macalister.

THE estimated expenditure on education, science and art, for the year ending March 31, 1908, is given in the Civil Service Estimates, recently issued, as 17,495,237*l.*, which is a net increase of 316,955*l.* upon the grants made in the fiscal year just ending. The following extracts show how some of the estimates compare with the grants made in the preceding year:—

	1907-8	Compared with 1906-7 Increase	Decrease
	£	£	
Board of Education ...	13,593,646	254,046	—
British Museum	171,041	1,043	—
Scientific Investigation, &c.	54,479	—	3,171
Universities and Colleges, Great Britain, and Intermediate Education, Wales ...	201,400	1,000	—
Public Education (Scotland)	2,022,554	50,426	—
Public Education (Ireland)	1,408,360	15,137	—
Queen's Colleges (Ireland)	4,700	—	161

The apparent decrease in the estimate under scientific investigation is explained by the fact that in 1906–7 the grant to the National Physical Laboratory for new buildings and equipment was 10,000*l.*, instead of the 5000*l.* to be granted to the laboratory in 1907–8.

THE executive committee has submitted to the trustees of the Carnegie trust for the universities of Scotland its sixth annual report, which is concerned with the administration of the trust during the year 1906. Under the scheme of allocation for five years of an annual grant of 40,000*l.* among the four Scottish universities, which became operative on January 1, 1903, sums of 37,289*l.* were claimed and paid during 1906. The grants for library purposes and for provisional assistance in teaching amounted for the year to 6400*l.* For buildings and permanent equipment the grants for 1906 reached 26,189*l.* Payments towards teaching endowments to the extent of 4700*l.* were made, and there is under this head an unexpended balance of 25,132*l.* Under the scheme of endowment of post-graduate study and research, appointments were made to seventeen fellowships and to thirty-seven scholarships. Grants of varying amounts were in addition paid to forty applicants. The total expenditure under this scheme was 6303*l.* during 1906, and it is estimated that during 1907 8064*l.* will be spent. The expenditure upon the Royal College of Physicians laboratory during the year was, so far as the trust is concerned, 314*l.*—this amount being independent of the capital invested in taking over the property of the laboratory buildings. The report directs attention to modifications in the scheme of payment of class fees adopted last year by the committee; the first limited payment of fees of further classes to those beneficiaries who had passed their graduation examinations up to date, and the second modification limited payment of fees of advanced classes to those who had proved their ability to profit by such classes. A striking diminution in the number of beneficiaries and in expenditure upon class fees followed the adoption of these modifications. The report is provided with extensive appendices, which supply detailed information concerning the numerous activities of the trust.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 13, 1906.—"The Velocity of the Negative Ions in Flames." By Ernest **Gold**. Communicated by Prof. H. A. Wilson, F.R.S.

The experiments described in this paper may be regarded as a continuation of the investigations of the properties of ions in flames carried out by Prof. H. A. Wilson in this country and by Marx and Moreau on the Continent.

The determinations of the velocity of the negative ions previously made had led to the conclusion that the ions were of the nature of corpuscles loaded with electrically neutral molecules. The present series of experiments shows that this is not the case, but that the ions are probably free electrons.

The first part of the paper gives an account of experiments made with platinum disc electrodes immersed in a flame obtained by burning the gas from a large Bunsen burner at a row of holes in a quartz tube (quartz for insulation). It is shown that the conductivity of the flame is unaffected by putting salt on the electrodes, although the current is increased from $7{\cdot}3\times10^{-6}$ to 261×10^{-6} ampere, a result which enables the gradient to be determined from the current.

The value of the conductivity obtained and the number of ions per c.c. deduced from experiments by Prof. Wilson and the author (*Phil. Mag.*, April, 1906) enable an approximate value to be found for the velocity of the negative ions in an electric field. The velocity so obtained, 8000 cm. per second for an intensity of one volt per cm., was of a different order from those previously obtained (1000 cm. per sec.).

The latter had been found on the assumption that for small potential differences between platinum electrodes the gradient in the flame was uniform from electrode to electrode, the very close way in which Ohm's law was followed for small applied E.M.F.'s serving as a foundation for the assumption. The measurement of the gradient for applied E.M.F.'s of the order of one volt across 5 cm. is complicated by the variations in the potential taken up by a platinum wire in the flame, due to changes in the temperature and ionisation. These changes are large compared with the quantities to be measured, and ordinary methods of deducing corrections leave possible errors of the same order as the corrected quantity. To avoid this difficulty a special arrangement was adopted in which, by using a thermocouple as explorer, the actual variations due to the applied E.M.F.'s were separated from the incidental variations in the flame. It was found in this way that the fall of potential consisted of a rapid drop at the electrodes, at the negative electrode for the free flame, and at the positive when salt was vaporised beneath the kathode, together with a uniform gradient in the body of the flame.

The results so obtained gave the gradient necessary to drive the ions of salt vapour from the kathode to the anode while they travelled upwards with the stream of gas.

If v is the upward velocity of the flame gases, h the height of the electrodes, d the distance between them, and x the distance the salt vapour extends from the kathode, the velocity k of the negative ions for unit electric field is given by $k=X/d-x=v/h$, where X is the gradient found as above. The velocity v of the flame gases was found by photographing the images of bright particles in the flame formed by reflection at a plane mirror attached to an electrically-driven tuning-fork.

The value found for the velocity of the negative ions for a gradient of one volt per cm. was found to be 12,900 cm. per sec.

The velocity of a corpuscle of mass m and charge e in an electric field of intensity X is $Xe\lambda/mu$, where λ is the mean free path and u the mean velocity of agitation of the corpuscles. Taking for e/m, λ, u, the values 10^7, 3×10^{-4}, $2{\cdot}32\times10^7$, respectively, we get for a field of one volt per cm. a value 13,000 cm. per sec. nearly, a result in close agreement with the value for the velocity of the ions found experimentally. It appears, therefore, that the

negative ions in flames are free electrons, and not atoms or loaded corpuscles.

Interesting results, suggesting a field for further investigation, were found for the gradient when salt was vaporised beneath both electrodes.

January 24.—"On a New Iron Carbonyl and on the Action of Light and Heat on the Iron Carbonyls." By Sir James **Dewar**, F.R.S., and Dr. H. O. **Jones**.

The paper contains an account of the extension of the experiments, previously described, on the action of light on the liquid iron pentacarbonyl and on the action of heat on the resulting solid compound, diferrononacarbonyl. In the course of the experiments, new and interesting observations were made, and a new compound of iron and carbon monoxide discovered.

The action of light on iron pentacarbonyl alone or in solution results in the formation of $Fe_2(CO)_9$ and carbon monoxide, except in two cases, (1) when the solvent is nickel carbonyl, and (2) when the temperature is above 56° C.

The absence of any action due to light above 56° C. has been confirmed by using tubes fitted with a small manometer, which showed no change of pressure when no solid was deposited, and showed that the deposition of solid was a delicate test for any action.

At 35° C. solid was deposited, and pressure developed in five minutes in sunlight.

At 45° C. to 50° C. solid was deposited, and pressure developed in thirty minutes in sunlight.

At 56° C. *no* solid was deposited, and *no* pressure developed in five to twelve hours in sunlight.

The velocity of the reaction was measured, and it was found to be a reaction of the "first order." The rate of decomposition was compared with the rate of the reaction between ferric chloride and oxalic acid, which was investigated by Lemoine; it was found that iron carbonyl was slightly more sensitive to light than the mixture used by Lemoine.

The rate of the reverse action of carbon monoxide on the solid, which takes place in the dark, was also measured, and was found to be very small at the ordinary temperature, but to have a fairly normal temperature coefficient; the velocity was approximately trebled for an increase of 10° C.

Thus a reasonable explanation of the absence of any action of light above 56° C. can be suggested. If the direct action induced by light has a very small temperature coefficient, as the reaction investigated by Lemoine has, the reverse action being about 240 times as rapid at 56° C. as at 16° C. would easily prevent the accumulation of appreciable quantities of the products of the decomposition.

The action of heat on diferrononacarbonyl alone has been shown to produce a decomposition represented by the equation $2Fe_2(CO)_9 = 3Fe(CO)_5 + Fe + 3CO$. When the solid was heated in the presence of hydrocarbons, ether, bromobenzene, or iron pentacarbonyl, however, *green* solutions were obtained, iron pentacarbonyl was produced, but no gas was evolved; if alcohol, pyridine, acetone, or acetonitrile was the liquid used, *red* solutions were obtained, but no gas was evolved; with nickel carbonyl as solvent, gas was evolved and iron deposited. From the green solutions, under suitable conditions, lustrous green crystals were deposited; these were found to be a new compound, *iron tetracarbonyl*, $x\{Fe(CO)_4\}$, where x is large, probably about 20.

The new compound has a molecular volume of 84 for the unit $Fe(CO)_4$, and is very stable. It is not decomposed by hot concentrated hydrochloric acid, is attacked by hot concentrated sulphuric acid giving carbon monoxide and *ferrous sulphate*, and is readily decomposed by cold nitric acid.

Iron tetracarbonyl dissolves in hydrocarbons, ether, iron pentacarbonyl, nickel carbonyl, acetone, and acetonitrile to give green solutions which do not change on heating for a short time, and which deposit the green compound unchanged when evaporated out of contact with air; in pyridine and alcohol the compound dissolves to give a green solution, which changes slowly in the cold and rapidly on heating into a red solution.

The green solutions exhibit a characteristic absorption band in the yellow, while the red solutions show no selective absorption.

Chemical Society, February 21.—Prof. R. Meldola, F.R.S., president, in the chair.—The constitution of hydroxyazo-compounds: W. B. **Tuck**. Several of the hydroxyazo-compounds were examined spectrographically, and it was found that the absorption spectra of the *p*-hydroxy-compounds agree closely with those of their derivatives. The ethers of *o*-compounds also agree with the *p*-compounds, but the benzoyl derivatives are similar to benzoquinonebenzoylphenylhydrazone.—The influence of solvents on the rotation of optically active compounds, part ix., a new general method for studying intramolecular change: T. S. **Patterson** and A. **McMillan**.—Displacement of halogens by hydroxyl, i., the hydrolytic decomposition of hydrogen and sodium monochloroacetates by water and by alkali, and the influence of neutral salts on the reaction velocities: G. **Senter**. On the basis of the results obtained, the hypothesis put forward by R. J. Caldwell, that the accelerating influence of neutral salts on certain catalytic actions is due to the withdrawal of water and consequent concentration of the reacting substances, was criticised. It is considered that the effect in question is due to the action of the ions of the salt on H′ and OH′ ions.—The interaction of ammonium salts and the constituents of the soil: A. D. **Hall** and C. T. **Gimingham**.—The reduction products of *o*- and *p*-dimethoxybenzoin: J. C. **Irvine** and Miss A. M. **Moodie**.—Constituents of natural indigo, part ii.: A. G. **Perkin**. Numerous Java indigos have been found to contain kæmpferol. The leaves of *Indigofera sumatrana* contain a trace of what is probably kæmpferol.—The velocity of hydrolysis of aliphatic amides: J. C. **Crocker**.—The rates of reaction of formamide, acetamide, propionamide, butyramide, *iso*-butyramide, valeramide, capronamide with hydrochloric acid, have been determined at from 40° to 80°. The reactions are bimolecular, and the order of the relative reactivities is the same for each temperature. A relation between the reactivity of the amides at constant temperature and the strength of the corresponding organic acids was indicated.—The rusting of iron: W. R. **Dunstan**. In order to explain the fact that the rusting of iron can take place in the absence of carbonic acid, and that only iron, oxygen, and liquid water are necessary, the working hypothesis was suggested that the formation of hydrogen peroxide is concerned in the change, rusting being prevented by those substances which are capable of decomposing the peroxide (Trans. Chem. Soc., 1905, lxxxvii., 1548). The results of further experiments carried out by the author show that iron rusts freely in the absence of carbonic acid, provided that iron, oxygen, and liquid water are brought together.—Contributions to the chemistry of the rare earths, part ii.: M. **Esposito**. The methods of Muthmann and Böhm and Pattinson and Clarke for the preparation of ceria have been found to give a fairly pure product. Lanthana and old didymia can be separated by fractional crystallisation of the oxalates from strong nitric acid. Lanthana is best obtained by fractional crystallisation of the double ammonium nitrates. After one hundred and ten fractionations, lanthana, praseodymia, and neodymia were obtained in a state of considerable purity.—Derivatives of multivalent iodine, part iii., action of heat on iodobenzene dichloride and on the *m*- and *p*-nitro- and *p*-chloro-derivatives: W. **Caldwell** and E. A. **Werner**.—The organic phosphorus compound formed by yeast-juice from soluble phosphates. Preliminary notice: W. J. **Young**. A lead salt of the compound was prepared from the fermentation mixture by first removing any free phosphate by magnesium nitrate, and then adding lead nitrate. Analyses of two preparations, in which the carbon, hydrogen, lead, and phosphorus were determined, gave the empirical formula $C_3H_5O_6PPb$. From a solution of this the free acid can be obtained, which reduces Fehling's solution, gives Mohlisch's α-naphthol reaction, is slightly dextrorotatory, and can be titrated with alkalis.—Experi-

ments on the synthesis of the terpenes, part x., synthesis of carvestrene and its derivatives: W. H. **Perkin**, jun., and G. **Tattersall**. Continuing their work on the synthesis of carvestrene, the authors have prepared *m*-cineol by the action of magnesium methyl iodide on ethyl *cyclo*-hexanone-3-carboxylic acid, and the *cis*- and *trans*- modifications of *m*-menthane-1 : 8-diol have also been obtained.

Zoological Society, February 19.—Sir Edmund G. Loder, Bart., vice-president, in the chair.—Remains of a bear from the superficial deposits of a cavern in the mountains of Corsica, where bears, though now extinct, were formerly numerous, at least up to the sixteenth century: Dr. C. I. Forsyth **Major**. Despite the fact that no truly fossil bears were as yet known from Corsica, Dr. Forsyth Major considered the Corsican bear to have been autochthonous, whilst in his opinion the recent mammals of Corsica (and Sardinia) had been, almost without exception, introduced by human agency. In any case, they could not be adduced as proofs of a recent connection of those islands with either of the neighbouring continents.—English domestic cats: R. I. **Pocock**. The author urged that the surest basis for their classification and the most satisfactory clue to their descent was furnished by the two distinct patterns found in so-called tabby cats. In one type the pattern consisted of narrow vertical stripes; in the other of longitudinal or obliquely longitudinal stripes which, on the sides of the body, tended to assume a spiral or subcircular arrangement characteristic of the "blotched" tabby. This distinction was long ago pointed out by Blyth. One or the other of these types was to be found in cats of almost all breeds, whether "Persian," "short-haired," or "Manx." There appeared to be no intermediate stages between the two. The cats of the "striped" type were no doubt descended from the European wild cat and the North African wild cat; but the origin of cats exhibiting the "blotched" pattern appeared to be unknown. It was to the cat of the latter kind that Linnæus gave the name *catus*, which was therefore no longer available for the European wild cat; this cat, therefore, must take the name *sylvestris*.—Report on the deaths that occurred among the mammals and birds in the society's menagerie during 1906: Dr. C. G. **Seligmann**. 356 Mammals and 283 birds were submitted to *post-mortem* examination, and the results showed that (1) tuberculosis occurring in birds in the gardens was usually due to infection by the gut; (2) the hearts of rheas, cassowaries, ostriches, and some of the larger storks kept in the gardens were often extremely flabby, and death in these birds was in a large number of cases due to cardiac failure; (3) new growths were rare both in mammals and in birds, but one case of carcinoma arising in the kidney, and occurring in a Chilian pintail (*Dafila spinicauda*), had been observed, as well as two instances of benign new growths occurring in birds not inmates of the gardens.—A peculiarly abnormal specimen of the turbot: J. T. **Cunningham**. The specimen was captured near Padstow, on the north coast of Cornwall. It was a young fish, measuring only 4·4 cm. in length, and a normal specimen of slightly smaller size, taken at the same time, was completely metamorphosed to the asymmetrical condition of the adult. In the abnormal specimen the right side was almost entirely destitute of colour, as in the normal condition, but both eyes were on this white side, instead of being on the left side, as in normal turbot. On the left side pigment was present over the whole surface except the head and the anterior part of the base of the dorsal fin, which were white. The fish was kept alive in captivity for two months, and was observed to lie always with its eyes uppermost, so that the upper side was white and the lower side coloured.—Ideas on the origin of flight: Dr. Baron F. **Nopcsa**. The author stated that from the mechanical point of view a patagium and a set of flight-feathers were different organs. He pointed out the osteological analogies between bats and pterosaurs, on the one hand, and between birds and dinosaurs on the other. He suggested that bats and pterosaurs had arisen from leaping, arboreal forms, whilst birds had come from a terrestrial, cursorial stock.—The azygos veins in the Mammalia: F. E. **Beddard**.

Royal Microscopical Society, February 20.—Lord Avebury, F.R.S., president, in the chair.—An early criticism of the Abbe theory: J. W. **Gordon**. This was a reply to a paper by Mr. Conrady with the same title, read before the society on October 17, 1906. At the conclusion of his paper Mr. Gordon exhibited on the screen some photographs of the spectrum produced by the fine ruling of an Abbe diffraction plate.—Some Tardigrada from the Sikkim Himalaya: James **Murray**.—Some Rhizopods from the Sikkim Himalaya: Dr. Eugène **Penard**.—An incident in ant life: Major **Sampson**. A thick living arch of travelling ants was seen by Major Sampson, now in Southern Nigeria, across a sunny road, and in the centre hundreds of pupæ being carried along in the shade thus caused. This is remarkable, because the African ant, as a rule, dislikes the sun.

Physical Society, February 22.—Prof. J. Perry, F.R.S., president, in the chair.—Transformer indicator diagrams: Prof. T. R. **Lyle**. The term "transformer indicator diagram" has been applied by Prof. Fleming to any series of periodic curves which give the forms, relative phase positions, and magnitudes of the waves of current and E.M.F. on both the primary and secondary sides of a transformer when working. Such diagrams have been obtained by many investigators in different ways, but by none of the methods hitherto used has it been possible to determine directly and independently either the wave of magnetic flux F in the core, or the wave of magnetising-current turns usually represented by the vector sum $n_1C_1+n_2C_2$. It is shown in the paper that the integral $\int(n_1C_1+n_2C_2)dF$ for one cycle is equal to the total iron loss per cycle, and the advantage of being able to determine both $n_1C_1+n_2C_2$ and F directly and accurately is apparent. By means of the wave-tracer designed by the author, not only can the E.M.F. and current waves be accurately determined, but also the wave of magnetic flux pulsating in the core of the transformer, and in addition the magnetising current wave, $n_1C_1+n_2C_2$, can be obtained with the same accuracy as any of the other quantities.—Ionisation of gases by α particles of radium: Prof. **Bragg**. The present paper contains an account of further progress in the work of determining the relative amounts of ionisation produced by the α particle of RaC in different gases and vapours. The view is discussed that the ionisation (i) is connected with the expenditure of energy (ϵ) of the α particle by the expression $\delta i/\delta\epsilon=kf(v)$, where k is a constant for each gas which may be termed the specific ionisation in terms of air as unity, the determination of which for various gases has been attempted in the present paper, and $f(v)$ is a function of the velocity of the α particle only. It is established that the total number of ions produced by the α particles of RaC varies with the nature of the gas, and is for most compound gases and vapours examined about one-third greater than for air. The conclusion is drawn that the primary action of the α particle is a subatomic one. The production of ions may be considered a secondary consequence which varies with the energy expended, the speed of the particle, and the nature of the molecule ionised. The stopping-power of a gas is more nearly an additive property of the atoms in the molecule than any other property except mass, and this is an effect quite apart from the proportionality of stopping-power to the square root of the atomic weight. For atomic weights below 30 the stopping-power, divided by the atomic square roots, is abnormally low, an effect curiously similar to the case of atomic heats. There does not appear any evidence that the chance of an atom being ionised is dependent upon whether it is already ionised, that is, occasionally the molecule may lose several ions.

Anthropological Institute, February 26.—Dr. A. C. Haddon, F.R.S., vice-president, in the chair.—Note on a dolmen called "La Pierre Turguaise," at Presles, France: A. L. **Lewis**. The monument consists of a chamber, with an entrance, formed by two small stones, which originally supported a third. The roof is formed of nine stones. The axis is between twenty and twenty-five degrees south of west and north of east. The total length is about 45 feet. The monument appears to have been sepulchral, but rites of some kind were also probably performed at it.—The ethnology of modern Egypt: Dr. C. S. **Myers**. The measurements, notes, and photographs taken in this investigation led to the conclusions (1) that, compared with the "prehistoric" people of 5000 B.C., the modern

inhabitants show no sensible difference in head measurements or in the degree of scatter of individual measurements about their average; (2) that the modern Copts throughout Egypt are less negroid than the modern Moslem population; (3) that both the Copts and the Moslems in Upper Egypt are more negroid than those in Lower Egypt; (4) that from the anthropometric standpoint there is no evidence of plurality of race in modern Egypt.

Geological Society, February 27.—Sir Archibald Geikie, Sec.R.S., president, in the chair.—The Lower Ordovician succession in Scandinavia: W. G. **Fearnsides.** The paper is a stratigraphical account of the Dictyonema shales, the Ceratopyge beds, the Didymograptus shales, and the Orthoceras limestone of Sweden and southern Norway, and is based upon field-observations of Scandinavian type-localities made by the author during the summer of 1906. The beds are discussed under the following headings:—(*c*) Didymograptus shales and Orthoceras*kalk*, (*b*) Glauconite shales and Ceratopyge*kalk*, (*a*) Dictyonema and Bryograptus shales, which are found to be applicable to all the sections visited. This stratigraphical evidence is considered in its bearing upon the question of the definition of the boundary between the Cambrian and the Ordovician systems, and the author follows the Scandinavian authorities in considering that, so long as the Dictyonema horizon is available, the evidence of sudden faunistic change within the series discussed is too slight to warrant a palæontological separation of the systems at any other horizon. A comparison of the British Tremadoc and Arenig series with these Scandinavian rocks concludes the paper, and it is maintained that the time has now arrived for British geologists to come into line with their Continental brethren, and to include the Dictyonema and the overlying Tremadoc beds as the lowest series of the Ordovician system.—The occurrence of pseudomorphous pebbles of pyrites at the Crown Reef Mine (Witwatersrand): C. B. **Horwood.** Reference is first made to the existence of calcite "pebbles" in the Main Reef, which Mr. Julius Kuntz believes to be due to the replacement of quartz by calcite. Pellets of iron-bisulphide, known as "buckshot," occur at the Rietfontein "A" Mine in the Buckshot Reef; they exhibit radiate fibrous structure, and are probably of concretionary origin. At the Crown Reef Mine a few "pebbles" of pyrites, some measuring as much as an inch in length, occur in a narrow band of conglomerate at the contact of the reef with a basic dyke.

DUBLIN.

Royal Dublin Society, February 19.—Prof. A. W. Conway in the chair.—Electrical seed-testing: Prof. T. **Johnson.** A demonstration was given of the method of using the apparatus devised by Dr. A. D. Waller, F.R.S., for testing for a "blaze" current in electrical seed-testing.—Series in spectra: Prof. A. W. **Conway.** A sphere of positive electricity is supposed, capable of executing radial elastic vibrations of low frequency. In any mode a negative electron could at certain periods be at rest for some time at any one of the nodal surfaces. The frequencies of the oscillations of an electron at the various nodes would be connected by an equation

$$a+bn^{-2}+Cn^{-4}\ \ldots,$$

where n is a natural number.

PARIS.

Academy of Sciences, March 4.—M. Henri Becquerel in the chair.—The heats of combustion and formation of some nitrogenous principles playing a physiological *rôle*: M. **Berthelot** and Ph. **Landrieu.** Thermochemical data for hæmatin, bilirubin, and hæmoglobin from the horse.—The phosphorescence of uranium salts in liquid air: Henri **Becquerel.** At the temperature of liquid air the bands observed in the spectrum at ordinary temperatures are partly resolved into lines, and the bands not resolved into lines contract and are more sharply defined. The phosphorescent spectrum is similarly modified.—The alcoholysis of castor oil: A. **Haller.** Castor oil was treated with various alcohols containing 1 per cent. of hydrochloric acid, and the esters obtained submitted to repeated fractional distillation in a vacuum. Methyl, ethyl, *n*-propyl, and isobutyl ricinoleates were obtained, the physical constants of which are given. The presence in the oil of the glycerides of stearic, ricinoleic, and dioxystearic acids was confirmed.—The purification of sewage: A. **Muntz** and E. **Lainé.** In previous work the authors have found that for intensive nitrification peat forms the best medium for the work. This result has now been applied to the purification of sewage. The filter-bed consists of spongy peat, to which chalk has been added in sufficient quantity to neutralise the acidity, together with a little garden mould to supply the necessary nitrifying organisms. After passing through two small septic tanks, the sewage is filtered through the peat-bed at the rate of 1 to 1·25 cubic metres per day per square metre of surface, and analytical data are appended showing the completeness of the purification.—The obliteration of the pleural cavity in the elephant: Alfred **Giard.** A continuation of the discussion raised by Mme. Phisalix.—Remarks on the preceding paper by M. Edmond **Perrier.**—The formulæ of addition of spherical functions: Niels **Nielsen.**—The constitution of the atom: H. **Pellat.** Starting with the present theory of the constitution of the atom as being formed of a centre positively charged around which gravitate negatively charged electrons, the calculation is made that for sodium, zinc, iron, and copper, the only light radiations possibly emitted by the vapours should be well in the ultra-violet. As this is not in accordance with the known facts, it is pointed out that some of the fundamental assumptions of the theory must be modified.—The refraction of bodies: Jules **Amar.**—Some new modes of formation and preparation of titanium tetrachloride: Em. **Vigouroux** and G. **Arrivaut.** Commercial ferrotitanium, from which the greater part of the iron has been removed by treatment with dilute hydrochloric acid, is dried and heated in a current of chlorine. A good yield of titanium tetrachloride is thus obtained, and details are given of the method of purifying it, especially from the accompanying ferric chloride.—The synthesis of tertiary amidines: phenyl-amido-ethane-oxymethane-phenylimino-phenylamine: Emm. **Pozzi-Escot.**—The constitution of hordenine: E. **Léger.**—A method of synthesis of non-substituted β-ketonic nitriles: Ch. **Moureu** and I. **Lazennec.**—A new method of estimating ammonia in waters: Albert **Buisson.** The method is based on the product of an insoluble compound by the addition of mercuric chloride and sodium carbonate.—The origin of the formation of aldehydes in cheese: MM. **Trillat** and **Sauton.** The bite in cheese has been shown to be largely due to the formation of aldehydes. In the present paper the best means of preventing aldehyde formation is studied.—The toxic power of the definite principles in *Tephrosia Vogelii*: M. **Hanriot.**—The colloidal properties of starch: E. **Fouard.**—The relations existing between the oxyhæmoglobin and the gases of the blood: MM. **Piettre** and **Vila.**—The influence of the physical nature of the walls on the increase of activity of the pancreatic secretion by calcium salts: C. **Delezenne.**—The structure of the cubical form of sodium chlorate possessing rotatory power: H. **Copaux.** The cubical crystals of sodium chlorate owe their rotatory power to the macles of a quasi-cubic orthorhombic form, slightly doubly refractive.—A contribution to the anatomical study of the Raphia of Madagascar: P. **Claverie.**—The edible fishes of Lake Mélah (Algeria): J. **Bounhiol.**—A new form of anidian evolution: Jan **Tur.**—The existence in the Sipunculidæ of Schizogregarians belonging to the family of the Selenidiideæ: L. **Brasil** and H. B. **Fantham.**—Reclamation of priority on the subject of a note by M. Maurice Dupont: Charles **Henry.**—The physiology of the hypophysis of the brain: C. **Paulesco.**—The intestinal absorption, the formation, and the utilisation of reserves in rotifers: P. **de Beauchamp.**—The function of the intestine in fibrinogensis: M. **Doyon,** Cl. **Gautier,** and A. **Morel.**—The lava and minerals of the volcanoes of the Puys chain; the age and cause of the eruptions: Ph. **Glangeaud.**—The graphitic schists and quartzites of Berric, and on their relations with those of Morbihan, of Sarzeau-Guérande, and Belle-Ile: M. **Pussenot.**—The cañons of Provence and the irregularities in the curves of equilibrium of underground water: E. A. **Martel.**—The diminution in the intensity of the earth's magnetic field as a function of the altitude in the *massif* of Mont Blanc: A. **Senouque.**

NEW SOUTH WALES.

Royal Society, December 5, 1906.—Prof. T. P. Anderson Stuart, president, in the chair.—Bibliography of Australian, New Zealand, and South Sea Island lichens (second paper): E. **Cheel.**—(1) Analysis of a specimen of sea-water from Coogee: (2) analysis of the ash of a New South Wales seaweed (Ecklonia); (3) analysis of Roman glass from Silchester, with special reference to the amount of manganese and iron present: C. J. **White.**—Analyses of chocolate shale and of tufaceous sandstone, from the Narrabeen series: S. G. **Walton.** In these analyses special attention was paid to the determination of smaller pieces of the rarer elements.—Gold nuggets from New Guinea, showing a concentric structure: Prof. **Liversidge.** These nuggets presented the usual external appearance, but when sliced, polished, and etched with aqua regia, they showed in parts a concentric structure, but no macro-crystalline structure. Out of a very large number of gold nuggets examined for several years past, these two are the only ones which have shown a lamellar structure. Apparently the layers of gold were deposited within a cavity, in the same way as agates are built up by the deposition of layers of quartz and chalcedony. The evidence is against the successive layers having been deposited around a central nucleus. The gold in one was 88·95 per cent. and silver 1 per cent., and the other 88·25 per cent. and silver 1·05 per cent.—The rate of decay of the excited radio-activity from the atmosphere in Sydney: S. G. **Lusby** and T. **Ewing.** The rate of decay of the excited radio-activity in Sydney is found to be practically the same as that obtained by Rutherford and Allan for Montreal (*Phil. Mag.*, 1902) and by Bumstead in New Haven (*Am. Journ. Sci.*, 1904).

DIARY OF SOCIETIES.

THURSDAY, MARCH 14.

ROYAL SOCIETY, at 4.30.—On the Gravitational Stability of the Earth: Prof. A. E. H. Love, F.R.S.—The Total Ionisation of Various Gases by the α-Rays of Uranium: T. H. Laby.—On the Ionisation of Various Gases by the α-, β- and γ-Rays: R. D. Kleeman.—Capillary Electrometer Records of the Electrical Changes during the Natural Beat of the Frog's Heart: Prof. F. Gotch, F.R.S.

ROYAL INSTITUTION, at 3.—Biology and Progress: Dr. C. W. Saleeby.

SOCIETY OF ARTS, at 4.30.—The City of Madras: Sir James Thomson.

MATHEMATICAL SOCIETY, at 5.30.—Exhibition of a New Calculating Machine: G. W. Evans-Cross.—On the Reduction of the Factorisation of Binary Septans and Octans to the Solution of Indeterminate Equations of the Second Degree: Dr. T. Stuart.—Invariants of the General Quadratic Form *Modulo* 2: Prof. L. E. Dickson.—On Partial Differential Equations of the First Order: J. Brill.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—*Adjourned discussion*: The Transmission of Electrical Energy by Direct Current on the Series System: J. S. Highfield.

FRIDAY, MARCH 15.

ROYAL INSTITUTION, at 9.—Problems of Applied Chemistry: Prof. G. Lunge.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Petrol Motor-Omnibuses: W. Worby Beaumont.

SATURDAY, MARCH 16.

ROYAL INSTITUTION, at 3.—Röntgen, Kathode, and Positive Rays: Prof. J. J. Thomson, F.R.S.

MONDAY, MARCH 18.

VICTORIA INSTITUTE, at 4.30.—Survivals of Primitive Religion amongst the People of Asia Minor: Rev. G. E. White.

TUESDAY MARCH 19.

ROYAL INSTITUTION, at 3.—The Visual Apparatus of Man and Animals: Prof. William Stirling.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Victoria Falls Bridge: G. A. Hobson.

ROYAL STATISTICAL SOCIETY, at 5.

SOCIETY OF ARTS, at 8.—Oils, Varnishes, and Mediums used in the Painting of Pictures: A. P. Laurie.

ZOOLOGICAL SOCIETY, at 8.30.

MINERALOGICAL SOCIETY, at 8.—On the Minerals of the Silvermines District, co. Tipperary: A. Russell.—On Baddeleyite from Ceylon: G. S. Blake and Dr. G. F. Herbert Smith.—On the Silver Deposit in the Perran Mine, Perranuthnoe, Cornwall: F. H. Butler.—Zinciferous Tennantite from the Binnenthal: Dr. G. T. Prior and R. H. Solly.

FARADAY SOCIETY, at 8.—The Potential of Hydrogen liberated from Metallic Surfaces: H. Nutton and H. D. Law.—Electrode Potentials in Liquid Ammonia: F. M. G. Johnson and N. T. M. Wilsmore.—The Impedance of Solutes in Solvents as manifested by Osmotic "Pressure": J. G. A. Rhodin.—The Electrolytic Deposition of Zinc, using Rotating Electrodes, ii.: Dr. T. Slater Price.

WEDNESDAY, MARCH 20.

SOCIETY OF ARTS, at 8.—Smoke Prevention in Factories and Electric Supply Stations: J. B. C. Kershaw.

ENTOMOLOGICAL SOCIETY, at 8.—The Vinegar Fly (*Drosophila funebris*): E. E. Unwin.—The Structure and Life-history of the Holly Fly: Prof L. C. Miall, F.R.S., and T. H. Taylor.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Exploration of the Air: Major B. F. S. Baden-Powell.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Some South African Tardigrada: James Murray.—*Exhibition*: Specimens of British Mycetozoa: A. E. Hilton.

THURSDAY, MARCH 21.

ROYAL INSTITUTION, at 3.—Biology and Progress: Dr. C. W. Saleeby.

CHEMICAL SOCIETY, at 8.30.—The Synthesis of Polypeptides: Emil Fischer.—Organic Derivatives of Silicon, Part iii., *dl*-Benzylmethylethylpropylsilicane and Experiments on the Resolution of its Sulphonic Derivative: F. S. Kipping.—On the Reduction of Carbon Dioxide to form Aldehyde in Aqueous Solutions: H. J. H. Fenton.—The Mechanism of the Rusting of Iron: G. T. Moody.—Some Compounds of Guanidine with Sugars, Part i., R. S. Morrell and A. E. Bellars.

LINNEAN SOCIETY, at 8.—On the Origin of Angiosperms: E. A. Newell Arber and John Parkin.—*Exhibitions*: Water-colour Sketches of Alpine Flowers: Miss Helen Ward.—Photographs of Transvaal Trees and Tree Scenery: J. Burtt Davy.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Rail Corrugation: J. A. Panton.

FRIDAY, MARCH 22.

ROYAL INSTITUTION, at 9.—Rays of Positive Electricity: Prof. J. J. Thomson, F.R.S.

PHYSICAL SOCIETY, at 5.—Experimental Mathematics: Mr. Pochin.—Logarithmic Lazytongs and Lattice Works: Mr. Blakesley.—A Micro-manometer: Mr. Roberts.—Electrical Conduction produced by heating Salts: Mr. Garrett.

INSTITUTION OF CIVIL ENGINEERS, at 8.—A Point in Turbo-Alternator Design: F. J. Kean.

SATURDAY, MARCH 23.

ROYAL INSTITUTION, at 3.—Röntgen, Kathode, and Positive Rays: Prof. J. J. Thomson, F.R.S.

CONTENTS.

SUPPLEMENT.

SUPPLEMENT TO "NATURE."

VIRCHOW'S LETTERS TO HIS PARENTS.

Rudolf Virchow, Briefe an Seine Eltern, 1839 *bis* 1864. Edited by Marie Rabl, geb. Virchow. Pp. xi+244. (Leipzig: W. Engelmann, 1906.) Price 5 marks.

IN an excellent and yet modest introduction to her father's letters, Frau Rabl expresses the opinion that they have "almost the value of an autobiography"; in this she underestimates their worth, for even at the best an autobiography is but a picture drawn long after the early struggles are over, whereas we have here a picture painted as the events happened, and painted with a rare skill and uncommon intimacy, because it was not drawn for the public gaze, but for his father's eye. Even had Virchow become, as was originally intended, merely a surgeon in the army, and had he remained, as at one time he feared, simply a unit in the great average mass, these letters would still have a permanent value as an interesting record of student life in Berlin during the fourth decade of last century; but since they depict the struggles of youthful years which culminated in a triple triumph at the dawn of manhood, they form indeed one of the most important contributions ever made to the study of great men. Before his thirtieth year Virchow had overthrown a speculative pathology which regarded disease as a manifestation of humours of the blood, and by the application of the methods used in the more exact sciences and the use of the microscope replaced it by one which rested on a solid foundation of fact. He had by then begun the study of the antiquities and people of his native province of Pomerania; by then he had thrown in his lot, at the risk of place and life, with the patriots who sought to curtail the autocracy of the crown and ameliorate the condition of the poor and oppressed. He was a splendid fighter, and he fought for truth and freedom in politics as well as in science.

Virchow himself held the opinion that the key to a man's mental development was not to be found in a study of the outward events, which everyone might see, but in an intimate knowledge of the inward events, which only the man himself could know. But even when these letters have supplied us with a knowledge of both outward and inward events we are still at a loss to explain why it was that an only son of a small farmer in a Pomeranian village, who received the orthodox education of an army surgeon, became the Virchow we known in pathology, politics, and anthropology. Heredity scarcely helps us; his father, with the best will in the world, only succeeded in continually mismanaging his small farm, and was permanently in financial straits; his mother we can picture from a letter Virchow addressed to her while he was still a junior student in Berlin; in that he enjoins her to give over complaining of the hardness of fate—what she names fate, he says, is merely the result of human deeds—and advises her to cease confiding her domestic troubles to chance acquaintances. Her love and meekness towards him were unbounded. His uncle on his mother's side was an architect of some repute in Berlin; his uncle on his father's side laboured with success to improve the accoutrement of the Prussian soldier.

The circumstances of Virchow's youth resemble very closely those of Ruskin, except that Virchow's father was a poor man. Both were only children; in both cases the father was the dominant partner and took elaborate pains to teach the child to observe; in both cases the children, by the time they reached early manhood, had fixed their gaze on a universe while their fathers' eyes never strayed far beyond the village pump; with the natural result that the intimate relationships between father and son became sorely strained. "Only you misunderstand me," the youthful Virchow writes to his father, "if you think my pride and self-confidence spring from my knowledge; its blanks I know best; they spring from a consciousness that I desire better and greater things, and strive more earnestly for a full and complete mental life than most men." His father had accused him of being self-conceited, egoistical, and wildly utopian. Much of the correspondence relates to finance and clothes. Virchow senior counsels the purchase of ready-made trousers; "everybody who knows advises me against them," replies his son—and the son always took his own way. In his early student days he set his heart on a felt hat, but managed to jog along by borrowing one until the spring came, when the particular fashion of that year had declared itself, and he had accumulated sufficient funds for the purpose of purchasing a new one. "It is sad to think," he writes, "that my whole future should hang on a seasonable fall of rain or a few weeks of good weather in the harvest." Virchow never forgot the little farm. "How does the corn look?" he continually asks; "are the meadows doing well?" Even when his name was known in all the capitals of Europe, he promises his father to be home in harvest to give him "a hand with his potatoes."

Some years ago the writer of this notice inquired into the circumstances which led to young men taking up the study of medicine. In seven cases out of one hundred the reason was found to be that medicine was the only means of livelihood open to them which gave an opportunity of continuing a study of the natural sciences—especially botany and natural history. That was the reason which led Virchow to the study of medicine; at school the natural sciences were the hobbies of his spare hours. Things have changed since Virchow's day; nearly all the men who occupied the chairs of chemistry, botany, and natural history were then trained for medicine; nowadays one may hope to make a livelihood as well as a hobby of them.

One is surprised to find so little mention of Johannes Müller in these letters; his was the master mind among Virchow's teachers. He mustered among his pupils all the men who made Berlin a

great medical centre—Du Bois-Reymond, Brücke, Haeckel, Helmholtz, Henle, Remak, Schwann, and Virchow. Virchow himself would be the first, in his maturer years, to acknowledge the debt he and all Germany owes to Müller. A. K.

INORGANIC CHEMISTRY.

Introduction to General Inorganic Chemistry. By Prof. Alexander Smith. Pp. xviii+780. (New York: The Century Co., 1906.)

Systematic Inorganic Chemistry from the Standpoint of the Periodic Law. By Dr. R. M. Caven and Dr. G. D. Lander. Pp. xix+374. (London: Blackie and Son, Ltd., 1906.) Price 6*s.* net.

AMONG recently published chemical books, of medium weight, as the clothiers say, these two are worthy of particular attention, for they embody careful attempts to present chemistry in a somewhat new way, and they have, each of them, a distinct individuality.

Prof. Alexander Smith, of Chicago, has already expressed his views on the whole subject of chemical teaching in a work reviewed in these columns a few years since, and he has published a "Laboratory Outline of General Chemistry" which has many merits, and has received the compliment of translation into German. We turned, therefore, to his present exposition of general inorganic chemistry with special interest and with considerable expectations. This new book embodies an attempt to interweave as much of the theory and detail of inorganic chemistry as will provide a reasonable course for a student entering upon the study of chemistry at a university. Prof. Smith adopts the plan of developing the theory piecemeal so that

"no conception is defined, and no generalisation or law is developed, until such a point has been reached that applications of the conception and experimental illustrations, later to be related in the law, have *already* been encountered, and there is about to be occasion for further applications and illustrations of the same things in the chapters immediately succeeding."

This is a difficult plan to carry out thoroughly in a science where there is really no one clearly definable sequence of topics that is the most natural or logical, and where indeed the most elementary facts and most familiar phenomena will, if we like, provoke the most far-reaching questions of theory. But Prof. Smith has met the difficulties of his task with great skill, and has given us a very judicious and well-balanced selection of the facts of inorganic chemistry with a body of theoretical information little less than is to be found in a fairly advanced work on physical chemistry. In this last direction the author has gone much further than most writers of modern text-books, and his exposition of principles is in many respects original in form, and for that reason all the more interesting. The divorce between inorganic and physical chemistry is admittedly artificial, and no one can question that great gain to the study of inorganic facts is derived from the application of chemical dynamics and the doctrine of equilibrium. The infusion of electrochemistry, accompanied by the doctrine of ionic dissociation, will not be so universally acceptable, but probably most chemists will consider the introduction of the new dualism entirely justified by the present state of knowledge.

Whilst Prof. Smith has skilfully handled the theoretical matters which he has introduced, we cannot help thinking that he has attempted rather too much, and that in some cases the compression of the treatment imposed by the limits of the book will leave the student in the possession of thin knowledge and vague ideas. The part of Prof. Smith's book that seems to the present writer to be the least satisfactory is the introduction (chapters i. to iv.), and this is the more to be regretted as it may prejudice the reader at the outset and deter him from proceeding to the vastly better material beyond. The fault that is to be found is one not uncommon in American books, though it is of Teutonic origin; it is the attempt to read into chemistry a kind of philosophical completeness and logical exactitude which it does not really yet possess. The delimitations of an "abstract concrete science," the meaning of "explanation," the explanation that "a cause is a condition or occurrence which always precedes another condition or occurrence," "stochastic and formulative hypotheses," the review of iron and sulphur with a view to the distinction between chemistry and physics; these seem hardly fruitful topics.

Nor do we think that Prof. Smith is happy in his treatment of them. On p. 5 it is stated in leaded type that

"the most obvious characteristic of a chemical phenomenon is that all the physical properties of the substance alter, that this alteration is abrupt, that, in fact, the products are different substances, that the recognition and study of such a phenomenon is accomplished entirely by observations of a physical nature."

Now is this true of so simple an occurrence as the heating of a piece of chalk? Where is the obvious and abrupt alteration of all physical properties?

Again, on p. 32, the leaded statements distinguishing between an element and a simple substance are almost cryptic in their subtlety, besides being mere dogmas as applied to members of the argon family.

These examples might be multiplied, but enough has been said to indicate an objection that will be felt, we venture to think, by most readers, in relation to this exceptionally valuable and interesting book. It might be worth considering whether, if they are to be retained at all, these philosophic excursions should not be confined to an appendix.

Drs. Caven and Lander have written a compact work on inorganic chemistry from the standpoint of the periodic law, intended for students who have reached the last stage of their degree course. It is entirely different in scope and style from the work just noticed, and it has its own very distinct merits. It will probably satisfy admirably the requirements of students who desire to knit up the "ravelled sleeve"

that usually results from two years of the most conscientious teaching of inorganic chemistry, no matter how, by whom, or to whom the teaching be administered. The book is condensed, but it is not dull; there is, in fact, a sort of grip about it which is decidedly sustaining. Many subjects of difficulty, such as the complex cyanides and the amines, are treated with much clearness and perspicuity, and most new things in inorganic chemistry are well elucidated. It is really a work on systematic chemistry, a study of chemical compounds *per se*, detached from all the arts of man, a sort of comparative anatomy based on the periodic law. Judged from this point of view, and not as a work that purports to contain all that a degree student should know of inorganic chemistry, it seems to the present writer as good as any work that has been written with the same object, and a great deal better than most of them.

Very few mistakes have been noticed in reading the book, but the expression (p. 8), "the modified form of Gay-Lussac's law is Avogadro's law," would shock the author of the first book under notice, and it is certainly not felicitous. On p. 44 the hydrides of sodium and potassium are (in view of Moissan's work) unfairly denied the character of definite compounds; and on p. 202 nitrogen trioxide is said to dissociate completely into nitric oxide and nitrogen peroxide on evaporating. The authors propose and use the terms *basigenic* and *oxygenic* respectively for base-producing and acid-producing, and there seems to be some need for such words; it is certainly confusing to speak of the basic properties of oxygen and the basic properties of caustic soda.

ARTHUR SMITHELLS.

GEOGRAPHY FOR SCHOOLS.

A Progressive Course of Comparative Geography on the Concentric System. By P. H. L'Estrange. Pp. xii+148. (London: Geo. Philip and Son, Ltd., 1906.) Price 6*s*. net.

Philips' Progressive Atlas of Comparative Geography. Edited by P. H. L'Estrange. Pp. 148. (London: Geo. Philip and Son, Ltd., n.d.) Price 3*s*. 6*d*. net.

Stanford's Octavo Atlas of Modern Geography. Third edition. Pp. 104+50 maps. (London: Edward Stanford, 1906.) Price 25*s*.

THE very title of Mr. L'Estrange's book expresses an admirable idea. The graduation of geographical teaching in such a way as to adapt the matter to boys and girls of different ages, and yet to make it educational at every stage, and hence to present at successive stages tasks of gradually advancing difficulty, is admittedly one of the hardest and at the same time one of the most important problems which the teacher has to face. In his attempt to accomplish this task Mr. L'Estrange has produced a work on which a very great amount of thought and pains have been bestowed, with such a wealth of instructive maps extremely useful for teaching purposes, and of equally instructive pictorial illustrations, and with a text possessing so many valuable features, that it may be unhesitatingly and cordially recommended to every teacher of geography.

It is to be regretted, however, that one cannot feel the same confidence in recommending the book for the use of the pupils. Notwithstanding all that Mr. L'Estrange has succeeded in doing, notwithstanding the fact that he has made important contributions to the solution of the problem that he has set himself, it can scarcely be admitted that he has been quite successful in so mastering the store of information he has amassed as to lead the learner securely onwards in the manner he has designed. This results partly, it would seem, from the fact that he has never formed any clear conception of the function of geography as distinguished from geology. He gives us no definition of the subject, but opens at once with an account of the structure of the earth's crust such as is given by the geologist. The greater part of this account is, no doubt, also of geographical interest, but if Mr. L'Estrange had recognised the fact that geography and geology differ in their points of view, he would probably have given less importance to some and greater importance to other parts of his physical geography.

The main feature of Mr. L'Estrange's work is an attempt to graduate the subject in three stages, A, B, and C, the A stage suitable to the lower section of a school in which a boy may spend two years, the others to the higher sections. The boy is intended in each successive stage to go over the same ground, to gain additional knowledge and to exercise his thoughts on more difficult problems in the higher stages, but "all without overlapping or ill-ordered acquisition of knowledge." This plan is followed both in the text and the maps, and the manner in which it is carried out in the maps is one of the most important contributions the author has made to the accomplishment of his task.

The plan is in a large measure sound, but probably most teachers will be disposed to think that he has pushed the idea of covering the same ground at every stage too far. They will question whether some of the subjects dealt with are suited for the A stage at all; for instance, that of map projections, which is distributed in a very unsatisfactory manner over stages A, B, and C. This fault, however, can be remedied by the teacher himself reserving the entire subject for the C stage. It is a more serious defect where we find that a reference to a higher stage is necessary to the complete understanding of a lower one, or ideas suited only to a more advanced stage are introduced in the treatment of subjects quite proper to a less advanced stage. Thus on p. 12, after the consideration of the whole subject of running water, we are suddenly introduced in stage A to the conception of alluvial valleys, explained as "flat plains of rich soil deposited by rivers in their lower courses"; yet in the general treatment of running water in the A stage there is no account of the formation of such plains, to understand which one has to consider an action (of a quite simple character) reserved for the C stage, while in the A stage of the general matter we are introduced to the very difficult conception of

a "graded river." It is still worse to meet with statements that cannot but tend to beget confused thinking on the part of the learner, as where we are told that "on a flat surface streams begin by cutting deep perpendicular-sided ravines . . . as in the cañons of Colorado" (p. 8, col. 2), or where, from the wording of the text, a boy would be led to believe that a river in subsiding after a flood deposits matter only along its banks (p. 9, col. 1), or where he is told (p. 32, col. 2) that "the length and direction of rivers [in Great Britain] are largely determined by the surface features," which ought to lead him to try to think what other circumstances may contribute to determining those things. These points may seem trifles, but for the A stage more particularly it is essential that the statements should be strictly accurate and unequivocally clear. More serious misconceptions are sure to be engendered by such statements as that "the circulation of the waters of the ocean brings warmth to the coasts of British Columbia and Western Europe" (p. 18, col. 2). That is quite true if we understand by the coast the mere line of contact of land and water, but boys and girls ought to understand and never forget that it is not true 6 inches inland. Indeed, the whole of the important subject of temperature is very inadequately treated. There is no systematic development and consistent application of the fact stated on p. 16, col. 1, that "movements of air naturally bring warmth to cooler regions or coldness to warmer," and the neglect of this, one of the most serious omissions apparently due to the failing to form a distinct conception of the function of geography, gives rise to other statements in the book that cannot but mislead.

In the preface, Mr. L'Estrange points out that in most of the maps in his book the projections adopted are such as show the parallels of latitude by straight lines. For larger areas the projection most frequently used is the homalographic, which is indeed very good where comparisons of area are important, but is not satisfactory for wind maps, for which it is used in Plate 4, with the result that in the January map the arrows representing the direction of the wind over the Yellow Sea and the Sea of Japan will be read as indicating north-west winds if we refer them to the parallels of latitude, but nearly due north if we refer them to the meridians. By Mr. L'Estrange Mercator's projection is eschewed throughout, but, in spite of its obvious faults, for wind maps there is none better.

The coloured plates, sixty-nine in number, of Mr. L'Estrange's book are now to be had separately under the title of Philips' "Progressive Atlas of Comparative Geography." They consist mainly of maps on each of which there are either names or references by means of letters and numbers printed in brown, blue, and red. On the named maps the brown names are those which it is considered proper for the boys and girls in the A stage to learn, those in B learning also the blue, and those in C adding the red. The maps with references are in other respects duplicates of the named maps, and are intended as test maps. In addition, there are various climatological, commercial, and industrial maps and diagrams, all well executed for the purpose for which they are intended. The "Atlas," like the corresponding plates in the "Geography," is provided with an index on a simple and ingenious plan, only the nearest degrees of latitude and longitude marked on the map being given, with the bearing from the intersection of those lines. Thus Nagpur is entered 20 80 N.W., meaning that it lies north-west of the intersection of 20° N. 80° E., a method which enables one to find the place on the map referred to with great ease. Unquestionably this "Atlas" is fitted to be extremely useful in schools.

"Stanford's Octavo Atlas" is well known for its merits of handiness, of as much fulness as is compatible with its size, and as much clearness as is compatible with its fulness. In this new edition the more important changes that have taken place on the map of the world since the last edition are indicated. The difficulty of inserting new names on the maps might to some extent have been met by inserting them in the index, where the excellent plan is adopted of including more names than are to be found on the maps, so that those who use the atlas are at least enabled to fix the position of a place on the proper map, and thus see its relations to the places which are named thereon. The fact is, however, that some names, such as Kotlass in Russia and Nelson in British Columbia, have already found a place on maps, but not in the index. For a new edition it would be well to reprint this index, abandoning the present plan of giving no reference to the number of a map, but only the name of the country to which a place belongs. Thus one gets the latitude and longitude of a place in Canada, then has to refer to the table of maps at the beginning, and, finally, to ascertain in which of the three maps of Canada there enumerated the place is to be found. In reprinting the index the opportunity might be taken to insert all places omitted. GEO. G. CHISHOLM.

PHOTOGRAPHY FOR COLLEGE STUDENTS.

Photography for Students of Physics and Chemistry. By Prof. Louis Derr. Pp. vii+247. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1906.) Price 6*s.* net.

PROF. DERR is hard to please. He says that good handbooks of photographic manipulation are abundant, but they are apt to be unsatisfactory because their business is not to explain principles. Of complete treatises there are also not a few, but in them the thoughtful student is likely to be "overwhelmed with an avalanche of detail and history"; and monographs are too highly technical and "confined to such limited portions of the photographic field that the desired information generally lies in the gaps between them." He has, therefore, endeavoured to prepare a volume that suffers from none of these disadvantages. He may have suited his book to the needs of his students, but the result

to a stranger presents itself as a very uneven treatment of the subject.

While lenses have eighty-nine pages devoted to them, more than a third of the volume, all the various methods of silver printing are dismissed in but forty-four *lines*. We find that toning silver prints has fourteen lines devoted to it, platinum printing twenty-two lines and two equations, while the use of spoiled lantern plates by cleaning off the films and utilising the glass compares with the above important subjects with its twenty-nine lines. The incompleteness of the consideration of some other subjects, such as halation and intensification, leads sometimes to statements that may convey a false impression. We read, for example, that by continuing the development of an exposed gelatino-bromide plate "the image will gain steadily in density until all the silver present has been reduced, when of course the process ends"—a statement that even mere rule-of-thumb photographers know, often to their cost, is not true. Here, as in one or two other cases, theoretical considerations seem to have misled the author with regard to facts. In short, he does not seem at home in the treatment of what might be called the more strictly photographic parts of the subject.

It is easy to discover the sections of the subject that the author delights in, and it is in these that the value of the book consists. The chapters on lenses do not go deeply into the matter, but they are interesting and clear, and give those details that students want. The representations of the light reflected from the glass-air surfaces of single, doublet, and triplet lenses, and a lens with four separate glasses, are novel as book illustrations and very instructive. In the directions given for testing a lens for its defining power, the fact that commercial plates are not flat is very properly emphasised, but this fact is overlooked in the method given for testing a camera for "register." It is to be regretted that depth of definition is treated of in the orthodox manner, namely, only as it affects that part of the plate immediately adjacent to the lens axis. In direct contrast to this, the author does not follow in the footsteps of most of his predecessors with regard to illumination, considering the effects of focal length and aperture only, but demonstrates exactly how the brightness of the image on the plate must fall off at a distance from the lens axis under even the best experimental conditions.

The chapter on exposure shutters shows that the author is practically familiar with them. He gives the main facts concerning them, and the methods that he has used himself in investigating their mode of action. He gives a table, two and a half pages in length, of the distances that a body falls in each hundredth of a second for a distance fallen of from 2 feet to 20 feet. This ponderous method of timing shutters is surely obsolete. The rotating bicycle-wheel method is also described, as well as methods of investigating efficiency.

Photomicrographs of the grain of plates that have been subjected to various treatments are a notable feature of the work. C. J.

THE FAUNA OF THE TAY DISTRICT.

A Fauna of the Tay Basin and Strathmore. By J. A. Harvie-Brown. Pp. lxxxvi+377; plates and maps. (Edinburgh: D. Douglas, 1906.) Price 30*s*.

WITH the appearance of this handsome work the author has the satisfaction of having completed the tenth volume of "A Vertebrate Fauna of Scotland"; and we have great pleasure in congratulating him on having progressed thus far with a task stupendous enough to have frightened any man from attempting. Not that Mr. Harvie-Brown has written the whole, or anything like the whole, of the preceding nine volumes. On the contrary, he was associated at the commencement of his work with the late Mr. T. E. Buckley, who contributed largely to several of the volumes; while the second volume—on the birds of Iona and Mull—was written by the late Mr. H. D. Graham, and the late Mr. H. A. Macpherson was joint-author (with the editor in chief) of the one on the fauna of the North-west Highlands and Skye. The volume on Shetland is, again, the work of Messrs. Evans and Buckley. Nevertheless, the burden of the work as a whole has been borne by Mr. Harvie-Brown, and if he live to complete his task the author of the present volume will have accomplished for the whole of Scotland what his coadjutor Macpherson did for "Lakeland"; and this, too, in a style which few can equal and none surpass. For Mr. Harvie-Brown is not only an exceedingly careful and industrious investigator, who will never let go a trail until he has hunted it to the end, and will never rest satisfied until he has completely refuted a doubtful assertion, but also a writer gifted with the power of putting facts in a pleasant light and of interesting his readers (who we hope are many) from start to finish. He is, in fact, both an accomplished and elegant writer and an enthusiastic and painstaking field-naturalist—a combination which can scarcely fail to produce attractive and trustworthy work, as it has done in the volume now before us.

As to the importance of works of this nature—more especially to those who come after us—no words of ours are necessary. With the exception of one of a dotterel on her nest by Mr. C. Kearton, and of a second of the Perthshire Museum, the illustrations in the present volume are by Mr. W. Norrie; and when this has been stated, any commendation would be superfluous.

In two respects the author has been specially favoured by adventitious circumstances in the case of the present volume. In the first place, the area of which he treats lies in the heart of that great bay on the east coast into which the estuaries of the Tay and the Forth discharge, and it is consequently one peculiarly favourable for the arrival of birds migrating or driven from the eastward. That such is really the case is evident by a glance at the map of the spread of the little auk over Scotland, facing p. lxxxxv. In the second place, Perthshire possesses a number of local observers specially interested in the fauna of the district; and likewise a museum entirely devoted (as it should be) to the illustration of the local natural history. As examples of the richness of the avifauna

of the district, reference may be made to two lists of birds seen on single days given in the introduction. In the first of these the author records having seen from the road thirty-four species of birds during a drive in the Crieff district; while in the second no less than fifty-four are mentioned as having been seen by the Duchess of Bedford during a few hours' watching at Meikleour.

In the matter of nomenclature the author sticks to the scientific names which have been so long in general use for British mammals; while in the matter of the limitations of genera he likewise follows the old-fashioned usage, retaining, for instance, the blackbird and the ring-ousel in the same genus as the thrush. He will not even accept Microtus, in place of Arvicola, for the water-rat and its relatives; while as to the proposal to adopt Myotis for certain bats, he will have none of it. In one point, and one only, we take serious exception to the author's classification—namely, in his reference of the slow-worm to the Scincidæ, in place of to the Anguidæ, of which it is the type.

Were space available, nothing would please us better than to refer at length to many of the author's observations on birds and mammals; but editorial restrictions peremptorily forbid, so that we can mention only a few points.

Two of the most interesting features in the book are the maps showing the recent spread and increase of the starling and the tufted duck in Scotland. In the former case the map

"shows two distinctly different movements in dispersal of the same, or (?) closely related, races of starlings—one from the north and east (and possibly from Faroe also), and one by purely increase and extension from the south. . . . In the map of the tufted duck's nesting-dispersal, the advance is shown of a species coming for the most part from the south by simple increase, but suggesting also . . . more than merely a south-to-north direct increase, and something of a possible arrival from the east, along the two very principal routes which are followed by migrants at the present day."

Is there, we wonder, some general unsuspected cause connected with these and other recent colonisations?

Of equal interest are the observations with regard to the advent and spread of the squirrel in this and the adjacent districts. The author might, however, have referred to the fact that the British squirrel is certainly a well-defined local race.

In many cases, as we have seen, the author has chronicled the steady increase and spread of birds. In other instances, on the contrary, he has the melancholy task of recording their impending extermination. "Meanwhile," he writes, for instance, "our ospreys are on the verge of despair; they are in anticipation of rapid and final extinction." Although he adds that the resources of civilisation may even yet come to their assistance ere the curtain is drawn. The goshawk and the kite, although formerly abundant, now only linger on as stragglers. Mr. Millais, who had a pair from a keeper at Rohallion, writes that

"it is a pity he destroyed them, as they are probably the last pair that bred in the country. Rohallion, with its great craggy fir-woods, was to my knowledge the last stronghold of both goshawks and kites."

With this reference to the end of the kite and the goshawk as breeding species, we must likewise reluctantly bring to an end our survey of an admirable volume. R. L.

GEODETICAL TABLES.

Auxiliary Tables to Facilitate the Calculations of the Survey of India. Fourth edition. Revised and extended, under the direction of Colonel F. B. Longe, R.E., by Lieut.-Col. S. G. Burrard, R.E., F.R.S., (Dehra Dun: Office of Trigonometrical Branch, Survey of India, 1906.) Price 2 rupees.

THE growth of the Indian Survey and the improvements that have been introduced from time to time are to some extent mirrored by the increase in size and usefulness of the tables, which the department find it necessary to publish. The fourth edition of these useful tables "to facilitate the computation of a trigonometrical survey and the projection of maps for India," which fill a tolerably thick quarto volume, bears possibly the same relation to the modest first edition that the work of the survey of to-day does to the work accomplished some sixty years since. In that first edition only seventeen tables appeared. Each successive issue increased that number, till now we have no fewer than sixty-nine tables and six appendices containing useful matter likely to prove of assistance to geographical explorers.

This new issue and wider employment of tables tells also of the changes that have been made in the method of projection used in the construction of Indian maps. In the olden time the projection was so arranged that while the central meridian of a map was a straight line, all others were curved and concave to the central meridian. This was found to be inconvenient, especially when it was required to place two maps together so as to form a single map. A modified polyconic projection, in which all the meridians are straight lines, is now employed. This system, introduced by General Walker, will in future be used for all maps on the scale 1 : 1,000,000 and larger scales.

With regard to the tables themselves, they necessarily take the form that long experience has approved. This is a sufficient answer to any criticism, but to those who have been accustomed to a different method of calculation it may seem strange to find the logarithms of numbers less than unity affected with a negative sign. As doubts have lately been expressed of the superiority of the method employed in astronomical calculations, it is not unimportant to notice that so influential a body as the Indian Trigonometrical Survey prefers to retain the use of a negative characteristic. There are not, however, many tables in which this peculiarity is required. Many tables have reference to "Graticules of Maps," and give the sides and diagonals of areas varying from $\frac{1}{16}$ of a degree to four degrees, on such scales as are used in the department.

In the meteorological tables, if one might make a suggestion, it would be to the effect that Loomis's coefficients for determining the differences of height with the barometer might have been superseded by the results of more modern investigations, such as those of Angot or Rykatchef. Applying what appeared to be more trustworthy values to the example quoted, a result was obtained which differed some fifty feet, or about three-quarters per cent., from that given. This discrepancy seemed too large, but some of it may be due to want of experience in the use of tables. It would be interesting to know what degree of accuracy has been reached in the determination of heights by means of the barometer, and what is the correct way of assigning an average temperature, moisture, &c., to the mass of the atmosphere between the two stations A not inconsiderable error must be introduced by unknown variations of temperature, accompanied, as these may be, by possible inversions.

THE CENTRAL NERVOUS SYSTEM.

Das Cerebellum der Säugetiere. Eine vergleichend anatomische Untersuchung. By Prof. Louis Bolk. Pp. 337; illustrated. (Jena: Gustav Fischer, 1906.) Price 15 marks.

PROF. LOUIS BOLK has risen far above the opportunity that the title of this work would seem to offer, and has written a book of quite uncommon interest. To this success several factors have contributed. In the first place, his own labours, and those of Profs. Charnock Bradley and Elliot Smith, to whom he makes due acknowledgment, have brought much new light and interest to the subject. Symptomatic of this triad advance is a new nomenclature of a somewhat unfortunately triune character, varying from simple numerals to idyllic descriptive terms.

In the second place, the author has stepped beyond the limits of rigidly specialised morphology, and has entered the arena of general science. His courage carries him beyond the assertion that morphology is of profound interest to the physiologist, into the statement that morphology is a high road, although a narrow one, to the elucidation of function. It is a bold theme, and has rarely been better emphasised; but in this case its application is obviously weakened by the morphologist's concentration on the value of mass. A knife, some spirit, and a plate, a pair of forceps, and a jar or two, together form but a pioneer outfit with which to delimit the frontiers of function, or even of structure, in the central nervous system. A microscope and the methods of the histologist would have added marvellously to the data upon which such a theme might have been sustained. This notwithstanding, the enthusiasm of its sustentation has greatly added both to the interest of this book and to the value of the work on which it is based.

Many anatomists, for the convenience of description, have divided the cerebellum into a median portion, the vermis, and two lateral hemispheres. According to the author, the pursuit of convenience has here overclouded important facts. The cerebellum is primarily divided into an anterior and a posterior lobe, and it is only in the latter that there is any real distinction into mesial and lateral lobules. He has carefully examined the correspondence between the mode of growth of the cerebellum and this true lobulation, and concludes that the organ grows by expansion from a definite series of centres, and that these centres are in a large measure independent, as is shown by their relative behaviour in different mammalian cerebella. From this point Prof. Bolk advances with the postulate that the functional capacity of each domain must have the same independence. Further, since the function of the cerebellum as a whole is to play some part in the adequate performance of muscular movements, each of these centres must control some particular province of movement. From this it is but a short step to the allocation of function. Symmetrical movements are controlled from mesial centres, asymmetrical movements from lateral centres. The more anterior the muscles involved, the more anterior the centre. It therefore follows that the anterior lobe is concerned with movements of the head, eyes, tongue, jaws, larynx—all parts in which symmetrical movement is the most common. In the posterior lobe the first centre is also a mesial one, and controls the neck. Then follow both mesial and lateral centres for the control of the limb movements, and so on.

This method has at least induced the author to make most interesting comparisons between the cerebella of different mammals. When the animal's mode of progression is a symmetrical one, the lateral limb centres are small, the mesial large and complicated; when asymmetrical the relation is reversed. Where, as in the giraffe, the neck assumes a new importance, there is a coincident expansion of an appropriate mass in the cerebellum. In ruminants—but this is not quite so certain—there is an appropriate enlargement of the jaw-centre in the anterior lobe.

Now there is much probability in the idea that definite portions of the musculature are primarily connected with appropriate districts of the cerebellar cortex. Nerve-fibres ascending from the medullary nuclei doubtless enter the cerebellum as definitely marshalled as are their precursors in the spinal cord. It is extremely likely that outgoing fibres leave it no less well arranged. Most probable, too, is the idea that fibres from cephalic districts are distributed to anterior portions of the cerebellum. The crude forms of experiment, which have up to the present been made available, may even for some time prove no more than this. It is certainly, therefore, to the credit of Prof. Bolk to have arrived at similar ideas by means of his, unfortunately also crude, methods of observation.

When the full meaning of the cerebellum is discussed, there is, however, a demand for evidence of a somewhat different kind. We have acquired a taste for the kind of evidence that Prof. Sherrington has brought to bear upon the function of the spinal cord. This is the attitude of Prof. Bolk, and it is a wise one. The elongation of the giraffe's neck is, as he

himself points out, accompanied by more than an added complexity in the movements of this particular district. There is a new "figure" to equilibrate. It might also be suggested that there is something new in the location of eyes and semicircular canals at the end of so long a flail.

No one interested in the central nervous system can read Prof. Bolk's book without attention or without criticism. J. S. MACDONALD.

PARTIAL DIFFERENTIAL EQUATIONS.

Theory of Differential Equations. By Dr. A. R. Forsyth, F.R.S. Vol. v., pp. xx+478; vol. vi., pp. xiv+596. (Cambridge: University Press, 1906.) Price 25*s.* net.

THE appearance of these volumes marks the happy conclusion of a work undertaken, as the author reminds us in his preface, twenty-one years ago. Doubtless it would have been finished earlier had it not been for unavoidable interruptions; but the delay must have brought its compensations, because many most interesting developments are of recent date.

Vol. v. deals with equations of the first order, and immediately suggests two reflections—one that Lie has made the most important contribution to the subject since the publication of Jacobi's memoirs, and the other that it is a great help to have such an outline of Lie's theory, with Mayer's simplifications, as that given in chapter ix. The Jacobian theory, too, with Mayer's developments, is given in chapters iii., iv. in a very attractive and readable form. Chapters vi., vii., viii. are mainly concerned with characteristics, and embody much of the work of Cauchy, Monge, Lie, and Darboux, as well as original contributions by Prof. Forsyth himself.

It may be a rather far-fetched comparison, but there does appear to be a kind of analogy between the achievements of von Staudt and Lie. Von Staudt's treatise on projective geometry does not contain a single diagram, but it is beyond question the most masterly work on the subject. Lie is almost, if not quite, as chary of graphical illustration, but the spirit of his work is geometrical throughout, and he stands in the same sort of relation to Monge that von Staudt does to Steiner. It is most interesting to see how the canonical equations of dynamics (pp. 398–406) are illuminated by the theory of contact transformations; and, again, it is mainly Lie's ideas which have prepared the way for a thorough discussion of *all* the solutions of a partial differential equation, including the special integrals which do not come into the ordinary classification.

The great advance which has been made arises from considering a differential equation, not merely as representing a property of a function assumed to exist, but as defining an aggregate of elements which are most vividly realisable in a geometrical form. In partial differential equations of the first order these elements may be taken to be tiny fragments of planes scattered about in space; the differential equation defines the system of elements, and a complete integral, if it exist, represents the collecting of the elements into surfaces which form a family. In Clebsch's treatise on geometry, there is a chapter on connexes to which he evidently attached importance, and which has obvious relations, not only to mixed concomitants, but also to ordinary differential equations. If it has not been already done, it might be worth while to see whether something might not be made out of these relations; Clebsch's work has, of late, rather suffered neglect. Again, it may be suggested that in dealing with partial differential equations of the second order it might be helpful to associate with given values (x, y, z, p, q, r, s, t) a fragment of a surface of the second order, just as a fragment of a plane is associated with (x, y, z, p, q). That fragments of this kind are less likely to be associable so as to form surfaces than corresponding plane elements is tolerably plain, and partly accounts for the increasing difficulty of treating equations of the second order without making particular assumptions.

Vol. vi. of the present work is practically devoted to partial differential equations of the second order. Thus we have chapters on Laplace's linear equation, with the elegant developments of Darboux, Moutard, and others; the methods of Monge, Ampère, Boole, Darboux, Hamburger, &c., with instructive comparisons, and examples worked out each way; together with a chapter on general transformation, embodying the most important of Bäckland's results. As an example of the power of Lie's methods even in the production of beautiful *particular* theorems, the proposition on p. 295 may be quoted:—

"When an equation of the second order (of the Monge-Ampère form) has two independent intermediate integrals, it is reducible to the form $s=0$ by contact transformations."

Very little, comparatively, has been done for equations of order higher than the second. Prof. Lloyd Tanner is one of the few pioneers in this region, and his results, obtained by a different method, are explained in chapter xxii.

Prof. Forsyth explains in his preface and final remarks the principles which have guided him in his choice of material. This must, indeed, have been a most difficult task. It would be easy to dub this treatise "encyclopædic," but it is not, and the fact that it is not is one of its merits. The literature on ordinary linear equations alone which has been published since Fuchs's memoir appeared in *Crelle's Journal* would much more than fill the whole of Prof. Forsyth's pages. No one who is not prepared to devote the whole of his time to the subject can possibly become familiar with all that has been written about it; and even if, as is quite possible, this treatise may occasionally disappoint those who consult it on some subsection of the subject in which they are specially interested, it is sure to be of great service by presenting an ordered and not unwieldy body of doctrine, together with suggestions of the directions in which further progress may be expected.

G. B. M.