THURSDAY, NOVEMBER 11, 1909.

THE INTERNAL COMBUSTION ENGINE.

The Gas, Petrol, and Oil Engine. By Dugald Clerk, F.R.S. Vol. i. New and revised edition. Pp. ix+380. (London: Longmans and Co., 1909.) Price 12*s.* 6*d.* net.

MR. DUGALD CLERK originally published this book under the title of "The Gas Engine" in 1886. Ten years later it reappeared in enlarged form as the "Gas and Oil Engine." It has now been found necessary, the author tells us, to re-write practically the whole of it, and in doing so the further change of dividing it into two volumes has been made. This is in itself evidence of the development of science and practice that has taken place during the last twenty-three years. The two new volumes are to be called "The Thermodynamics of the Gas, Petrol, and Oil Engine," and "The Gas, Petrol, and Oil Engine in Practice." It is the first of these volumes which is now issued. It is ostensibly a book on the thermodynamics of the gas engine, and it is as such, therefore, that it must be examined and discussed. We may say at once that it is quite unlike any other book on thermodynamics that we remember to have read. Its appeal must be to the comparatively small number of engineers and physicists who are familiar alike with modern practice in gas-engine work and with some of the most recent results in physics. To the experimenter in this important field of work, it will be invaluable as containing in compact form a record of the latest experiments as well as an occasional commentary upon them from the author's standpoint.

It interested us to compare the present volume with Mr. Dugald Clerk's book on the gas engine issued in 1896. We were the more interested in such a comparison because of the change that has come to the point of view of so many workers on account of later knowledge of the physical properties of the gases concerned in the gas-engine cycle. Mr. Clerk's point of view has also changed materially. The author remarks on p. 200:—

"Some things, however, have been definitely settled. Holborn and Austin's investigations have placed it beyond doubt that the specific heat of steam and carbonic acid increases considerably with increase of temperature, and that a small increase occurs with oxygen and nitrogen. Nernst's investigations have proved that the dissociation of steam and carbonic acid at about 2000° C. is unexpectedly small."

When the 1896 edition was published, and until a much later date, Mr. Dugald Clerk was disinclined to accept the contention of the French physicists that specific heat increased with temperature, and the thermodynamic part of that volume, which is, we notice, reproduced with but little change in the first 118 pages of the present one, was based on the constancy of specific heat. After reproducing this earlier work, Mr. Dugald Clerk now adds:—

"Throughout the present chapter the working fluid has been assumed to be dry air obeying perfectly the laws of Charles and Boyle; its specific heat has also been assumed to be constant throughout the temperature range. . . . It is now known that the specific heat of air is not quite constant between 0° and 1400° C. . . . The mean $K\rho$ between 100° C. and 1400° C. is about 8 per cent. higher than that between 100° and 200° C. . . . But it must be remembered that the efficiencies and mean pressures determined by these calculations for ideal air are not the efficiencies and mean pressures which would be proper to the actual working fluid. . . . Meantime, however, it may be taken that the reasoning and conclusions reached in this chapter are valuable when properly used."

From p. 119 onwards the author takes into account the variability of specific heat with temperature. Indeed, in virtue of its importance, the greater part of the book is devoted to the consideration of this matter and of the associated problems.

Practically all recent work is described at more or less length, and particular stress is laid on the important work carried out on gaseous explosions at the Royal College of Science, on the initiation of Prof. Perry. Mr. Dugald Clerk is able to reproduce a great deal of this experimental work which had not previously been published, and he analyses the results obtained with great skill and infinite patience. It seems a pity that the record of these experiments has not previously been published, and we can only surmise that their importance was not realised adequately, perhaps because the experimenters, Messrs. Bairstow and Alexander, did not bring out their points with the emphasis at Mr. Dugald Clerk's command. How far the accuracy of these experimenters will stand the test of time remains to be seen; the virtue that led Mr. Dugald Clerk to refer to them at such length is that they are the only experiments so far known from which can be obtained a series of cooling curves under various conditions of pressure and temperature. We anticipate that practical results of real use will be obtained from this work.

At the end of the volume the author reproduces the very valuable 1908 report of the Gaseous Explosions Committee of the British Association. It includes a description of Mr. Dugald Clerk's "zig-zag" experiments. It also criticises them, and gives reason for thinking that they may contain an error of as much as 10 per cent. The committee remarks, "If there be systematic error in Mr. Clerk's work it seems most likely that it lies in the estimate of heat loss," and proceeds to indicate a way in which this error can be corrected. It is very curious to read this report at the end of Mr. Dugald Clerk's book, when, on turning to his own account of these very experiments, he omits to discuss any correction of the kind. We think that it would have been better if some notice had been taken of the committee's remarks, although it may well be that to have done so would have led to such a mass of extra work that any author might shrink from it.

We are so grateful to Mr. Dugald Clerk for this interesting volume that we do not wish to press too hard the main criticism to which it is liable, viz. that it is insufficiently edited, that a tight enough grip is not held upon the subject, and that the style is not such as to make it easily readable.

THE DIAMONDS OF SOUTH AFRICA.

Die diamantführenden Gesteine Südafrikas, ihr Abbau und ihre Aufbereitung. By Dr. Ing. Percy A. Wagner. Pp. xviii+207. (Berlin: Gebrüder Borntraeger, 1909.) Price 7 marks.

AMONG the numerous works that have appeared on the subject of South African diamonds, the book before us is worthy of a very high place. The author has examined the diamond-bearing rocks and their relations during a visit to South Africa, and has studied the materials brought home in the laboratories of Prof. Rosenbusch in Heidelberg, and under Prof. R. Beck at Freiberg, to the latter of whom the work is dedicated.

The record of previous literature at the beginning is very full and complete, comprising the titles of 138 memoirs and books, besides general references to periodical publications. The distribution and character of the various "pipes" are clearly described, and the series of comparative ground-plans drawn to scale on p. 7 is very striking and instructive. The second division of the book contains an admirable account of the various minerals found in the pipes, of which minerals no fewer than about thirty species are described. In his chapter on the petrography of the country, the author adopts the views of Carvill Lewis and Bonney concerning the important part played by the rock to which the first-named author gave the name of "Kimberlite"; but besides the form of the rock first described from the Kimberley district, Dr. Wagner indicates the existence of a variety much richer in mica (biotite), which occurs in dykes in Orangia and northern Cape Colony. These rocks have been carefully studied by the author, who gives chemical analyses of them and the results of investigations under the microscope, illustrated by two plates containing photographs of rock-sections.

Since the discovery of diamonds enclosed in masses of eclogite (the "griquaite" of Beck) in the pipes of South Africa—a discovery announced in this country by Sir William Crookes and Prof. Bonney in 1907—special interest attaches to the various fragmentary rock-masses which occur so frequently in the "blue and yellow grounds" of the South African mines. The author devotes especial attention to the characters of this diamond-bearing eclogite, and cites the case of a similar rock having been found in the Bingera diamond field of New South Wales, as related by Mr. G. W. Card. It is interesting to notice that not only diamond but crystalline plates of graphite have been found by Harger and by Beck, enclosed in the eclogite masses. Various other rock fragments and mineral aggregates occurring with the eclogite masses are described in detail. The evidence of the existence of diamond enclosed in olivine, and of microscopic diamonds distributed through kimberlite, is also discussed, and the bearing of all these and other facts on the vexed question of the origin of the diamond is considered. The whole of the observations bearing on the subject appear to us to be stated very clearly and impartially.

We naturally look in this work for some account of the new diamond-fields of German South-west Africa, but at present the information upon the subject appears to be somewhat meagre. According to the only scientific account of the district which has as yet appeared, the diamonds occur in an undisturbed formation of Cretaceous Sandstone. This sandstone, according to Merensky, however, consists in great parts of grains of chalcedony and agate, derived from an amygdaloidal diabase, and it is this rock which is regarded by him as the original source of the diamonds. In 1908 this diamond-field had yielded a great number of small diamonds (usually four or five to the carat) of the aggregate weight of 39,762 carats and of a value of 550,000*l*.

The later chapters of the book deal with the methods of mining the "blue ground," and the different kinds of treatment to which it is subjected in order to extract the diamonds. A number of photographs of the various workings, and of the machinery employed, adds to the interest of these chapters, the information in which has been apparently obtained from trustworthy sources. The work closes with some interesting statistics showing the weight and value of diamonds yielded by each of the mining districts, and the average value per carat in each case. From 1898 to 1908 nearly thirty-one millions of carats were obtained in South Africa.

A LOST OPPORTUNITY.

The Stone Ages in North Britain and Ireland. By the Rev. Frederick Smith. With an introduction by Prof. Augustus H. Keane. Pp. xxiv+377; illustrated. (London: Blackie and Son, Ltd.) Price 6*s*. net.

THE problem of the Stone ages is one that is full of complications. The greater part of it yet remains unsolved, for the sum of our actual knowledge of the conditions of Palæolithic man is as nothing in comparison with our ignorance. By small degrees advances are made. It is found, for example, that in other continents the remains of analogous culture stages bear that striking resemblance to those of our own that is one of the most surprising features of the study of prehistoric man in all periods. But such additions to knowledge, interesting as they are, help but little to enable us to picture the lives of the men whom they concern. The advance must of necessity be slow, for it is given to few to be able to read in nature's writing the very incomplete record of early man. While empiricism may make a lucky shot now and then, it can be only to the trained and reflective searcher that we must look for any effectual progress. Of such trained and industrious men there is no lack, and their accumulated experience, sifted by a master, might even now be brought into line for the less instructed public. Meanwhile, we have enthusiasts, like the Rev. Frederick Smith, who spend years in gathering specimens and deducing theories from them, and present us with ample volumes, like the present one, well printed and fully illustrated, and with this for the moment we must be content.

Mr. Smith is an amateur in all senses of the word.

His love for every stone he has found appears throughout the whole book, and his grief at the loss of one specimen, of which he has only kept a drawing, is almost pathetic. That he is an amateur in the other sense is clearly shown by his method of presenting his case. A careful statement of the evidence which leads him to attribute this or that specimen to the Palæolithic or any age is hardly to be found, while his attitude is one of pure dogmatism with regard to the artificial character of the stones he is principally dealing with. It is manifestly unsafe to judge of such a point as the latter from a drawing alone, and that is all the reviewer has in the present case. But it is not unjust to assume that in Mr. Smith's own drawings of the stones he is dealing with, all the features that lead him to think them to be "artefacts" are shown at their best. Yet to the unprejudiced eye, familiar with man's handiwork in stone under primitive conditions, whether prehistoric or modern, there are very few in Mr. Smith's book that could safely be pronounced "artefacts."

This may appear to be a hard saying, and in a limited degree it is so, for, in default of some evidence, it is hard to think that the majority of the stones represented in Mr. Smith's figures show any signs of human handiwork. Nevertheless, it is quite conceivable that they may be the best that Scottish Palæolithic man could produce. But what is wanted is something approaching proof of human intention in the fashioning of them. Mr. Smith, in short, has mistaken a much-loved hypothesis for fact. As hypothesis, no one would have found fault with his volume. He has spent much time and many words, moreover, in demolishing phantoms; for instance, he is apologetic that his "implements" of basalt and similar rocks do not show the familiar "bulb of percussion," so common in flint tools, and yet he surely must know that the fracture of flint differs essentially from that of basalt or granite; he adduces (p. 14), as proof of the Palæolithic age of the stones, the fact that he never encountered a polished weapon, as if all tools or weapons of the later ages were polished; most assuredly the majority are chipped only. He refers to glacial striæ in support of the same contention, and for this we would commend to him the vast series of Neolithic scrapers with glacial markings that have been collected by Dr. Allen Sturge. Two pages of text and three figures are devoted to a single chipped flint, described (and doubtless rightly) as accidental by "a Cambridge expert." Here a claim is made that the facets of the surface are made to fit the ball of the thumb. As if the human hand had no power of adaptability! It is very likely that this and other flaked flints, whether the flaking be natural or artificial, will be found to fit the ball of the thumb, but the virtue lies in the thumb, not in the flint.

One other instance of Mr. Smith's arguments is worth quoting. He was distressed that the flaking on one of his flints had been set down as due to "thermal" causes. This criticism he meets by the statement that he had watched some of his flints pass through all the rigours of Scottish winters for no less a period than twenty long years, and that they showed no signs of thermal flaking at the end of it. Arguments of this kind can only convince the converted, and even the support of Prof. Keane, enthusiastic as he is, will hardly suffice to carry conviction to the unbiassed. The chapter on Ireland is of a piece with the rest. The author's naïve surprise at finding in Ireland precisely the same forms he had been finding in Scotland recalls to one's memory the letter from Egypt of the late Mr. Auberon Herbert, who found there the very same broken edges to flint flakes that he had seen in England, though it must be confessed that Mr. Smith does not go to quite the same lengths as Mr. Herbert.

A book of this kind makes one sad. Working on a stable foundation, Mr. Smith's pertinacity and enthusiasm might have enabled him to add his mite to the sum of our knowledge of early man. He has chosen, on the other hand, to follow a will o' the wisp.

CHEMICAL TECHNOLOGY.

(1) *L'Industria delle Materie Grasse.* Vol. i. I Grassi e le Cere. By Dr. S. Facchini. Pp. xxiii+651. (Milan: Ulrico Hoepli, 1909.) Price 6.50 lire.

(2) *Gomme, Resine, Gomme-resine e Balsami.* By Dr. Luigi Settimj. Pp. xvi+373. (Milan: Ulrico Hoepli, 1909.) Price 4.50 lire.

(3) *Analisi Chimiche per gli Ingegneri.* By Dr. Luigi Medri. Pp. xiv+313. (Milan: Ulrico Hoepli, 1909.) Price 3.50 lire.

(4) *Die Chemische Industrie.* By Gustav Müller unter mitwirkung von Dr. Fritz Bennigson. Pp. viii+488. (Leipzig: B. G. Teubner, 1909.) Price 11.20 marks.

(5) *Chemical Industry on the Continent: a Report to the Electors of the Gartside Scholarship.* By Harold Baron. Pp. xi+71. (Manchester: University Press, 1909.) Price 1*s.* net.

(6) *Laboratory Guide of Industrial Chemistry.* By Dr. Allen Rogers. Pp. ix+158. (London: Constable and Co., Ltd., 1908.) Price 6*s.* net.

(1, 2, and 3) THESE three volumes belong to the well-known and excellent "Manuali Hoepli." Dr. Facchini's treatise is the first volume of a series which, when completed, will cover the whole ground of the industry of fats, oils and soaps. It deals with the general chemistry of the fats and waxes, and the methods used in their analysis. It is a concise but fairly complete summary of the information included in the larger treatises on the subject, and should prove a useful book of reference in cases where the larger works are not available. The same remarks apply to the treatise on gums and resins by Dr. Settimj, which necessarily is in the main but a well-arranged and useful abstract of Tschirch's standard handbook.

Dr. Medri's little book on analysis is a compilation designed specially for the use of engineers rather than chemists. It summarises the methods of analysis of air, water, cement materials, combustibles—solid, liquid and gaseous—and of several of the principal metals and alloys in general use. There is also a short chapter on explosives.

(4) Councillor Gustav Müller's essay on chemical industry contains a wealth of information hitherto scattered in official publications and technical journals, and only to be gleaned with difficulty. There is little doubt that it will become an indispensable book of reference to the chemical merchant and manufacturer, as well as a guide to the works manager, on all economical and statistical questions concerning his industry. The early chapter on general economic development contains a brief history of the growth of chemical industry in different countries, with full statistics for all the different branches dealt with. Valuable information is collected with regard to patents and trade marks, and the existing "trusts" or "Kartels." A chapter covering eighty pages, on the legal control of the industry, includes a discussion of patent laws, factory acts, workmen's insurance and health regulations, and includes details of the tariff rates for Germany and of trading treaties with other countries. In the second part of the work, a chapter is devoted to each individual branch of chemical industry, and here complete statistics of imports and exports for several years past are collected for each substance considered. The whole work is excellently arranged, and cannot but prove of the very highest utility.

(5) Mr. Harold Baron's report is the outcome of a tour undertaken in 1905 as Gartside scholar in the University of Manchester. Under the tenure of these scholarships, each scholar has to select some industry or part of an industry for examination, and investigate this comparatively in the United Kingdom and abroad. The present report is an account of a visit to a large number of chemical and textile works in Belgium, northern France, and Germany, with comments on their character and organisation. The report makes interesting reading, and contains a good deal of information likely to prove instructive to those not well acquainted with Continental chemical works and their methods. The description given of the wonderful works of the Bayer Company at Elberfeld and Leverkusen deserves to be widely read. At Leverkusen the works are equipped with a water supply capable of producing thirteen and a quarter million gallons per day, the daily consumption of Cologne, a town with 400,000 inhabitants, being only thirteen million gallons daily. Some idea of the vastness of the colour works may be derived from the fact that the azo-colour department alone necessitates the use of 78,000 tons of ice per annum for cooling purposes. Mr. Baron's report is, on the whole, a just and accurate statement, but a few errors occur which need correction. For example, some of the statements with regard to the processes of manufacturing artificial silk need revision. Such errors were, perhaps, to be expected in a report prepared under the conditions of the present and dealing with a very wide field.

(6) Dr. Rogers's book and system we conceive to be based on entirely wrong principles. His scheme of training in industrial chemistry adopted at the Platt Institute, Brooklyn, consists in passing the students (the nature of whose chemical knowledge is rather uncertain) through a course of preparations and exercises under works-conditions in miniature. No attention is paid, apparently, to fundamental principles and process control. In less than 140 pages an enormous number of cookery-book recipes are given for the preparation of inorganic and organic compounds, pigments and lakes, driers, varnishes, paints and stains, soap and allied products, leather, wood pulp, and paper. The preparations are carried out with small works-plant, of which several illustrations are given in the book. We doubt the value of such a course in the education of a works-chemist, and consider that it would probably be to the detriment of the interests of his subsequent employers as tending to develop a blind and thoughtless empiricism. One of the most important factors in the success of a chemical works is a proper system of control, on scientific principles, of all stages of manufacture. We consider that it would be far better to work out a few—very few—manufacturing processes in detail, carefully studying by a proper system of tests the effects of varying the conditions, than to acquire a smattering of a large number of indiscriminately chosen works-operations. It is only by means of careful scientific control that chemical works in this country can hope to compete with foreign competition. To teach industrial chemistry as a series of cookery operations, involving the use of certain stock utensils, is likely to prove fatal in all cases, except in countries such as the United States, where high tariffs make economy of production a secondary consideration.

W. A. D.

HANDBOOKS ON ANIMAL STUDY.

(1) *Zoologia.* By Angel Gallardo. Pp. 474. (Buenos Aires: Angel Estrada Cia., 1909.) Price 6 dollars.

(2) *Einführung in die Biologie.* By Prof. Karl Kraepelin. Pp. viii+322. (Leipzig and Berlin: B. G. Teubner, 1909.) Price 4 marks.

(3) *The Freshwater Aquarium and its Inhabitants.* By Otto Eggeling and Frederick Ehrenberg. Pp. vii+352. (New York: Henry Holt and Co.; London: G. Bell and Sons.) Price 8*s.* net.

(4) *Bilder aus dem Ameisenleben.* By H. Viehmeyer. Pp. viii+159. (Leipzig: Quelle und Meyer, n.d.) Price 1.80 marks.

(5) *Die Schwarotzer der Menschen und Tiere.* By Dr. O. von Linstow. Pp. viii+144. (Leipzig: Quelle und Meyer, n.d.) Price 1.80 marks.

(1) IT seems almost axiomatic that if a text-book of zoology begins by dealing with the obscure details and overwhelming nomenclature of cytology, it is a bad book. Bad because organisms are not aggregates of cells, and because such a method is essentially an inverted one in relation to the grasp of the beginner. In this text-book, written for the School of Pharmacy at Buenos Aires, the inversion appears complete. The end of the book is an introduction showing how zoology has been pursued in the republic, whilst the beginning is occupied by Karyokinesis, modes of segmentation, and other difficult subjects. After general histology, we have evolution and transformation-theories treated in that diagrammatic and

dogmatic way that is so destructive of their interest and advancement. The classification of animals adopted, Unicellularia, Radiata, Bilateralia, is almost as antique as that of the animal and vegetative functions maintained in the earlier part of this book. The "worms" are reduced to a type characterised by a trochosphere-larva and nephridia, whilst, for the benefit of medical students, only parasitic forms are described. The book is, in fact, a compilation of the "cram" order, and is devoted mainly to the structure and life-history of parasites. In no single instance is the scale of a figure given.

(2) In spite of the very large output of books on biology, there is still no modern work in which the factors of the life of plants are correlated with those of animal life in a broad and intimate manner. This text-book is, perhaps, as near an approach to such a treatment as the limits of a cheap school-book allow, and in the second edition just issued the breadth of treatment has been increased. The contents are divided into three parts. First come the relations of organisms to environment; then follows an account of structure and functions; lastly, a brief chapter on psychology and anthropology. Between the last two parts is a short, clear account of evidence for the theory of descent. Of these three sections, the first is undoubtedly the most novel for a work of this kind. It is very doubtful whether the author has not attempted to compress far too much information into these pages, and certainly the attempt to teach the subject from such a book as this without simplifying its contents would be disastrous. The work itself appears to be a well-illustrated summary of facts, but is as hard to assimilate as a concentrated foodstuff. The teacher must supply the zymogen.

(3) In this American book the experience of the professional "aquarist" and importer has been combined with that of the practised amateur. The result is a volume full of interesting matter and of practical suggestion to naturalists and teachers. The introduction of many beautifully coloured fish from Texas, Florida, India, and other countries into the northern States enables a very great choice of interesting subjects to be drawn upon. The climbing perch, the "shooter" that brings its prey down by spitting, and the lovely Paradise fish Macropodes, the nests of which are readily constructed in captivity, are some of the more striking oriental fish introduced by one of the authors. The Reptilia and Amphibia are also fully considered, and the book concludes with most useful advice on the choice of natural and artificial foods. In these days of experimental stations and school laboratories, such a practical guide as this should be very welcome. The illustrations are excellent, and the only fault we have to find with the work is its weight, which not only splits the binding, but tires the hand.

(4) The value of this little book lies in the fact that its descriptions of the occurrence and habits of ants are largely written down from the author's observation. The sketches are thrown into a conversational form so as to appeal to children. The various beetles found in ants' nests are fully considered and figured, and the author is evidently acquainted with the literature of the subject. We can heartily recommend this little book as a record of long and patient observation, and as a very useful *résumé* of the most distinctive and interesting features in the life of these highly organised animals.

(5) Dr. von Linstow's popular account of human and animal parasites ends badly from the beginning. On the cover of the book there is a gruesome picture of infected pond-life, and a tragedy occurs on almost every page. The contents describe some appalling cases of the course of parasitical diseases, and whilst we fully acknowledge the abundant knowledge and clear exposition that has gone to its making, we can hardly believe that such a treatise is appropriate to a series suitable for children and people generally. Pan certainly has a terrifying aspect when seen thus, and it would have relieved the depression if the available prophylactic and remedial measures could, as far as possible, have been described.

ELEMENTARY PHYSICS.

(1) *An Introduction to Physical Science.* By Dr. F. H. Getman. Pp. ix+257. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd., 1909.) Price 6*s.* 6*d.* net.

(2) *An Elementary Course in Practical Science.* Part iii. By C. Foxcroft and S. J. Bunting. Pp. 64. (London: G. Philip and Son, Ltd., n.d.) Price 6*d.* net.

(1) THE book by Dr. Getman is intended for those students who, owing to little knowledge of physics, find it difficult to understand lectures on general chemistry. It deals in a brief manner with all the usual sections of physics, with the exception of sound. It is in many respects an admirable book. The chief laws and principles are in most cases very clearly expressed. As an example of this, attention may be directed to the concise and unambiguous treatment of the distinction between "mass" and "weight." The diagrams are good, and logical order is preserved. There is no doubt that a student thoroughly conversant with the contents would have little difficulty with his chemistry from a physical point of view. On the other hand, we think that for several reasons the book itself presents difficulties. The definitions, particularly in the first chapter or two, are sometimes rather loose. Matter is apologetically defined as "that which occupies space," a statement which is worthless. Surely a better provisional definition is "matter is that which has weight," and then the extension of "weight" to "gravitational attraction" could follow at a later stage. Again, a solid is defined as "a body which at ordinary temperatures does not change its shape under slight changes of pressure." This is untrue. There is no distinction, except in degree, between solids and fluids in this respect. The terms "stress" and "strain" are insufficiently defined, being merely given as alternatives for force and distortion respectively.

We feel, too, that the cutting out of detail, which the author admits in the preface, has been carried too far. The descriptions of experiments are thus in many cases vague, and in a few instances actually misleading. For example, in the determination of the

latent heat of water, we are told that "a *weighed* quantity of dry ice is now added to the water." Such procedure would, needless to say, be fatal to the accuracy of the measurement. It may be mentioned also that in describing the measurement of an electric current with a tangent galvanometer, the author neither mentions the very necessary adjustment of the coils parallel to the magnetic meridian, nor does he show the bearing of the strength of the earth's field on the absolute value of the current. Altogether, from the point of view of practical physics the book leaves much to be desired. Indeed, the author goes so far as to suggest that the practical part may be entirely omitted.

A further point should be mentioned. Although there is an extensive set of very suitable numerical examples given, practically no specimen examples are solved. It is very doubtful whether an average student could, unaided, successfully attack them. When it is remembered that it is mainly by the frequent use of numerical and practical exercises that the principles of physics are most easily and thoroughly instilled into the mind, it will be recognised how serious are the above omissions.

(2) This book is the third of a series on simple physical measurements, &c., and is drawn up on the same general method as the previous ones, viz. to leave as much as possible to the student's initiative and common sense. The exercises, although still very simple, are of a somewhat higher standard, and include further measurements in the subjects previously dealt with, and a few experiments in elementary chemistry. This method of teaching is somewhat novel, and probably the correct one. Where time is a consideration, however, it may not be practicable.

OUR BOOK SHELF.

A Brief Course in the Calculus. By W. Cain. Pp. x+280. (London: Blackie and Son, Ltd., 1909.) Price 6*s*. net.

THIS is a new publication of an American book, and deals with both the differential and the integral calculus. Following the more recent English treatises on the same subject, the author begins with an introduction on graphs, in which he confines himself to the simplest cases of the usual functions. The value of such an introduction would, perhaps, be enhanced if the reader were shown how to draw quickly even rough graphs of such functions as x^2+x+1, $(x^2-1)/(x+2)$, &c., indeed, of *rational* functions. The point of view of the author may be obtained from his own words (p. 27):—"The above examples represent loci whose asymptotes are easily determined by inspection. For other cases, particularly where the asymptotes are inclined to the axes, advanced treatises on the Calculus must be consulted."

Derivatives are introduced through the notion of a limit. After the derivative of x^n has been established (without using the binomial theorem), discussion of the slope of a curve and of rates follows. If the graphical part had been developed more fully, the latter notions might have taken precedence of and led up to derivatives. Such a mode of treatment would perhaps have given a greater air of reality to the derivative in the case of readers who have time for only a short course in the calculus, and whose power of mathematical perception has not been highly trained. The author, however, has good authority for the order he adopts, and he keeps well in view the needs of those who want a careful study of the subject as well as those who are likely to apply their knowledge to geometry, mechanics, and physics. He has dealt fully and carefully with the outstanding parts of the subject, and works out many examples; it is doubtless in consistency with his whole aim that he does not give a very large number of examples to be worked out by the reader, in this respect differing from most authors of mathematical books. To teachers and students who prefer a smaller number of examples, and need a work in which the method and province of the calculus are presented by a careful writer, the book can be recommended as likely to be a useful introduction to the subject. P. P.

The Life of a Fossil Hunter. By Charles H. Sternberg. Pp. xiv+286; with 46 plate illustrations. (New York: Henry Holt and Co.; London: George Bell and Sons, 1909.)

THIS is a simple and readable story of the experiences of a fossil hunter in the wild west of North America. As Prof. Osborn remarks in his brief introduction, "the revivification of the past" by the discovery of fossils "is attended with as great fascination as the quest of live game." No one has met with greater success in such pursuits than Mr. Charles Sternberg, the well-known collector of extinct vertebrates, who now recounts some of his experiences during the past forty years; and he has produced a small book which will be read with pleasure by all who are acquainted with the fine specimens which he has obtained for several of the great museums. The well-printed text is illustrated by a large number of inset plates representing scenery, fossils discovered by the author, portraits, and several excellent restorations of extinct reptiles from the American Museum of Natural History, New York.

In the early days of his explorations, Mr. Sternberg was exposed to danger from the Indians whose country he invaded, and there are several interesting stories of his adventures both with them and the settlers. In later years, and even under the most improved conditions, the hardships have still remained considerable, for the most fruitful regions for fossils are always those most destitute of vegetation, where the whole face of the rock is exposed and can be closely scanned. The suffocating nature of the dust and the alkaline or saline condition of most of the available water supply always prove troublesome, and the laborious excavation of fossils in such circumstances, beneath a burning sun, involves real enthusiasm for the work. Mr. Sternberg, after long experience, has brought his methods to perfection, and he gives interesting illustrations of the manner in which the most fragile skeletons can be disinterred from the rock without injury. He began by collecting fossil leaves from the Dakota Cretaceous sandstone. Afterwards, with the encouragement of the late Prof. E. D. Cope, he obtained mosasaurs and fishes from the chalk of Kansas. Then he made several successful trips to the Permian of Texas, in which he discovered numerous new reptiles and labyrinthodonts. Finally, he has worked the Laramie Cretaceous formations of Wyoming, and the Loup Fork Tertiary formation of Kansas. Besides enriching the museums of America, Mr. Sternberg has contributed many important specimens to those of Europe, especially to the Palæontological Museum of Munich and the British Museum. The latter is indebted to him for a skull of Triceratops, a skull and a skeleton of Pteranodon, several Mosasaurians, some fine chalk

fishes, and a mandible of a primitive Mastodont (*Tetrabelodon dinotherioides*). He is still in the field, now accompanied by his sons, whom he has trained to follow him. A. S. W.

The Book of Nature-Study. Edited by Prof. J. B. Farmer, F.R.S. Vol. IV. Pp. viii+210. (London: The Caxton Publishing Company, n.d.) Price 7*s.* 6*d.* net.

THE fourth volume of this attractive publication is devoted entirely to botany. The descriptions by Dr. W. H. Lang of some common plants flowering in the spring and summer appeared in the previous volume; the continuation refers to plants that flower later in the year and others of special morphological interest, such as the honeysuckle, dodder, sundew, and types of trees. The Scots pine serves as a representative gymnosperm, while a brief account of pollination and seed dispersal closes Dr. Lang's contributions. His precise and orderly descriptions provide excellent models for a student to emulate.

To Dr. W. Cavers has been entrusted the somewhat difficult task of preparing an interesting account of the cryptogams, and in this he is very successful. He adopts a less formal method of description than Dr. Lang, and by confining himself merely to the more important characters, he is enabled to direct attention to a large number of species. Most of the indigenous ferns and fern allies are noted, and the more striking mosses and liverworts. Lichens form the subject of a separate chapter, but algæ are omitted, and only outlines of the fungal groups are indicated. This section and the former one are confined to morphology as distinct from ecology, which provides the bulk of the third section contributed by Miss C. L. Laurie, although the heading, "Woodland Vegetation," appears in the contents. The ecological section suffers from a want of definition of the main objective. The descriptions of the moors, commons, and heaths are quite definite, perhaps somewhat brief, but the interpolation of parasites and saprophytes in the middle of plant associations presents an unnecessary confusion of ideas. The chapter on woodland vegetation is very instructive, albeit the paragraphs are somewhat disjointed, and no definite tree formations are fully described as such.

The illustrations are numerous and excellent; the coloured plates of single plants, notably of the honeysuckle, are admirable specimens of reproduction, and the plain photographs are practically as effective for their purpose. Two photographs of lichens, the woodland photographs by Miss Tidman, and the illustrations of the mistletoe and goat-willow are perhaps the choicest: but it is somewhat invidious to draw distinctions, as the contributors include Dr. O. V. Darbishire, Mr. H. Irving, and Mr. Chalkley Gould.

Éléments de la Théorie des Probabilités. By Émile Borel. Pp. viii+190. (Paris: A. Hermann et Fils, 1909.) Price 6 francs.

LIKE all Prof. Borel's works, this is a very pleasant book to read. It is in three parts, dealing respectively with discontinuous problems, continuous problems, and those in which *a priori* probabilities are involved. The second part contains, among other things, a useful sketch of Gauss's theory of errors; and the third gives some applications to statistics and biology. Some of the problems are quite amusing; for instance, "Pierre plays écarté with a stranger, who turns up a king the first time he deals. What is the probability of his being a professional cardsharper?"

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.*]

Magnetic Storms.

THE last English mail which arrived in India brought the newspapers containing the account of the magnetic storm of September 25, and in the *Times* Sir Oliver Lodge's opinion on the cause of such storms is given. It appears, however, that three of the statements contained in that account are not entirely supported by experimental and observational evidence, and would not be subscribed to by those who have recently been working at the problems of atmospheric electricity.

(1) Sir Oliver Lodge remarks:—"Some of them" (electrons from the sun), "especially at the times of the equinox, may come down near the equator. Those which journey to the Poles are accompanied by an opposite current in the crust of the earth from the equator to the Poles, and this it is which disturbs the telegraphs, being picked up or tapped by them *en route*." Now if a large quantity of negative electricity were suddenly added to the upper atmosphere, and this induced a corresponding charge of positive electricity on the earth's surface, it would of necessity disturb the existing potential gradient in the atmosphere.

The extent of the disturbance can be roughly calculated by treating the earth's surface as an infinite plane. Suppose that the electrons moving in the upper atmosphere and adjacent space are uniformly distributed; their electrostatic and horizontal magnetic effect at the earth's surface will then be the same as if they were confined to a plane parallel to the surface of the earth. Let the surface density on the plane be σ and the velocity of the ions in the plane v; H will then be changed by $2\pi\sigma v$. Now Dr. Chree states (NATURE, September 30) that during the magnetic storm H varied by more than 740 γ; for convenience let us take the change in H to be only 700 γ, *i.e.* 0·007 electromagnetic unit. Hence $2\pi\sigma v = 0{\cdot}007$, or $\sigma = 0{\cdot}007/2\pi v$. If σ is measured in electrostatic units this becomes $0{\cdot}007V/2\pi v$, where V is the velocity of light. The electrostatic field between the charged plane and the earth would be $4\pi\sigma$, *i.e.* $4\pi \times 0{\cdot}007V/2\pi v$ or $0{\cdot}014V/v$. Expressing this field in volts per metre, we have $0{\cdot}014 \times 300 \times 100V/v$, *i.e.* $420V/v$. Now v cannot be greater than V, hence the smallest value of the field would be 420 volts per metre. This value is more than four times greater than the normal value of the potential gradient in the atmosphere, and it is of the opposite sign. This calculation is not supposed to be quantitatively accurate, but it gives in a simple way the order of magnitude of the effect. Hence it is seen that the large electrical charges which would be required to produce the magnetic effects observed, even if they moved with the velocity of light, would be easily recognised by their effect on the potential gradient. For many years instruments have been in use in different parts of the earth giving continuous records of the potential gradient in the atmosphere, but, so far as I am aware, no effect of a magnetic storm has ever been reported. Such an instrument is in use in Simla. On the day of the storm the weather here was perfect, so that if any effect of the kind had taken place it would have been clearly seen; but, as a matter of fact, there is absolutely nothing on the record to distinguish the period of the magnetic storm from the periods on either side of it: the potential gradient was entirely normal throughout September 25 and 26. It would therefore appear that the great earth currents associated with magnetic storms are not, as Sir Oliver Lodge suggests, due to induced charges.

(2) Sir Oliver Lodge further says, regarding the electrons:—"Those which enter the atmosphere elsewhere act as nuclei for condensation of moisture, and by screening the sun's rays are probably responsible for some of the dull and overcast weather." This statement is apparently based on a misconception of Mr. C. T. R. Wilson's experiments on the condensation of water vapour on ions, for these experiments do not afford any real support to

such an idea. Mr. Wilson's results showed that ions may become the nuclei for condensation, but only when the air is both dust-free and supersaturated four-fold. An infinity of ions in dusty air, or in air supersaturated three-fold, would not cause clouds, and as neither dust-free nor supersaturated air have ever yet been met with in the atmosphere, it is difficult to see how electrons from the sun could produce cloudy weather.

(3) These considerations apply, but with still greater force, to Sir Oliver Lodge's next sentence:—"Local thunderstorms are also a not unlikely result." This is not the place to go into the controversy over the Wilson-Gerdien theory of thunderstorms, but it ought to be pointed out that very strong reasons have been put forward for doubting that the condensation of water on ions plays any part in thunderstorms. GEORGE C. SIMPSON.

Meteorological Office, Simla, October 21.

The Identity of Certain Large Birds on Egyptian Vases.

IN looking to-day for an archæological reference in my friend M. Jean Capart's valuable volume on "Primitive Art in Egypt" (English edition), I noted that he has determined certain birds, delineated on a series of decorated vases, as ostriches. The vases I refer to are to be found on p. 116, Fig. 88; p. 118, Fig. 91; p. 119, Fig. 92; p. 120, Fig. 93; p. 121, Fig. 94; and p. 123, Fig. 96. I venture to suggest that the birds intended to be represented are not ostriches, but flamingos. The inbent beak, the dorsal body-contour, the horizontal ventral region, and the long, lanky legs, uncovered by feathers in the tibial region as in ostriches, all so characteristic of the flamingo, are delineated with great truthfulness on a large scale on the vase illustrated on p. 123, Fig. 96. The crosier-staff-like head is common to all the drawings I have indicated. Although the representation of the bird on p. 120, Fig. 93, is rather too small and ill-defined to base much upon, the curvature of the neck is yet more that of a ciconiiform than of a struthious bird. Indeed, on p. 119, Fig. 92, the group of birds at the right-hand corner of the vase is actually in proximity to water, which would hardly be the case if the artist intended it for one of ostriches; while on the vase illustrated on p. 121, Fig. 94, the four birds delineated have very characteristic horizontal flamingo tails, especially the individual on the extreme left of the row, in which it is spread. These attitudes are in striking contrast with those of certain other large birds included in the zoological group on the rocks of Upper Egypt, reproduced on p. 204, which must be admitted to represent ostriches, at the first glance, from the attitude of their legs in walking, their plumage contour, and their straight beaks.

The above suggestion I have made during the past two or three years to several Egyptologists, who have recognised its valency; but as I have seen nowhere this emendation, which I believe it to be, recorded, I think it may be of interest to give it publicity, inasmuch as the ethnographical deductions to be drawn from these rude pictures can be correct only if the artist's intention has been accurately interpreted. HENRY O. FORBES.

The Museums, Liverpool, October 31.

November Meteors.

THE absence of moonlight during the Leonid epoch of the present year will be favourable for observations of this historic shower. For determining on which of the three dates of November 14, 15, and 16 it may occur, calculations made by the writer point to the night of November 16 as that of the maximum, when, as was the case on the corresponding night of last year, the number of meteors radiating from the Sickle may be found by observers to be considerable. The following are details as to this and also other showers that become due during the remainder of the month of November:—

Leonid epoch, November 16, 8h. G.M.T. This shower is of the sixteenth order of magnitude, having its principal maximum on November 16, 15h.; other maxima take place on November 16, 10h. and 18h., and November 17, 21h.

Epoch November 21, 9h. 30m., shower of fourth order of magnitude. The principal maxima occur on November 19, 21h. 15m., and November 20, 18h. 30m. Two other maxima occur on November 20, 2h. 30m. and 5h. 30m.

Epoch November 21, 17h. This shower, which is of the fifteenth order of magnitude and immediately follows the former, has its maxima on November 21, 21h., and November 22, 11h. 30m.

Epoch November 26, 1h. 30m. This shower, of third order of magnitude, has two principal maxima, on November 26, 15h., and November 27, 2h. There is another maximum on November 27, 5h.

Epoch November 29, 20h. 30m., of third order of magnitude; has its principal maximum on November 29, 17h., with an earlier maximum on November 29, 3h. 30m.

Dublin, November 8. JOHN R. HENRY.

The Absence of a Lunar Atmosphere.

WITH reference to Mr. Alexander Johnson's letter on this interesting subject, I should like to point out that the theory of radiation pressure is not applicable to gases. Beyond a certain range of minuteness, the effect of radiation pressure on particles diminishes, and the size of a particle on which the repulsive force of light is at a maximum is vastly greater than molecular magnitudes. As this is very important, I quote certain numerical determinations given by Prof. Arrhenius ("Worlds in the Making," pp. 97, 98):—

(1) Diameter of a totally reflecting sphere which would be in equilibrium near the sun under the opposing forces of gravitation and radiation pressure = 0·0015 mm., the specific gravity of the sphere being the same as water.

(2) For radiation pressure to be effective, the diameter of the particle must exceed 0·3 of the wave-length of the incident radiation. If smaller than this, gravitation predominates.

(3) Radiation pressure is at a maximum when the diameter of the particle equals the wave-length of the incident light (*e.g.* 0·5 μ for the blue-green region about λ 5000 A.U.).

(4) In the case of sunlight, which is not homogeneous, Prof. Arrhenius gives 0·00016 mm. as the diameter of particles on which the effect is greatest.

As regards the absence of a lunar atmosphere, it seems that we must fall back on the kinetic theory of gases and attribute it to the gradual escape of the more swiftly moving molecules into the surrounding space.

CHARLES W. RAFFETY.

Wynnstay, Woodcote Valley Road, Purley, Surrey, November 1.

Pitchblende as a Remedy.

As there is now no longer the least doubt as to important cures being effected by means of radium, the question arises whether crude pitchblende would not also have beneficial effect if applied in the case of minor chronic ailments. Perhaps one of the readers of NATURE will be able kindly to give some information on this subject. The very minute proportion of radium in pitchblende need be no real objection. If we substitute, in the case of pitchblende, grams for milligrams and days of application for so many minutes, a disparity of one million is soon made up, and there may be some action, although perhaps different from that of a pure radium salt. Moreover, we must expect a beneficial influence from minute quantities of radio-active substance if the assumption is to be finally proved that certain thermal waters owe much of their virtue to such traces. In addition to raw pitchblende, a possible utility of pure (yellow) uranium oxide might also be considered. H. WARTH.

SOUTH AFRICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE seventh annual meeting of the South African Association for the Advancement of Science opened at Bloemfontein on Monday, September 27, under the presidency of the Governor, Sir Hamilton Goold-Adams. The advantage of Bloemfontein for such a conference, in that it is in the centre of South Africa, was observable in the number of busy men

who were able to run down from Johannesburg, Pretoria, and Kimberley for the occasion, to whom the usual two days and two nights' journey in the train necessary to travel from one centre to another would have been prohibitive. The meeting was the most successful so far held, from the fact that the Governor, the municipality, the Press, and the citizens generally, united in welcoming the delegates from the various centres, and in showing appreciation for the objects of the association.

In the opening address the president struck the dominant note of the meeting, namely, that science is not of purely academic interest, but that the results won by scientific men could be understood by the unlearned if they tried, and that the results could be applied to everyday life with material benefit. The text of the address was the "Application of Chemistry in Agriculture." The mining industry has a very important bearing on the prosperity of the country, "yet agriculture must be considered as the main and permanent foundation upon which the future progress of the nation must rest."

The acting mayor, Mr. A. E. Parfitt, in welcoming the delegates, said, "I daresay that from a sanitary point of view this town excels all others in South Africa," a wonderful statement in view of what the town was like only a few years ago. This fact was more fully brought out by Dr. Tomory, medical officer of health for the town, later on in his paper on "Recent Methods of Water Purification," in which he dealt with the merits of slow sand filtration and the American methods of rapid chemical treatment; the Bloemfontein system is a compromise between the two.

Prof. W. A. D. Rudge, of Grey College, Bloemfontein, president of the section of astronomy and mathematics, opened the sectional meetings at the Normal College buildings on September 28 with an address on the "Genesis of Matter." Mr. Hugh Gunn, Director of Education in the Orange Free State, president of the education section, took for the subject of his opening address "The Problem of Rural Education." He considered this to be the most exigent question of the moment. Farmers had done their best, but the badly provided farm schools, staffed with one teacher, whose emoluments were poor, and whose qualifications corresponded, were inadequate. Rural schools were regarded as being on the lowest rung of the educational ladder. He calculated that barely one-quarter of the area of South Africa was provided with school facilities, and that 80,000 children of school age were not attending school. Of this number he thought two-thirds lived in the rural districts. He wished to abolish single-teacher schools, and to replace them with three-teacher schools. This could be done by providing transport facilities. A beginning had been made in the Orange Free State with satisfactory results, and he hoped to see the system extended.

Dr. C. F. Juritz, of Cape Town, opened the section devoted to chemistry and geology with an address on "Agricultural Chemistry." The following are the more important papers read in the various sections. Unfortunately, the sections were reduced to three, and had subsequently to be divided to enable all the papers to be read, hence some confusion ensued in regard to placing the papers in their proper section.

Water vapour on Mars, J. de Fenton; notes on the geology of Natal, J. A. H. Armstrong; revised list of the mammals of South Africa, E. C. Chubb; puberty rites of the Basuto, and prehistoric African fauna and flora as evidenced by African philology, Rev. Father Norton; maize breeding, R. W. Thornton; cultivation of maize, J. Burtt-Davy; solar radiation, H. E. Wood; the great snow-storm of August, 1909, H. E. Wood; the Breede River irrigation works, T. E. Scaife; notes on the recent magnetic storm, G. W. Hopkinson; the flora of Portuguese East Africa, T. R. Sim; the vegetation of the southern Namib, Dr. R. Marloth; lime and milk, R. Pape; the composition of milk in Cape Colony, St. C. O. Sinclair; notes on the fauna and flora of Sarawak, J. Hewitt; mental healing, Right Rev. Bishop Chandler; the value of the practice and teaching of hygiene in schools, Dr. Targett-Adams; the salt pan of Haagenstad, G. W. Cook; the bearing of recent theories on the nature of the earth's interior on the question of deep mining, Prof. E. H. L. Schwarz; itacolumite from Swaziland, Prof. G. H. Stanley; observations on the vascular system of *Hemitelia Capensis*, H. G. Morris; notes on the anatomy of Widdringtonia and Callitris, W. T. Saxton; the principles of the naturalisation of forestry, C. Robertson; architecture, H. Baker; the relative growth of our white and black population, J. M. P. Muirhead; classics in our secondary schools, Dr. J. Brill; biography of Mohlomi, traveller, witch-doctor and chief, A. C. McGregor; the tercentenary of the telescope, H. B. Austin; the English language and literature in South Africa, Prof. Stanley Kidd; education in a Swiss canton, A. M. Robb; practical education, T. Lowden; agricultural training of natives, Hobart Houghton; weights and measures for South Africa, R. T. A. Innes.

Members of the association were taken round the new buildings of the Grey University College and the Grey School. The admirable building stone from the Bloemfontein commonage and the northern Free State allows the local architects to build elegant buildings; but this may become somewhat of a disadvantage, and leads often to cases where the effect of a window from the outside is considered more than its usefulness in the inside. A second excursion was to the military cantonments at Tempe, but the most instructive outing was to the dry farm at Groot Vlei, where lucerne, fescue, burnet, sainfoin, and other fodder plants, besides cereals, are grown without irrigation. A large area of the farm is planted with the Australian salt bush, which thrives admirably; the soil does not appear to be brak here, but, rather, is unproductive on account of its being clogged with fine silt.

Two popular lectures were given in the Town Hall, one on "Celestial Chemistry," by Dr. C. F. Juritz, and one on "Explosives," by Mr. W. Cullen, of the Modderfontein dynamite factory. At the close of the latter the British Association medal and cheque of 40*l*. were presented to Dr. Harry Bolus, the botanist.

At the annual general meeting the report of the council was presented, which showed a large decrease of membership owing to the prolonged depression in South Africa. To meet the decrease in income it was proposed to abolish one of the permanent offices, either the Johannesburg or the Cape Town one; it was also proposed to issue the Transactions in monthly parts. In view of the opening of the Union Parliament in Cape Town next year by His Royal Highness the Prince of Wales, it was proposed to hold the 1910 meeting in Cape Town at about the same date. His Excellency Sir Hamilton Goold-Adams was asked to offer the presidency of the association to His Royal Highness.

Mr. Lowden brought forward the subject of a prize scheme, which was discussed at some length both at Cape Town and at Johannesburg, and urged that something should be done to induce young students to take up science subjects. He suggested that if nothing else could be done, the association should offer at least a medal for the first two students matriculating in each science subject, and that if the funds of the association were not available, a subscription should be raised for the purpose. After some discussion the president stated that he would like to mark in some

way his appreciation of the work of the association and the honour done him in electing him the president for the year, and he thought he could do this by offering to defray the cost of the die of a suitable medal for the purpose suggested by Mr. Lowden. On the proposal of Mr. Innes, seconded by Dr. Juritz, it was resolved to accept this offer with many thanks, and to name the awards the "Gould-Adams" medals.

The Bloemfontein Museum deserves an article to itself; the members of the association were shown over the collections, and from cupboard and cranny objects of the utmost value were unearthed, including meteorites, stone and iron ones, Karroo fossils, early printed books, engravings, manuscripts, Bushmen implements, and a complete quagga skin. The collections urgently need proper accommodation, and it is hoped that the visit of the association brought home to the authorities some realisation of what a valuable asset for the town they had in their museum.

Dr. R. T. A. Innes was elected honorary secretary for the Transvaal and Free State, and Dr. C. F. Juritz for Cape Colony and Rhodesia, Dr. R. T. Lehfeldt honorary treasurer.

At the close of the meeting forty-five members left for a train and wagon trip to Basutoland, the railway authorities having placed a special train at the disposal of the association.

AMERICAN CAVE VERTEBRATES.[1]

PROF. EIGENMANN has brought together in an attractive and copiously illustrated quarto volume the results of his investigations on the cave fauna of America, upon which he has been engaged for many years. He points out that each cave is a separate environmental unit requiring special consideration, but all share to a greater or less extent certain common features, viz. the reduction or total absence of light and the relative constancy of other physical conditions, such as temperature.

The blind cave vertebrates form a very mixed faunistic group, derived from a variety of epigean ancestors. It appears, however, that "a certain predisposition in habit and structure must be present to enable a species to dispense with light and to live in caves." No mammals appear to have become especially adapted for permanent cave life, though, of course, many spend a large part of their lives in such situations. They may be "twilight animals," but they still have normal eyes. The same is the case with birds, and there are also no cave reptiles, which is remarkable when we consider that many snakes and lizards are blind, and burrow underground.

It is amongst the amphibia and fishes that true cave vertebrates are to be found. Two of the North American salamanders, of the genus Spelerpes, which habitually live in caves, still possess what appear to be normal eyes, while two others, of the genera Typhlotriton and Typhlomolge, have their eyes quite degenerate, resembling in this respect the European Proteus. The Amblyopsidæ are the typical North American cave fishes. "All the members of this family, eight in number, have degenerate eyes; five have mere vestiges; six permanently live in caves; one is known only from a spring, and another from open streams." More remarkable is the fact that in Cuba two sightless fishes, Stygicola and Lucifuga, belonging to a marine family many of which are blind, have become adapted to the fresh waters of caves.

[1] "Cave Vertebrates of America. A Study in Degenerative Evolution." By Prof. Carl H. Eigenmann. Pp. ix+241. (Washington: Carnegie Institution, 1909.)

Space forbids us to follow the author in his detailed and interesting discussion of the origin of the cave fauna. We may note, however, that he seems inclined to regard blindness as an antecedent rather than as a consequence of cave life, for it is only animals which are already accustomed to find their food by the sense of touch or smell which could ever establish themselves in complete darkness. In Amblyopsis, and other blind fishes, great numbers of special tactile organs are developed, especially about the head, and these serve for ascertaining, by disturbances in the water, the whereabouts of prey.

In the case of the loss of colour, however, which is such a general character of animals living in perpetual darkness, it is different, and Prof. Eigenmann regards this character as due in the first place to the direct influence of the environment upon the individual. To quote his own words, "The bleached condition of animals living in the dark, an individual environmental adaptation, is transmissible, and finally becomes hereditarily fixed." This conclusion is based upon the fact that in Amblyopsis the bleaching takes place even when the young are reared in the light. "Natural selection cannot have affected the coloration of the cave forms, for it can be of no consequence whether a cave species is white or black. It could only affect the coloration indirectly in one of two ways: first, as a matter of economy, but since the *individual* is in part bleached by the direct effect of the darkness, there is no reason why natural selection should come into play at all in reducing the pigment as a matter of economy; second, Romanes has supposed that the colour disappeared through the selection of correlated structures, a supposition he found scarcely conceivable when the variety of animals showing the bleached condition was considered." It appears to us that these conclusions are of great interest and importance, and that Prof. Eigenmann has made out a strong case for the inheritance of acquired characters in this instance. In the case of Proteus it appears that the bleached condition has not yet become hereditarily established, for this animal becomes darker when exposed to the light. Possibly, after all, the inheritance or non-inheritance of acquired characters is largely a question of time, or, perhaps better, of the number of successive generations which have responded ontogenetically to the particular stimulus which evokes the character in question.

A great part of the volume is devoted to the consideration of the structural changes which accompany the degeneration of the eyes, and the author has given us a large amount of very valuable information on this difficult subject, including a detailed account of the development of the eye of Amblyopsis. From many points of view this interesting work will well repay a careful perusal. ARTHUR DENDY.

THE PRESERVATION OF NATURAL MONUMENTS IN GERMANY.[1]

THE German Government has been, for the last two years, organising a national system for the preservation of the natural monuments of the country. During the last year the scheme has developed in comprehensiveness, and has produced gratifying results. There are now forty local committees, and at the end of last year the first Congress for *Naturdenkmalpflege* in Prussia was held at Berlin. A considerable number of valuable reports has been issued; the present volume, edited by the energetic Government Commissioner for the Care of Natural Monuments, Prof. Conwentz, contains a report of the con-

[1] "Beiträge zur Naturdenkmalpflege." By Prof. H. Conwentz. Heft 3. Pp. 157–296. (Berlin: Gebrüder Borntraeger, 1909.) Price 2 marks.

gress, and a general report on the work of the past year up to March 31.

The whole matter is another triumph of German organisation. Throughout the committees, which are interacting, are zoologists, ornithologists, botanists, geologists, and archæologists. The useful term "natural monument"—Alexander von Humboldt seems first to have employed it—includes practically everything indigenous which possesses scientific interest. In this report, for instance, which is well illustrated, there are accounts, not only of the *Porta Westfalica*, a human monument, but of interesting trees, "erratic" blocks of stone, moraines, diluvial sandstone formations, many characteristic specimens of the flora and fauna of the country, including various subdivisions, such as lichens and Lepidoptera. The term and the whole conception of the scheme are absolutely comprehensive. Many charts have already been prepared showing the local distribution of the "monuments"; such publications are of the highest scientific interest, especially when their subjects may still be counted on by the observer as existing in actuality.

It is to be hoped that this report may find its way to the hands of some English statesman. It gives an object-lesson of what can be done, and of how it may be done, to preserve the natural character of a country. In England the enclosure of sites and preservation of scenery too often result in the destruction of both fauna and flora. Where are the denizens, vegetable and animal, of White's Selborne? The present writer for many years had the privilege of research in a certain wild corner of Wensleydale which was as rich in rare plants and birds as any district in Great Britain. The ownership changed hands, and the whole of the wild life of the place was destroyed, first, by drainage for the purpose of making a coursing-ground, and later by operations connected with the water-supply of a great manufacturing town. This was vandalism no less brutal than the destruction of an exquisite statue.

It would be a profound satisfaction to lovers of nature if our country could be preserved in an efficient and comprehensive way. It is a work that could well be initiated by the Board of Agriculture. Dr. Conwentz, by the publication last year in English of his book "The Care of Natural Monuments, with Special Reference to Great Britain and Germany," has already given us a guide to both principle and execution. The present report—which can be read at one sitting—justifies his guidance. A. E. CRAWLEY.

THE MIGRATIONS OF PLAICE.[1]

THE marking of plaice was commenced on the east coast of Ireland in August, 1905, and in a recent report Mr. G. P. Farran deals with such recaptures as have been made up to the end of 1907.

The principal plaice grounds on the coast of Ireland considered are within the areas prohibited to steam trawling, and the recaptures have been chiefly made by the local sailing trawlers and by line fishermen. In these circumstances it seems possible that here, as in other "prohibited" areas, some cases of recapture by steam trawlers may, for obvious reasons, be suppressed by the fishermen concerned.

Omitting certain fish liberated under unfavourable conditions, the total proportion of recaptured marked plaice stands at 46 per cent., from which Mr. Farran concludes that the local fishermen remove no inconsiderable portion of the stock of plaice on their fishing grounds. As an instance of how heavily a small area can be fished may be noted an experiment made in Skerries Bay. One hundred and eighty plaice were marked in April, 1906, out of which number no fewer than one hundred and nineteen, or 66 per cent., had been reported before the end of 1907.

In contrast to the long migrations which have been observed in the North Sea and at Iceland, very little tendency to extensive wanderings is shown by the plaice in these experiments. The majority were retaken within ten miles of the position of liberation. It is interesting to note that an inshore movement in the Dublin Bay area was evident in the autumn. A similar tendency has been noticed at this time of the year in some other parts of the British Isles, and is a well-known feature of the small plaice grounds off the Danish coast.

The choice of a suitable label for these experiments seems to have presented some difficulty. The German pattern of Dr. Heincke was found satisfactory for the size of fish most frequently met with, but unsatisfactory experiments were made with one or two other kinds. It seems curious that no attempt was made with the Petersen form of label, which has been successfully employed in the Danish, English, and other investigations, and, in Dr. Schmidt's classic experiments at Iceland, continued to be returned with the fish more than three years after their liberation.

Mr. Farran's mode of tabulating his data has certain disadvantages. The usual method adopted in recording recaptures is to take them in chronological order. Had this plan been followed instead of taking the consecutive numbers of the labels (an arrangement which seems to have little to recommend it), reference and comparison with the experiments of other investigators would have been facilitated.

[1] Department of Agriculture and Technical Instruction for Ireland. Fisheries Branch. Scientific Investigations, 1907, No. iii. "Plaice Marking Experiments on the East Coast of Ireland in 1905 and 1906." By G. P. Farran. Pp. 86+xxxiii plates. (Dublin, 1909.)

NOTES.

POLITICAL, municipal, industrial, and philanthropic activities are liberally represented in the list of Birthday Honours published on Tuesday, but science and other intellectual interests receive scant recognition. There are six new privy councillors, six new baronets, and thirty-two new knights in the list. Among the privy councillors is Sir Henry Roscoe, F.R.S., and among those who have received the honour of knighthood are Prof. W. A. Tilden, F.R.S., and Mr. E. H. Shackleton, the leader of the recent Antarctic expedition. Prof. A. H. Church, F.R.S., has been appointed a Knight Commander of the Royal Victorian Order (K.C.V.O.). Mr. T. L. Heath has been promoted to be Knight Commander of the Bath (K.C.B.), and Dr. Sven Hedin has been appointed an honorary Knight Commander of the Indian Empire (K.C.I.E.).

THE following is a list of fellows who have been recommended by the president and council of the Royal Society for election into the council for the ensuing year:—*President*, Sir Archibald Geikie, K.C.B.; *treasurer*, Mr. Alfred Bray Kempe; *secretaries*, Sir Joseph Larmor, Prof. J. R. Bradford; *foreign secretary*, Sir William Crookes; *other members of the council*, Dr. H. B. Baker, Dr. W. H. Gaskell, Prof. E. H. Griffiths, Prof. Horace Lamb, Prof. H. M. Macdonald, Major P. A. MacMahon, Dr. C. J. Martin, Sir Andrew Noble, Bart., K.C.B., Prof. W. H. Perkin, Prof. E. B. Poulton, Prof. J. H. Poynting, Lieut.-Colonel David Prain, C.I.E., Prof. R. A. Sampson, Dr. A. E. Shipley, the Right Hon. Sir James Stirling, Dr. A. Strahan.

WE regret to see the announcement of the death of Dr. W. H. Dallinger, F.R.S., on Sunday, November 7, at sixty-seven years of age.

SIR GEORGE DARWIN, K.C.B., F.R.S., has been elected an honorary member of the Calcutta Mathematical Society.

DR. J. J. DOBBIE, F.R.S., director of the Royal Scottish Museum, Edinburgh, has been appointed principal chemist of the Government laboratories in succession to Sir T. E. Thorpe, C.B., F.R.S., who has retired.

THE date of the annual exhibition held by the Physical Society of London, which was fixed some time ago for December 10, has been altered to Tuesday, December 14, so that the exhibition may be open in the afternoon as well as in the evening.

A REUTER message from Berlin states that in the course of excavations conducted by the Museum of Silesian Antiquities at Ottitz, near Ratibor, a clay figure representing a nude female divinity was unearthed in a Stone-age dwelling. The figure is said to be the most ancient model of the human form in existence.

AT the meeting of the Junior Institution of Engineers on Tuesday, November 16, the presidential address, on "The Propelling Machinery of Warships," will be delivered by Vice-Admiral Henry J. Oram, C.B., Engineer-in-Chief of the Fleet.

THE opening meeting of the Illuminating Engineering Society will be held on Thursday, November 18, at the premises of the Royal Society of Arts, when the inaugural address will be delivered by Prof. Silvanus P. Thompson, F.R.S., the first president of the society.

SIR ARTHUR RÜCKER, F.R.S., and Prof. Arthur Schuster, F.R.S., both members of the board of advisers of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, made official visits to the magnetic survey yacht *Carnegie* while at Falmouth, inspecting the instruments and methods of work.

A REUTER message from Washington states that the National Geographic Society has awarded its gold medal to Commander Peary. The subcommittee appointed to examine the explorer's records and proofs reported that they afford conclusive substantiation of his claim to have reached the North Pole, and this report was unanimously accepted by the board of managers. The society has passed a resolution referring to a subcommittee of experts the question whether any explorer reached the North Pole before 1909.

SIR WILLIAM WHITE, K.C.B., F.R.S., chairman of the council of the Royal Society of Arts, will open the new session of the society on November 17 with an address, the subject of which will be "An Imperial Navy." Before Christmas there will be four ordinary meetings of the society, at which papers will be read by Mr. T. Thorne-Baker, on "Phototelegraphy"; the Hon. R. C. Parsons, on "Resilient Wheels for Vehicles"; Mr. J. Buckland, on "The Destruction of Plumage Birds"; and Mr. H. Pearson, on "The Diamond Fields of Brazil." One meeting of the Indian section will be held, at which Sir James Wilson will read a paper on "The Punjab," and Mr. Samuel Simpson will treat "Agricultural Development in Nyasaland" at a meeting of the Colonial section. There will be one course of Cantor lectures; in them Mr. C. C. Turner will give a popular account of the progress which has been made in aëronautics.

THE Hampstead Scientific Society inaugurated a new astronomical observatory and meteorological station on the southern margin of Hampstead Heath on Saturday. Mr. P. E. Vizard presided over a large meeting of the society in Heath Mount School, and short addresses were given on the value of the astronomical work which could be done by Dr. F. Womack, and on the meteorological work by Dr. H. R. Mill. Sir Samuel Wilks, F.R.S., referred to the efforts the society had made to secure this observatory, which has cost about 250*l*. The party then visited the observatory, which, by the kind permission of the Metropolitan Water Board, is placed on the top of the covered reservoir on the highest point of Hampstead, 450 feet above sea-level. The small astronomical observatory has a revolving dome, and contains an 8½-inch equatorial reflector by Grubb, presented to the Society by Dr. Womack. A sidereal clock has been presented by Mr. E. Duveen, and it is hoped that a driving clock will be added later. The meteorological equipment consists of a barometer in the observatory, a Stevenson screen with the usual thermometers, a rain-gauge and a sunshine recorder, all of them exposed in an unexceptionable manner, so that the observations cannot fail to be of much value for climatological purposes. Interesting comparisons may be looked for between the Hampstead records and those taken only a few feet above sea-level in St. James's Park. In a district so subject as London is to partial visitations of fog and thunderstorms, the multiplication of trustworthy meteorological stations in representative positions is much to be desired.

ARRANGEMENTS have been made for an International Congress of Radiology and Electricity at Brussels on September 6, 7, and 8, 1910, in connection with the exhibition to be held there. The congress will be held in three sections, and the subjects to be dealt with will include the following. In the first section, general questions of terminology and methods of measurement in radio-activity, and subjects connected with ions, electrons, and corpuscles will be dealt with. The second section will be divided into various subsections, dealing respectively with fundamental theories of electricity, study of radiations (including spectroscopy, chemical effects of radiations, and other allied questions), radio-activity, atomic theory, cosmical phenomena (including atmospheric electricity and atmospheric radio-activity). The third section will be biological, and will be devoted to consideration of the effects of radiations on living organisms. The sections will deal with purely biological questions as well as with the use of various radiations for medical purposes, both for diagnosis and therapeutics. In order to ensure the success of the congress, committees have been formed in the various countries which will take part in the congress, and the following men of science have already consented to act as presidents of the committee in each country:—Prof. Lenard (Germany), Prof. Exner (Austria), Prof. Oötvös (Hungary), Prof. Castillo (Spain), Prof. Barus (United States), Prof. Langevin (France), Prof. Rutherford (Great Britain), Prof. Blaserna (Italy), Prof. Birkeland (Norway), Prof. Lorentz (Holland), Prof. Ferreira da Silva (Portugal), Prof. Hurmuzescu (Roumania), Prof. Lebedew (Russia), Prof. Arrhenius (Sweden), and Prof. Guye (Switzerland). Communications regarding the congress should be addressed to Prof. Rutherford or Dr. W. Makower at the University of Manchester; or to Dr. W. Deane Butcher, Holyrood, Ealing, London, W., for matters connected with the biological and medical section. Intending members should communicate directly with the general secretary, Dr. J. Daniel, 1 rue de la Prévôté, Brussels.

SOME of the friends and former pupils of the late Prof. Arthur Gamgee have thought that they could best mark their high appreciation of his great scientific attainments

and single-hearted devotion to the prosecution of knowledge by forming a fund which should be of material benefit to his family—a widow and two daughters. Prof. Gamgee was widely known both in this country and abroad—he had, indeed, a European reputation—and it has seemed to those who have given their support to this fund, which was initiated some months ago, that it might be possible to augment still further the capital sum which it is desired should be raised if a knowledge of the objects of the fund was more widely spread, so that those who may wish to help should be invited to subscribe. It is not intended that any list of subscribers should be published. Towards the end of this month there will be a meeting of those who are in sympathy with the view that the raising of such a fund for his family would be the best and wisest appreciation of Prof. Gamgee's life-long devotion to science. The date and place of this meeting will be duly announced. Subscriptions may be sent to Prof. Arthur Schuster, Victoria Park, Manchester; Dr. A. D. Waller, Physiological Laboratory, University of London, S.W.; or Dr. G. A. Buckmaster, University College, London, W.C.

To the second half of the "Bergens Museum Aarbog" for 1909 Mr. Haakon Schetelig contributes an article on Norwegian antiquities received by the museum in 1908. The specimens include a roughly chipped stone implement from Vespestad; a bench of pine-wood from Hammer Church, Nordhordland; a portion of an iron sword, with silver mountings on the scabbard, from Sondhordland; a stone axe from Sogn; a flint javelin-head from Hardanger; and a bronze brooch from Lofoten.

In a paper published in vol. xxii., part i., of the Proceedings of the Royal Society of Victoria, Miss Morris and Miss Raff direct attention to certain features in the structure of the Australian lancelet, *Assymetron bassanum*, which have either escaped previous notice or have been inadequately described. The species in question occurs locally in depths up to 20 fathoms along the coasts of Victoria, and is commonly used in the laboratories of the colony in place of the typical Amphioxus. In another paper in the same issue Miss Buchanan commences a detailed account of the anatomy of Australian earthworms, dealing in this instance with the blood-vascular system, which is illustrated in the different species by diagrams.

In vol. xvii., No. 6, of the Proceedings of the Royal Physical Society of Edinburgh, Dr. Campbell Geddes directs attention to the extraordinary individual variation to be met with in the degree of development of the muscular impressions, crests, or tubercles of the appendicular skeleton of the human subject, and the inferences to be drawn therefrom. In the author's opinion such surface-details of the bones of the skeleton are only indirectly dependent on age, sex, and muscular activity, and are not, as Topinard believed, an index of the absolute muscularity of the individual. On the contrary, they depend directly upon, and therefore serve as an index to, the type of nutrition which the somatic cells of the individual enjoyed during life.

The origin and flora of the salt-marshes, salt-ponds, and fresh-water lakes of the northern coast of New Jersey have been studied by Mr. J. W. Harshberger, who gives the results of his investigations in the August issue of the Proceedings of the Academy of Sciences of Philadelphia. Such lakes and ponds are due to the advance of sand-dunes across the outlets of streams arising some distance inland. Most of the larger streams that have kept their outlets open are bordered for some distance from the sea with a characteristic salt-marsh vegetation. As the bars encroached on the outlets of the streams the water became brackish, and the salt-marsh plants gradually disappeared with the decrease of saltness. Finally, near the heads of several of the bays, as well as in some of the smaller ponds, the water becomes more and more fresh, and the salt-marsh plants are replaced by those accustomed to grow in or near fresh-water streams. Similarly, salt-ponds have become slowly changed into fresh-water lakes, with a corresponding alteration of the vegetation.

We have received the report on the progress and condition of the U.S. National Museum for the year ending June 30, 1908, in which detailed information is given as to the work accomplished on the new building up to that date, with illustrations of the complete structure. The progress of the work was considerably delayed owing to the failure of contractors to deliver the full complement of granite within a specified period. During the year under review the ethnological section of the museum was very largely augmented by collections illustrative of the natives of Borneo and the Philippines, the cliff-dwellers of Arizona, the Zuni Indians of New Mexico, and the Tahltau Indians of British Columbia. Mammals and birds from Malaya, the Philippines, and Costa Rica bulk largely among the additions to the zoological section, and the collections of fishes and invertebrates were largely augmented by the final distribution of the specimens obtained during the exploring cruise of the *Albatross* in the Pacific.

The nematodes come in for a large share of attention in the latest number of the *Zeitschrift für wissenschaftliche Zoologie* (Bd. 93, Heft iv.), in which Mr. E. Martini continues his studies on the subcuticula and lateral areas, and Dr. Fr. Bílek deals with the fibrillar structures in the muscle and intestinal cells of ascarids. Dr. Bílek's memoir, with its beautiful illustrations, constitutes a noteworthy addition to our knowledge of invertebrate cytology.

Messrs. Sanders and Co., Shaftesbury Avenue, have issued a very complete series of lantern-slides, 270 in all, illustrating spiders and their habits, a number of which we have had the opportunity of inspecting. The photographs were taken from nature by Mr. Richard Hancock, and show great manipulative and artistic skill. The series, of which a complete catalogue is also published, should be of great use to popular lecturers.

The *Journal of Morphology* for October (vol. xx., No. 3) contains two important cytological papers. In his "Observations on the Oökinesis in *Cerebratulus lacteus*," Naohide Yatsu describes the phenomena of maturation and fertilisation of the egg and its early cleavage stages. He deals especially with the behaviour of the "centriole," or, as English cytologists generally term it, the "centrosome," the latter term being used by the present author to designate the "centroplasm" which surrounds the "centriole," in other words, what is often termed in this country the "centrosphere." It is evident that the terminology of cytologists is in a somewhat confused state. Yatsu maintains the view that the middle piece of the spermatozoon carries a centriole into the egg at fertilisation, and that this gives rise by division to the cleavage centrioles.

Another paper in the *Journal of Morphology*—"Comparative Studies in Crustacean Spermatogenesis"—by M. Louise Nichols, besides the author's own observations, contains a useful *résumé* of the work of previous writers on the morphology of the crustacean spermatozoon. It seems that, according to Koltzoff, the curious immobile

spermatozoon of the higher Crustacea is constructed very much on the principle of a cartridge. After the spermatozoon has become attached to the egg by means of its processes, the "capsule" explodes and drives the nucleus and centrosome into the egg. The same journal also includes an interesting account of the life-history and habits of *Chactopterus variopedatus* by Mr. H. E. Enders, and a very full account of the development of the procephalic lobes of *Epeira cinerea* by Mr. A. E. Lambert, while Mr. Walter Meek contributes a description of the structure of the heart muscle of Limulus.

A PRELIMINARY revision of Philippine Myrtaceæ, by Dr. C. B. Robinson, published in the *Philippine Journal of Science* (Botany, vol. iv., part iii.), is primarily noteworthy for the number of species, just short of a hundred, described under the genus Eugenia. This is largely due to the incorporation under Eugenia of the segregates Jambosa and Syzygium, to which the greater number of species belong. Fully half the species are new types, and a considerable proportion of the remainder are endemic. Most of the Eugenias are trees yielding timber of value, although none supplies timber so commercially important as the myrtaceous tree *Xanthostemon verdugonianus*. Outside the genus Eugenia the family is poorly represented by a dozen species distributed over nine genera.

A NOTE on *Fomes lucidus*, one of the Polyporaceæ, contributed by Dr. E. J. Butler to the *Indian Forester* (September), deals with the probable parasitism of this fungus, as previously suggested by Dr. Raciborski. The author mentions a number of cases of fungal diseases, reported from different parts of India, on such different trees as Casuarinas, betel-palm, *Dalbergia Sissoo*, in which the source could not be definitely traced, but in all of which *Fomes lucidus* was found to be present; inoculation experiments are required to decide the question. In the same issue there are good illustrations of hills in the north Arcot division, Madras, showing the absence of tree growth in unprotected and protected but grazed areas as compared with the growth on a fully protected and partially planted area. For reproduction *Pterocarpus santalinus*, Red Sanders, proved to be better than *Terminalia tomentosa*, teak, or other species that were tried.

A FINE catalogue of plants, bulbs, and seeds has been issued by Messrs. Kelway and Son, of Langport, Somerset. The firm makes a special feature of hardy perennial plants, and their list of species in this section may be regarded as complete, but the catalogue is even more noteworthy in the selection of varieties offered under those plants that have been special objects of cultivation. The records of the Royal Horticultural and Royal Botanic Societies bear testimony to the splendid varieties of delphiniums, gaillardias, pyrethrums, and gladioli raised by Messrs. Kelway, and, above all, of pæonies, herbaceous, "imperial," and tree; the firm also raise their own forms of other favourites, such as zonal pelargoniums, hollyhocks, and phloxes. The catalogue cannot fail to arouse the enthusiasm of all garden-lovers; it is eminently practical in arrangement, description, and directions, is illustrated with choice photographic reproductions, and contains a few coloured plates taken in colour direct from the object.

AN account of the Peruvian National School of Agriculture is given in a new monthly publication entitled *Peru To-day*. The country possesses a rich soil and a climate enabling tropical products to be grown as well as those of the temperate zones. The coast is said to be well adapted to cotton raising; sugar and rice are also grown besides the ordinary cereal and other crops. A model vineyard has been started, and also an experimental sugar-cane station.

WE have received from Messrs. Pearl and Surface a paper on selection index numbers and their use in breeding, in which the authors discuss the case, commonly arising in practice, where it is desired to improve two or more features at the same time. Each of the several characters shown by the plant or animal receives a certain value, positive or negative. The sum of these values for each individual constitutes its index number. Those individuals with highest index numbers are then selected and used for breeding.

IN a recent number of the *Journal of Economic Biology* Mr. Southern describes a new species of Rhabditis, *R. brassicae*, discovered in a turnip in an advanced state of decomposition. The nematode worms commonly known as "eel worms" are found in water, soil, and decaying organic matter, and are responsible for a certain amount of damage to plants. Some genera, such as Tylenchus, are provided with a spine, by means of which the epidermis of the plant can be pierced and its juices sucked. In Rhabditis, however, this piercing apparatus is absent, and the author kept large numbers of the worms on the surface of a turnip for a month without the epidermis being affected; but once a way in was found, the worms were enabled to feed on the juices by means of their powerful sucking pharynx.

CONSIDERABLE attention is devoted to the culture of maize by the Transvaal Agricultural Department, and an account of the varieties most suitable is given by Mr. Burtt-Davy in the *Transvaal Agriculture Journal*. Dent maize is best for the main crops, as it usually gives the best yields and is in greatest demand; flint maize, on the other hand, is more suitable for districts where the rainfall is limited. Of the different varieties of dent maize Hickory King is most promising for the export trade, as it is purchased by corn-flour manufacturers, distillers, and brewers; by producing a choice grade of this variety still more profitable results may be obtained. Yellow varieties are grown for stock-feeding purposes.

THE quarterly issue of the *Eugenics Review* for October maintains the standard of former parts. In addition to the usual editorial notes and reviews, there is a short contribution by the honorary president, Sir Francis Galton, on the effects of small and persistent influences in moulding public opinion, and special articles on various aspects of eugenics. The note by Dr. Havelock Ellis directing attention to the sterilisation, on social grounds, of four mentally defective persons in Switzerland, and the Rev. J. H. F. Peile's discussion of the relation of the Church to the eugenic movement—a pressing and difficult problem—are, perhaps, of most general interest. It is to be regretted that the article by Dr. Slaughter, on selection in marriage, should be open to the criticism of Mr. Peile that much of the literature of eugenics is unconciliatory and dogmatic in tone. The adoption of a polemical style is inappropriate in a scientific contribution to the discussion of the subject, and defeats its own end in an article written for propagandist purposes.

THE *Century Magazine* for November contains a popular article, by Prof. Metchnikoff, on the utility of lactic microbes in the diet, their mode of action, and an explanation of the author's views on longevity.

THE winter session of the London School of Tropical Medicine was opened on October 26 by Mr. Whitelaw

Reid, the American Ambassador, when Prof. Osler delivered a masterly address on the progress of tropical medicine and the benefits resulting therefrom. Prof. Osler urged the great need there is for further extension in research on diseases of the tropics.

CONSIDERABLE activity is being manifested in the attempt to cope with the plague of sleeping sickness in Africa. The Sleeping Sickness Bureau, under the direction of Dr. Bagshawe, has issued its tenth Bulletin, containing a summary of researches on trypanosome diseases, their pathology and treatment; also a progress report on the Uganda sleeping sickness camps from December, 1906, to November, 1908, compiled by Dr. Hodges, the principal medical officer, Uganda. The welcome statements are made that sleeping sickness is greatly on the decrease in Buganda kingdom, and that the drug atoxyl at least prolongs life, and in exceptional cases is curative. A bibliography of trypanosomiasis and tsetse-flies, embracing papers published prior to April, 1909, and compiled by Major C. A. Thimm, of the Sleeping Sickness Bureau, is in the press.

IN *Symons's Meteorological Magazine* for October, Mr. C. Harding gives an interesting note, with diagram, of the summer weather (April–September) experienced in London and the suburbs during the last fifty years, prepared from the records of the Greenwich Observatory. The average number of warm days, on which a temperature of 70° and above was reached, was seventy-four; the greatest number of warm days was 127, in 1865. The last ten years, with the exception of 1906, have been cool. The average rainfall for the summer season is 12·29 inches —an amount which was exceeded this year by 1·80 inches.

A NEW barograph for recording minute and rapid oscillations of atmospheric pressure, invented by Mr. T. Shida, is described in the Proceedings of the Tokio Physical Society for April last. By a simple plan an aneroid barometer is made to record photographically; for the purpose of magnification, Kelvin's bifilar method is applied directly to a Bourdon tube, as used by Darwin and others. To protect the instrument, the whole system is enclosed in an air-tight case, with the exception of a small window provided with a lens for photographic registration. The case and tube have each a short piece of metal tube with stop-cocks communicating with the atmosphere. Specimens of the records are appended to the paper; the period of oscillation at Tokio was generally about six seconds, vibrations with the period of twelve seconds being most conspicuous. The author thinks that such observations may eventually explain the true cause of the pulsation of the ground.

A COPY of "Studies in Practical Topography," by Mr. H. T. Crook, published by the Manchester Tactical Society, has reached us. Mr. Crook vigorously criticises the prepared sheets issued for some recent military examinations in a chapter entitled "The Land of (*d*)1," and gives three interesting topographical studies on Ruthin and the Clwydian range, Ilkley Skipton and the Pennines, and the Ribble Valley.

AN excellent example of detailed geographical study of a small area appears in a paper, published in the *Mitteilungen* of the Vienna Geographical Society (vol. lii., No. 9), on the town of Graz. The author, Dr. G. A. Lukas, discusses the position, soil, water supply, climate, flora and fauna, and population of Graz and its neighbourhood with much detail, and the paper is accompanied by a geological map by Dr. Franz Heritsch. Specially interesting is the examination of the relation of local and outside conditions, and of the historical events which finally gave Graz the predominance over the equally well-situated Wildon.

A NEW series of calculating tables, by Dr. J. Peters, is announced (Berlin: Georg Reimer). The tables are to contain the products of all numbers of four figures by the numbers 1 to 100, so to multiply together two numbers of four figures it is only necessary to take two partial products from the tables and add them together, *i.e.* the multiplication is performed in two lines, which are written down from the tables.

A PROJECT for the formation of a museum of aërial navigation has been started under the auspices of the authorities of the Frankfurt Exhibition, the Frankfurt Aëronautical Society, the Physical Society, and other bodies in Frankfurt. It is pointed out that aërial navigation has a small past and a great future, and that the recent exhibition affords an excellent nucleus for a collection which can never be complete unless it is founded in the early days of the subject.

IN view of the exaggerated importance attached to aëroplane record-breaking feats by the unscientific public, it is somewhat of a relief to turn to Mr. Gerald Biss's criticisms in the *Standard* of October 26. Great stress is laid on the power of individuality as a factor in present-day flights, it being pointed out that it was Mr. Latham's individuality which made his wonderful flight of the previous Friday possible. In a paragraph headed "When Aviation is Farcical," Mr. Biss says:—"The truth of the matter is, in a nutshell, that the progress of aviation has been greatly overwritten by ignorant enthusiasts and is still in the days of its earliest infancy. After the present boom, which will, I am sure, be far more short-lived than either the cycle or the motor boom, it will behove designers to sit down and work out the questions of automatic stability, vertical rising, compactness to the point of the practical, security against sudden dropping, and so on. . . ."

THE view generally held that in the liquefaction of gases in the Linde or Hampson apparatus the cooling is due to the Joule-Kelvin effect has been attacked by Pictet in a series of articles which have appeared in the technical Press during the last half-dozen years. He has put forward an expression for the cooling which makes it depend on the work the gas does in overcoming the pressure in front of the expansion valve, and implies that it increases with increase of initial temperature and is almost independent of the fall of pressure. Messrs. W. P. Bradley and C. F. Hale, of the Wesleyan University of Connecticut, have made an extensive series of experiments on the cooling of the air in a liquefying apparatus in widely differing circumstances of pressure and temperature, and have found that the facts are qualitatively in agreement with the original theory, although there are quantitative differences to be explained, while they are diametrically opposed to the Pictet theory. The memoir is contained in the September number of the *Physical Review*.

IN a paper entitled "The Elastic Breakdown of Non-ferrous Metals," read at the recent Manchester meeting of the Institute of Metals, Prof. C. A. Smith, of the East London College, describes the special strain-measuring appliance called the sphingometer, devised and used by him for the tension, compression, and torsion strips. There were five conditions which the instrument was required to

fulfil, namely, (1) to determine the maximum, as well as the mean stress, on the material tested; (2) to be easily adapted to specimens of varying diameters; (3) to be easily adapted to specimens of varying length; (4) to measure accurately strains of at least one hundred-thousandth part of an inch; (5) to be of reasonable expense. The results of a large number of tests made with the instrument are given. These tend to prove that copper, aluminium, and other non-ferrous metals have very varying elastic properties, and it is consequently impossible to establish any definite law for elastic failure. It appears, however, that elastic failure always does take place according to a law which approximates closely to the maximum shear-stress theory.

In an article on the development of modern road surfaces in the Journal of the Franklin Institute for October, Mr. W. H. Fulweiler divides the methods of applying tar into three general heads:—(*a*) Brushing with a hot coating of coal-tar and dusting it lightly with sand; in general use in France. (*b*) Painting the surface by machine and dusting with sand; in general use in England. (*c*) Coating the surface with a fairly heavy coating of hot tar or tar compounds, and then covering with a light coat of screening, the surface being finally rolled. The latter is the general system adopted in America, and seems to be better adapted to the rougher surface of American roads. A refined grade of tar, considerably heavier than that used in France or England, is used, having more body and greater binding properties, and the coating applied is about twice as heavy. A light coating of clean gravel or fine stone chips is then put on instead of sand and rolled, thus renewing the wearing surface and filling the voids better than can be done by the use of sand. The treatment produces deeper penetration and more lasting effect, and succeeds best on macadam roads. It is practically mud-proof, absolutely free from road dust, apparently proof against very heavy motor traffic, and is the most satisfactory for American conditions. The cost is higher than that of the French and English methods.

An interesting pamphlet dealing with water-hammer in steam pipes has been issued by Mr. C. E. Stromeyer, chief engineer of the Manchester Steam Users' Association. According to the Board of Trade reports, water-hammer has been the cause of about 120 steam-pipe explosions. Mr. Stromeyer finds that nearly one-half of these have been due to the absence of drain-cocks on steam pipes, or to their injudicious use. A large number, chiefly on steamers, have been produced by admitting steam into pipes containing water. Others have occurred when water was admitted into steam pipes, or when steam condensed in them. Steam being admitted through valves on which water was resting, injudicious opening of valves having steam and water on both sides, and injudicious manipulations of steam valves, whereby plugs of water have been set in motion, have all contributed to swell the total of explosions. Mr. Stromeyer considers it inadvisable to lay down at present definite rules for the design of pipe arrangements in general, having been led to this conclusion by the fact that draining arrangements, designed to obviate explosions, have caused the majority of accidents, and also because in many cases of complicated pipe arrangements the water-hammer may often be attributed to any of the above-mentioned causes. Mr. Stromeyer complains of the insufficiency of the official reports of explosions having given him much difficulty in arriving at definite conclusions.

Mr. W. B. Clive, of the University Tutorial Press, Ltd., has published a second edition of "First Stage Sound, Light and Heat." The book has been revised and rewritten by Dr. R. W. Stewart, who has introduced a course of experimental work. The price of the book is 2*s*.

In connection with the Winnipeg meeting of the British Association last August, the *Manitoba Free Press* published a series of illustrated biographical sketches of the president, Sir Joseph Thomson, F.R.S., the presidents of the sections, the evening lecturers, and the general officers of the association. These biographies have now been re-issued in pamphlet form at the price of 50 cents. Copies of the booklet can be obtained from Mr. A. V. Thomas, c/o *Manitoba Free Press*, Winnipeg, at 7½*d*. each.

We have received a copy of the second part of vol. xiii. of the Transactions of the Leicester Literary and Philosophical Society. The booklet contains abstracts of lectures delivered before the society, the report of the council, and the annual reports of the sections of the society presented at the annual general meeting in May. The report states that the balance of the fund raised in connection with the visit to Leicester, in 1907, of the British Association has been voted to the council of the society for investment as the nucleus of a fund, the interest accruing from which is to be devoted in a manner to be decided by the council, annually, or at such times as the council may determine, to the development of local scientific knowledge, including that bearing upon the industries of the town. A cheque for 80*l*. has been received, and the council has appointed a special committee to consider and report as to the best means of applying the money in furtherance of the object intended.

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences in November:—

Nov. 11.	10h. 27m.	Mercury in conjunction with the Moon. (Mercury 1° 21′ S.).
16.	16h. 27m.	Venus in conjunction with the Moon. (Venus 0° 6′ S.).
,,	19h. 0m.	Vesta in conjunction with the Moon. (Vesta 1° 15′ N.).
17.	5h. 39m.	Uranus in conjunction with the Moon. (Uranus 3° 0′ N.).
22.	10h. 11m.	Mars in conjunction with the Moon. (Mars 4° 26′ N.).
23.	13h. 15m.	Venus in conjunction with Uranus. (Venus 2° 33′ S.).
,,	14h. 53m.	Saturn in conjunction with the Moon. (Saturn 1° 32′ N.).
,,	7h. 39m.	Minimum of Algol (*β* Persei).
26.	20h. 55m.	Eclipse of the Moon, partly visible at Greenwich.
,,	4h. 28m.	Minimum of Algol.
29.	23h. 22m.	Neptune in conjunction with the Moon. (Neptune 4° 14′ S.)

Re-discovery of Winnecke's Comet (1909*d*).—A telegram from the Kiel Centralstelle announces that Winnecke's comet was re-discovered at the La Plata Observatory, Argentina, on October 31. Its position on that date at 8h. 14·1m. (La Plata M.T.) was 17h. 11m. 51·6s., −27° 18′ 43″, and its magnitude was about 10·0; this position lies a little to the south-west of *θ* Ophiuchi. According to Prof. Hillebrand's elements, the perihelion passage took place on October 4·0 (G.M.T.).

Halley's Comet.—According to a note in the November number of the *Observatory*, Halley's comet is steadily increasing in brightness, and ten minutes' exposure, presumably with the Greenwich 30-inch reflector, gives a strong image. Reproductions of photographs are given in the *Observatory* (Greenwich, September 23), *Knowledge*, and the *Astrophysical Journal* (Yerkes Observatory, September 16, 17, 24, and 26). The *Observatory* (No. 415, p. 435) also gives an ephemeris for April and May, 1910, the time of perihelion passage being taken as April 19·65

G.M.T. From this we see that the nearest approach to the earth should occur on May 20, the distance then being 14·3 million miles. The revised elements indicate that the comet should transit the sun's disc on May 18d. 14h., but the transit will, of course, be invisible in Europe. It appears possible that, at that time, the comet's tail may extend beyond the earth and be visible in the midnight sky.

From observations made with the 40-inch Yerkes telescope Prof. Barnard concludes that the comet is brightening rapidly, and was not fainter than magnitude 13·5 on October 17–19; the diameter was estimated at 15″, the comet being a little brighter towards the centre.

The Astronomischen Gesellschaft prize has now been definitely awarded (*Astronomische Nachrichten*, No. 4366) to Messrs. Cowell and Crommelin.

SATURN.—A telegram from the Flagstaff Observatory announces that the lacings crossing Saturn's equatorial bright belt, detected at that observatory, have now been photographed there (Circular No. 114, Kiel Centralstelle).

MERCURY.—From the careful study of some twenty photographs, taken at the Massegros Observatory during the elongation of September last, M. Jarry-Desloges arrives at the conclusion that the rotation period of Mercury coincides with the period of revolution. The photographs show a number of details (*Astronomische Nachrichten*, No. 4366, p. 375, November 1).

THE "FLASH" SPECTRUM WITHOUT AN ECLIPSE.—Yet another important development in solar spectroscopy emanates from Mount Wilson, Messrs. Hale and Adams, in No. 3, vol. xxx., of the *Astrophysical Journal*, describing the apparatus and method whereby they have succeeded in photographing the bright-line spectrum of the lower chromosphere without waiting for a total eclipse. With their apparatus such photographs may now be obtained at any time when the sun is observable.

After describing the previous attempts to attain this end, made at Kenwood, Yerkes, and Meudon, they give a brief description of the additions to the 30-foot spectrograph which enabled them to accomplish it.

The main difficulty in such photography is to keep the solar image exactly tangential to the slit, but they have overcome this by fitting a slipping-plate over the slit-plate. This slipping-plate is moved, parallel to the slit-plate, by a fine screw, and carries a right-angled prism which reflects the image of the limb on to a second, similar, prism fixed in front of the slit so as to reflect the rays between the slit jaws. The observer watches the spectrum, and by moving the slipping-plate preserves the tangential position, which gives the "flash" spectrum, throughout the exposure. The tower telescope gives a solar image of 6·7 inches diameter, and a grating having 568 lines per mm. on a ruled surface 49 mm. by 82 mm. is employed; better results are anticipated when the new 150-foot tower telescope becomes available. At present provisional wave-lengths are given for 124 "flash" lines, which are tabulated to show coincidences with Rowland's solar lines and with the eclipse lines observed by Evershed, Frost, Jewell, and Lockyer, respectively. The deviation of the wave-lengths of these lines from those given by Rowland for the corresponding solar lines is less than the probable error of measurement; if the bright lines of the "flash" spectrum were due to anomalous refraction at the sun's edge, as suggested by Julius, the two sets of wave-lengths should differ considerably.

SEARCH-EPHEMERIS FOR GIACOBINI'S COMET, 1896 V.—A revised set of elements for the comet discovered by Giacobini on September 4, 1896, is published by that observer in No. 4364 of the *Astronomische Nachrichten*, and gives the probable date of perihelion passage as December 19, 1909.

Three search-ephemerides are also given, one assuming that perihelion will occur on December 19·364, the others for ten days before and after, respectively. The position for November 4 is $\alpha = 18h.\ 13{\cdot}1m.$, $\delta = 15^{\circ}\ 1'$ S., and the brightness is given as 0·58, unity being about equivalent to magnitude 12·0. The southerly declination and comparative faintness of the object render it unlikely that the comet will be observable, if found, except by the largest instruments.

THE UPPER AIR.[1]

THE past decade has been very fruitful in the investigation of the upper air. By the use of kites sufficient results have been obtained to furnish a tolerably complete knowledge of the variation in the meteorological elements up to a height of 2 km., while registering balloons have furnished information regarding the distribution of temperature up to heights of 15–20 km. The results of the Berlin manned balloon ascents were arranged and discussed very fully ten years ago, but no such comprehensive discussion of the much more numerous kite and registering balloon ascents has yet been attempted. The present report deals with the instruments and methods of investigation, and with the results for temperature and for wind.

The most important series of the earlier ascents with manned balloons was that made by Glaisher in 1860–70. Unfortunately, he was led to believe that artificial ventilation of the thermometers was unnecessary, with the result that his observations at great altitudes are untrustworthy. In the series of ascents made from Berlin in 1888–95, observations made with careful ventilation proved beyond doubt that large errors would arise in the absence of proper ventilation, and that Glaisher's results were almost certainly affected by such errors.

The following table shows the nature of the errors, and incidentally furnishes a comparison with one of the earlier *ballon-sonde* ascents:—

Height, metres	Fall of temperature °C. per 1000 metres		July 31, 1901	
	Glaisher	Berson	Berson and Süring	Ballon-sonde
0–1000	7·5	5·0	7·2	8·3
1000–2000	6·5	5·0	6·8	6·1
2000–3000	5·0	5·4	3·7	4·2
3000–4000	4·2	5·3	5·2	5·1
4000–5000	3·8	6·4	7·4	5·7
5000–6000	3·2	6·9	5·5	6·3
6000–7000	3·0	6·6	7·2	4·7
7000–8000	2·0	7·0	7·2	7·6
8000–9000	1·8	9·0	3·6	7·1

Temperature observations in manned balloons are now usually taken with an Assmann's aspirator, in which a ventilating current of about 4 m.p.s. is forced by a fan through a polished tube containing the thermometer and screening it from radiation.

The instruments used with registering balloons are of two types. In the large type the record is made on a metal or photographic sheet, covered with lamp-black, and wrapped round a revolving cylinder driven by a clock. Pressure, temperature, and humidity are recorded by separate pens. The barometer is a Bourdon tube or an aneroid, the thermometer some form of bimetallic instrument, and the hygrometer a bundle of hairs. In the small type the temperature record is traced on a cylinder or plate, which is itself moved at right angles to the direction of motion of the temperature lever by the changes of pressure. The temperature and pressure are then given by the ordinates and abscissæ of the trace obtained. The advantage of this arrangement is that no clock is required, and the instrument can be made much lighter and is more easily tested. The loss of the humidity trace is unimportant, because the hygrometric records at low temperatures are very untrustworthy, and the observations in the lower layers can be made with kites or manned balloons.

The instruments used with kites are similar to the *ballon-sonde* instruments of the larger type, but they have an arrangement for recording wind velocity. In the Dines instrument the records are traced on a flat, circular sheet of cardboard rotated by means of a clock and resting on a wooden tray beneath which the instruments are placed.

The *ballon-sonde* instruments are tested either (1) by keeping the thermometer at ordinary atmospheric pressure in testing for temperature, and the barometer at ordinary temperatures in testing for pressure, or (2) by testing the thermometer through the temperature range at different pressures and the barometer through the pressure range at

[1] Report on the Present State of our Knowledge of the Upper Atmosphere as obtained by the use of Kites, Balloons, and Pilot Balloons." Report of the Committee, consisting of Messrs. E. Gold and W. A. Harwood, presented at the Winnipeg meeting of the British Association, 1909.

different temperatures. The second is, of course, the more desirable plan, but the difficulties involved in applying it to the larger type of instrument are so considerable that the former method is generally adopted where such instruments are used. The simplicity of the smaller type of instrument devised by Dines enables the second method to be adopted in testing it, without elaborate and expensive apparatus.

Temperature records obtained simultaneously with different instruments show differences which, in the mean, do not exceed 1° C., and the temperatures may, in general, be taken to be correct to this degree of accuracy, but lagging of the instruments makes it doubtful if in all cases the recorded temperatures and heights actually correspond.

In dealing with the observations, it is found convenient to express temperatures in degrees C. above the absolute zero, −273° C. on the ordinary scale. Where necessary the letter A is used to characterise this scale. Atmospheric temperatures, both at the surface and in the upper air, lie almost always between 200° A and 300° A, so that the 2 may be dropped without risk of confusion. Gradients of temperature are expressed in degrees C. per km., and are reckoned + when temperature decreases upwards.

The mean value of the gradient up to 3 km. is as follows :—

	°
From the Berlin manned balloon ascents, 1888–1897	5·1
,, ,, ,, ,, 1897–1907	4·8
,, [Berlin and Lindenberg kite ascents	4·7
Calculated by Hann from mountain observations	5·7

It follows from these results that the mountains are colder than the free atmosphere at the same height, and many observers have verified this fact by direct comparison. Shaw and Dines found that in July, 1902, the temperature on Ben Nevis was 2·6° C. below that of the free atmosphere at the same height to the west of the mountain. Schmauss found that the temperature on Zugspitze (nearly 3000 m.), which lies on the northern edge of a mountainous region, was continually lower than that of the free atmosphere, but was higher than that at the same height on Sonnblick, which lies in the middle of the Alps.

It was pointed out by Von Bezold that increase of temperature on a mountain is limited by convection, whereas no immediate limit is set in this way to cooling. There is a one-sidedness in the heat exchange between the mountain surface and the atmosphere which would tend to produce the result found by observation. Moreover, convection always tends to raise the temperature of the upper air above what it would be otherwise, and, in addition, the cold of winter is, as it were, stored up in the snow, while no such process holds for the warmth of summer. Both conditions are probably effective in increasing the temperature difference. The most important deduction to be made from the results is that the mountains are not cold because the upper air is cooled by convection, but they are cooled by their radiation to space.

The mean values of the gradients up to 15 km., found from registering balloon ascents at ten European stations and for St. Louis, U.S.A., are given in the table :—

Height	0–1	1–2	2–3	3–4	4–5	5–6	6–7	7–8 km.
Gradient {Europe	3·6	4·3	5·2	5·8	6·3	6·8	7·2	7·4
{St. Louis ...	5·1	5·3	4·7	5·2	5·9	6·2	7·8	8·7

Height	8–9	9–10	10–11	11–12	12–13	13–14	14–15 km.
Gradient {Europe	6·8	5·0	3·3	0·7	−0·8	0·0	−0·1
{St. Louis ...	7·4	6·7	5·5	2·9	1·4	0·6	−0·9

The maximum value occurs in the layer 7–8 km., and its magnitude indicates that the effect of radiation is to leave practically unchanged the natural gradient in air in vertical motion. Gold showed that in the upper layers absorption exceeded radiation, and in the lower layers radiation exceeded absorption, and both processes would diminish the temperature gradient. At an intermediate stage absorption and radiation must balance, and the results indicate that this is the case at a height of 7–8 km. The temperature at different heights up to 15 km. shows practically no variation for the ten European stations except in the case of Pavlovsk, where the temperature is uniformly lower up to 10 km. and higher above 10 km. than at the other stations. The difference of temperature between Strassburg and Pavlovsk, taken to represent lat. 50° and lat. 60° respectively, is sufficient to produce a gradient of pressure at a height of 10 km. which would correspond to a steady west wind of about 24 m.p.s. (54 miles per hour). The difference between Strassburg and St. Louis (representing lat. 39°) would at the same height correspond to a steady west wind of 15 m.p.s. in intermediate latitudes. The observations are not sufficiently extensive to warrant much stress being laid on the absolute values of these velocities, but it is of interest to note that the approximate ratio of the west winds in lats. 45°, 55°, deduced from Oberbeck's solution by a purely theoretical treatment of the problem of the general circulation, is 16/21 for the upper strata, a result in tolerable agreement with the ratio 15/24 deduced from the temperature observations.

The problem of the vertical distribution of temperature in cyclones and anticyclones depends for its solution on upper-air observations. Hann deduced from the temperatures at high-level observatories that cyclones were colder than anticyclones, the mean difference of temperature up to 3·5 km. being as much as 5° C. Grenander found similar results by a consideration of the kite and balloon ascents at Hald and Berlin, while Von Bezold deduced from the Berlin manned balloon ascents that the relative coldness of the cyclone was maintained even up to 8 km.

The results in the present report, obtained by taking only those cases in which the sea-level pressure exceeded 770 mm. or was less than 750 mm., and correcting the observations for seasonal and local variations, showed that the cyclone was colder than the anticyclone up to 9 km., while at greater heights the conditions were reversed, and the anticyclone became much colder than the cyclone; but the effect of the temperature difference in the lower layers on the pressure difference is so considerable that even at 14 km. the pressure gradient is not reversed. In these circumstances it is difficult to see how air can be brought into the anticyclonic and out of the cyclonic regions in the upper air. The cirrus observations imply a definite outward motion over cyclonic regions, but a rotation in the same direction as at the surface, which can be the case only if the gradient of pressure is also in the same direction as at the surface. These results imply that there is motion across the isobars from the lower to the higher pressure. Now, although it is possible for such motion to exist if the velocity in the cyclonic region exceeds a certain value, or, in the anticyclonic region, lies between certain limits, it is not possible to have steady motion of this type, and the effect of damping would be to make the motion from the higher to the lower pressure. The evidence points to the conclusion either (1) that cyclones and anticyclones arriving in the European area are in general dissipating systems which are continually replaced by other systems arriving from what may be called productive regions, or (2) that there is interchange of air with regions in which the surface temperature or the temperature gradient differs sufficiently to produce mean temperatures greater in low-pressure areas and less in high-pressure areas than are found over Europe.

It is interesting in connection with this part of the subject to note that Shaw and Lempfert deduced from a discussion of surface air currents that the central areas of anticyclones were not the regions of origin of currents, and could not, therefore, be places where descent of air was taking place to any considerable extent. The temperature observations in the first 3 km. agree with this conclusion, since they show that there is no approach to a regular adiabatic gradient near the centres of anticyclones.

Perhaps the most remarkable phenomenon revealed by the observations from registering balloons is the comparatively sudden cessation of the fall of temperature at a height which varies from day to day, but is roughly equal to 10 km. Above this height, which may be regarded as the height of an irregular, but roughly horizontal, surface dividing the atmosphere into two regions, the temperature at any time varies very little in a vertical direction, showing, on the average, a slight tendency to increase. The lower and upper regions are characterised by the terms "convective" and "advective" respectively, and the height and temperature of the dividing surface

are denoted by H_c and T_c. The following table gives the values of H_c, T_c, for certain places in Europe :—

	Mean of 13 Stations	Munich	England	Strassburg	Paris	Pavlovsk	Koutchino	Milan	Vienna	Berlin
H_c	10·6	10·9	10·8	10·8	10·4	9·6	10·6	10·7	10·2	10·7
T_c	16°	16°	18°	15°	18°	18°	14°	17°	15°	16°
No. of cases ...	336	53	32	67	57	28	18	25	24	32
Latitude... ...	—	48°	52°	49°	49°	60°	56°	45°	48°	52°

There is very little variation for places between lat. 45° and lat. 55°, but at Pavlovsk H_c is about 1 km. below the average. Observations made in the equatorial regions show that the value of H_c there exceeds 15 km., so that there must be a considerable increase in its value in crossing the limit of the trade-wind region, and it appears probable that the equatorial currents and the trade winds form a closed system with little interchange of air with higher latitudes.

The annual variation in H_c, T_c is shown by the following table :—

Annual Variation in H_c.

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec
Mean of 13 stations...	10·3	10·4	9·1	10·1	10·5	10·7	10·9	11·4	10·4	11·9	10·8	10·1
Number of cases ...	26	22	32	39	31	27	24	61	46	38	25	25
Munich	10·0	10·4	9·2	9·2	11·2	11·0	11·7	12·0	10·3	12·3	11·8	11·4
Number of cases ...	4	3	6	4	2	4	3	11	5	5	2	5
Strassburg...	10·5	10·6	9·4	9·4	10·6	10·9	10·8	12·3	10·9	11·9	11·0	11·1
Number of cases ...	5	5	5	5	4	5	4	9	8	6	6	5

Annual Variation in T_c.

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean of 13 stations...	13	11	16	16	17	20	20	18	22	14	15	14
Munich	14	10	16	19	25	20	15	16	26	9	10	13
Strassburg...	11	10	16	20	17	17	21	15	23	13	12	10

The remarkable feature is the relatively high temperature and low value of H_c in March and September. This peculiarity and the fact that T_c is least near the equator suggest that the general nature of the process may be as follows. The cool air above the equator moves polewards, and in the natural course descends again to feed the trade winds. Owing to the irregularities of the earth's surface, the change of seasons and the very considerable difference between the northern and southern hemispheres, the process will be neither regular nor symmetrical. Consequently, the equatorial cold air will encroach on the advective region of temperate latitudes, and such encroachments will produce anticyclonic regions. The advective atmosphere would be reached there at a higher level, and initially at a lower temperature than in the average state, but the temperature would be gradually raised by absorption of thermal radiation to the normal value for that latitude.

The fact that H_c has minimum values in March and September, when equatorial temperatures are highest, appears at first to be contrary to this view; but the first effect of increased temperature will be to increase the strength of the trade winds, and as at the same time there is a transference of air across the equator to the southern hemisphere, a transference which can be made only through the upper return current, there will be a deficiency of descending air, and the equatorial cold air will encroach less than usual on the northern advective region. The reverse process would be expected to occur in September, but the autumnal transference of air to the northern hemisphere will be initially much more intense towards the great continental regions than to the Atlantic and European area, and it may well be that the equatorial current again encroaches less than usual on that region. It may be expected that the value of H_c in Asia and America will not show the September minimum.

The explanation of the discontinuity in the temperature gradient appears to be this. The fall of temperature is governed mainly by convection, and a necessary condition for convection to persist is that the radiation shall exceed the absorption in the upper layers of the convective system. A limit is therefore set to the height to which convection can extend, and at this limit the discontinuity in the fall of temperature occurs. It has been shown that the observed height is about the same as the limiting height of the convective system found from theoretical considerations based on the experimental knowledge of the radiating power of the atmosphere.

The results of the observations of wind velocity may be briefly summarised as follows. In general, the velocity increases with height, the greater part of the increase up to 2000 m. taking place in the layers immediately above the surface; 75 per cent. of the total increase takes place in the first 160 m. Above 500 m. numerous cases occur where the velocity decreases with height. The velocity for heights up to 10 km. is given approximately by the equation $V\rho = V_0\rho_0$ (Egnell's law), where V is velocity and ρ density, $V_0\rho_0$ being the values near the surface. The law implies that the pressure gradient remains constant and independent of the height. Now, owing to the fact that the temperature is higher over regions of high pressure than over regions of low pressure, the ratio of pressure gradient to density increases with height. The condition for a constant gradient up to 8 km. is approximately

$$t_0 = \frac{74\ \delta p}{p} \text{ degrees C.},$$

where t_0 is the excess of the mean temperature of the air-column at a place at pressure $p+\delta p$ above that at a place at pressure p. Observations show that for $\delta p = 20$ mm., $t_0 = 4°$ C. nearly, or double the amount necessary for constant gradient. It is to be expected, therefore, that $V\rho$ will increase up to 8 km., and the few pilot-balloon observations available point to such an increase.

The direction of the upper wind usually veers from that at the surface. The following table shows the deviations for winds from different quadrants in England and at Berlin :—

Deviation of the Upper Wind.

England.

Heights	0·5 km.	1·0 km.	1·5 km.	2·0 km.	2·5 km.	3·0 km.
W. ...	9	14	14·5	14	8	8
N. ...	4	8	3	−1	−3	−15
E. ...	15	22	20	28	35	21
S. ...	14	26	32	38	41	50

Berlin.

W. ...	18	23	23	20	23	22
N. ...	13	17	20	20	15	25
E. ...	27	30	38	45	46	44
S. ...	38	46	48	49	53	46

The deviation at Berlin is in nearly all cases greater than in England, especially for north winds, which back slightly in the upper air in England.

There is no marked difference between anticyclonic and cyclonic conditions in the change of wind velocity and direction with height. The following table gives the values deduced from observations at Berlin and Lindenberg in 1905 :—

	Height	Surface	1 km.	2 km.
Anticyclonic (A)	Deviation ...	—	30°	33°
	Velocity	4·1	8·2	8·4 m.p.s.
	Ratio to surface velocity	1·0	2·0	2·05
Cyclonic (C)	Deviation ...	—	30°	37°
	Velocity	5·9	10·5	10·7
	Ratio to surface velocity	1·0	1·78	1·82

The deviation is slightly greater and the ratio slightly less in C than in A. It would be natural to suppose that surface friction and irregularities would produce a decrease in velocity which increased at a greater rate than the velocity itself, and in that case the ratio in C would be greater than in A, as was actually found by Berson from the manned balloon observations.

SOLAR VORTICES AND MAGNETIC FIELDS.

II.

I HAVE already referred to the importance of applying in astronomical research the methods of the physicist. During the last quarter of a century the study of spectroscopic phenomena in the laboratory has been completely transformed. It may well be said that this transformation, which has involved such discoveries as spectral series, the effect of pressure on wave-length, and the Zeeman effect, has been directly due to the use of Rowland's concave gratings, of great focal length, arranged for photography. In astronomical spectroscopy great advances have also been made, but the spectroscope has continued to occupy the place it formerly held as an attachment of the telescope. Although Rowland used a long-focus concave grating for his classic study of the solar spectrum, the heliostat and lens employed with this instrument gave so small a solar image on the slit that the investigation of sun-spots and other details was impossible. We thus see that while in the observatory the spectroscope continued to be used as an accessory of the telescope, in the laboratory the parts were exchanged and the telescope was employed simply as an accessory of the spectroscope. It seemed obvious that a great opportunity for advance lay open to the investigator who would combine a long-focus spectroscope with a long-focus telescope. As it would be difficult, or perhaps impossible, to use for photography a sufficiently long spectroscope attached to the tube of an equatorially mounted telescope, some form of fixed telescope was plainly essential.

The tower telescope on Mount Wilson (Fig. 5) is designed to accomplish this purpose. It consists essentially of a 12-inch refracting telescope, of 60-feet focal length, mounted in a fixed position, pointed directly at the zenith. The ordinary telescope tube is replaced in this case by a light steel tower, firmly held in position by steel guy ropes. The 12-inch objective lies horizontally at the summit of the tower, and sunlight is reflected into it from the second of two adjustable plane mirrors. The first of these mirrors is mounted as a cœlostat, and is rotated by an accurate driving-clock about a polar axis at such a rate as to counteract the apparent motion of the sun. Thus a beam of sunlight is reflected from the cœlostat mirror to the second mirror, which sends it vertically downward through the objective. In the focal plane, 60 feet below the objective, an image of the sun, about 6·6 inches in diameter, is formed on the slit of a spectrograph, at a height of about 3 feet above the surface of the ground. After passing through the slit, the light of any desired portion of the solar image (a sun-spot, for example) descends vertically into a well about 30 feet deep excavated in the earth beneath the tower. Thirty feet from the slit the diverging rays encounter a 6-inch objective, through which they pass. After being rendered parallel by the objective, the rays fall upon a Rowland plane grating, ruled with 14,438 lines to the inch. The grating breaks up the light into a series of spectra, and the rays are returned through the same objective, which brings the spectra to a focus at a point near the slit. By inclining the grating at a small angle, the image of the spectrum is made to fall at a point slightly to one side of the slit, and here the photographic plate is placed. Thus a portion of the spectrum 17 inches in length can be photographed in a single operation. In the work on sun-spots, most of the photographs are taken in the third order of the grating, where the dispersion and resolving power are very high. When the spot spectrum is being photographed, only the light from the umbra is admitted to the slit. At the end of the exposure this portion of the slit is covered, and light from the photosphere, at a point removed from the spot, is admitted to the slit on either side. Thus the narrow spot spectrum is photographed between two strips of solar spectrum, used for comparison.

The advantages of this combined form of telescope and spectrograph are considerable. On account of the great thickness (12 inches) of the mirrors, the height of the cœlostat above the heated earth, and the use of a vertical beam, the definition of the solar image is always better than with the Snow (horizontal) telescope. Another important advantage is the nearly constant temperature at the bottom of the well, where the grating is placed. This permits long exposures to be given, when necessary, without danger of such displacements of the spectral lines as would be caused by expansion or contraction of the grating. The grating used in this spectrograph is a small one, which I have employed in most of my work since 1889, but the unusual focal length of the spectrograph permits the full visual resolution of the grating to be utilised in photographic observations. Thus it has become possible to photograph the widened lines and doublets, as well as a host of narrow lines, most of them due to chemical compounds, which had not previously been recorded in the spot spectrum.

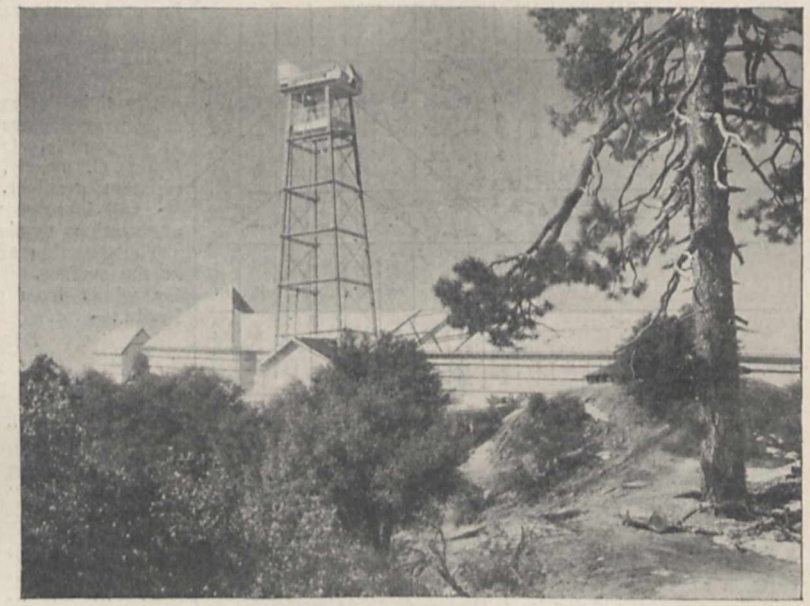

FIG. 5.—Tower Telescope on Mount Wilson.

Lack of time prevents me from discussing in this lecture the various studies of sun-spot lines carried out with this instrument before the attempt to detect a magnetic field in spots was undertaken. An extensive catalogue of these lines is nearly complete, a preliminary map has been issued and a better one is in preparation, and a series of investigations with the arc and electric furnace has suggested that the strengthening and weakening of certain lines is due to a reduction in the temperature of the spot vapours. At present we are concerned with the cause of the widening and doubling of spot lines, and the method of testing this question must now be described.

A Nicol prism was mounted above the slit of the spectrograph, and just above this a Fresnel rhomb. If the components of a spot doublet were circularly polarised in opposite directions, passage through the rhomb should give two plane polarised beams, the planes of polarisation making an angle of 90° with each other. Thus in one position of the Nicol one of the components should be photographed alone, and by turning the Nicol 90° this should disappear and the other component come into view.

When this test was applied with the tower telescope, in June, 1908, the true character of the spot doublets became apparent (Fig. 6). One or the other component of the

[1] Discourse delivered at the Royal Institution on Friday, May 14, by Prof. George E. Hale, For.Mem.R.S. Continued from p. 23.

doublet could be cut off at will by rotating the Nicol, precisely as Zeeman had done in the laboratory. On account of the unique character of the Zeeman doublets, this test alone was almost sufficient to prove the existence of a magnetic field in sun-spots. But one of the great beauties of the Zeeman effect is its many-sided character, which permitted the test to be multiplied and extended. From Zeeman's first experiments it was known, for example, that if the strength of the magnetic field is insufficient to separate completely the components of a doublet, the edges of the resulting widened line should be circularly polarised in opposite directions. Thus those lines which are widened, but not doubled, in spots might be expected to shift in position when the Nicol is rotated. This was found to be the case. Again, the lines which constitute the flutings of the spectra of compounds are not, in general, affected by a magnetic field. Hence such lines in the spectrum of a sun-spot should not be shifted when the Nicol is rotated. This, also, was found to be true. But a still more satisfactory test was suggested by another laboratory phenomenon. When a doublet is observed along the lines of force, with one of the components extinguished by the Nicol, reversal of the current through the magnet should extinguish the visible component and cause the invisible one to appear. In the sun, according to our hypothesis, reversal of the direction of revolution in a vortex should correspond to reversal of the current through the coils of a magnet. Hence the red component of a doublet should appear in the spectrum of a vortex rotating in one direction, the violet component in that of a vortex rotating in the reverse direction. Fortunately, the appearance, on opposite sides of the solar equator, of two spot vortices rotating in opposite directions (Fig. 4) made this test possible. The results were perfectly in accord with the hypothesis.

So far we have been considering only such phenomena as are observed parallel to the lines of force of a magnetic field; but a spectral line which, in such circumstances, appears as a doublet is usually transformed into a triplet when the observation is made at right angles to the lines of force. The circularly polarised side components of the doublet give place to plane polarised components, occupying the same position, while another line appears centrally between them. The light of this line is also plane polarised, the direction of the vibrations being parallel to the field, while the vibrations of the side components are in a plane at right angles to the field. Thus when a spot is carried by the solar rotation to a point near the limb we might expect the double lines in its spectrum to be transformed into triplets if produced by a magnetic field. The failure of the central line to appear seemed to raise an important argument against the magnetic hypothesis.

At this point the necessity of conducting laboratory investigations in immediate conjunction with astronomical observations is well illustrated. Fortunately, our laboratory was already well equipped for work of this nature (Fig. 7). In anticipation of the possibility that observations of the Zeeman effect would be needed in the interpretation of solar and stellar phenomena, a powerful electromagnet, with suitable accessory apparatus, had been provided. A brilliant spark, produced between metallic electrodes in the field of the magnet, furnished the source of light. As many of the double lines in sun-spot spectra are due to iron, this metal was selected for the first experiments. The spectrum was photographed, at various angles with the lines of force, with a powerful spectrograph, like the one used with the tower telescope, similarly mounted in an underground chamber.

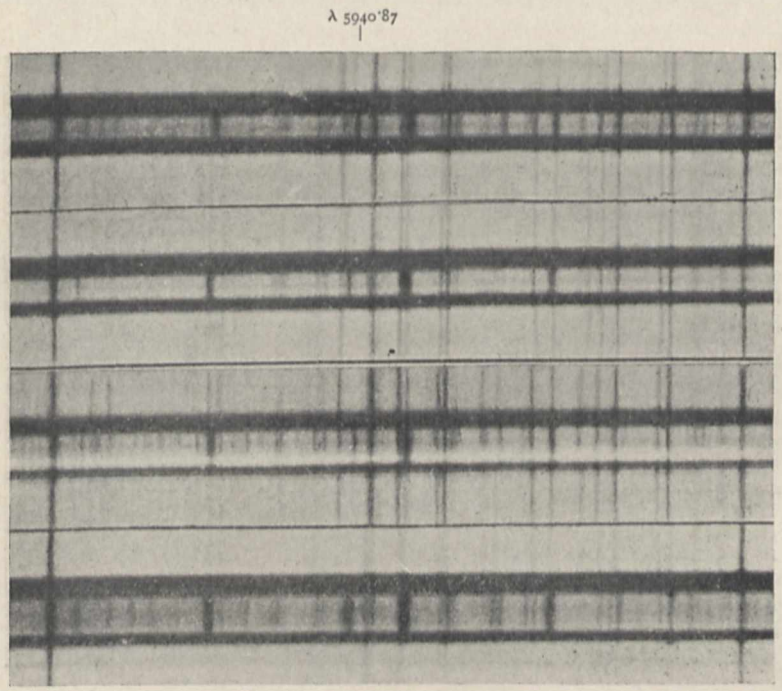

FIG. 6.—(1) Southern Spot, showing Red Components of Doublets. Nicol, 29° W. (2) Northern Spot, showing Violet Components of Doublets. Nicol, 29° W. (3) Northern Spot, showing Red Components of Doublets. Nicol, 61° E. (4) Spot Spectrum without Rhomb or Nicol, showing both Components of Doublets.

The difficulty of accounting for the behaviour of the iron doublets in the sun was removed by these investigations. It appears that these lines do not become triplets when observed across the lines of force. In reality they are changed to quadruplets, or doublets in which each of the components is a close double line. In the magnetic field of sun-spots, which is much weaker than the field used in the laboratory, the closely adjoining lines which constitute the components of the doublets cannot be separated. Thus these sun-spot lines should appear double at whatever position the spot may occupy on the sun's surface.

The distance between the components of doublets or triplets separated in the magnetic field varies greatly for different lines. Some exceptional lines are not affected in the least, others are merely widened, and others are clearly and sometimes greatly separated. It is therefore important to compare the widening and the separation of lines in a sun-spot spectrum with the corresponding phenomena in the magnetic field. With few exceptions, most of which may be accounted for by the presence in the spot spectrum of closely adjoining lines of other elements, the solar and laboratory results were found to be in good agreement. The following table gives a comparison of certain iron lines in the spot and laboratory:—

Wave-length	Δλ, spark	$\frac{\Delta\lambda, \text{spark}}{5\cdot1}$	Δλ, spot	
6213·14	0·703	0·138	0·136	−0·002
6301·72	0·737	0·144	0·138	−0·006
6302·71	1·230	0·241	0·252	+0·011
6337·05	0·895	0·175	0·172	−0·003

The column headed "Δλ, Spark" gives the distance between the components of the lines as observed in the laboratory. As the strength of the magnetic field used

in the laboratory was about 5·1 times that of the spot, the quantities obtained by dividing the separations in the second column by 5·1 are given in the third column. These separations are directly comparable with the separations of the corresponding lines in the spot, which are given in the fourth column. The fifth column shows that the differences between the solar and laboratory results are very small. As the strength of the field in the laboratory was about 15,000 gausses, the strength of the field in this spot would be about $15{,}000 \div 5{\cdot}1 = 2900$ gausses. The strongest field hitherto measured on our photographs of spot spectra is about 4500 gausses, corresponding to a considerably greater separation of the lines (Fig. 8).

When a similar comparison was made for various lines of titanium and chromium, a much less perfect agreement between the spot and laboratory results was found. It had already been observed that such lines as D of sodium and *b* of magnesium, which undoubtedly represent a much higher level than the great majority of lines in the spot spectrum, are but very slightly widened. As these lines are strongly affected by a magnetic field in the laboratory, it appeared evident that the strength of the field in spots must fall off rapidly in passing outward through the spot vapours. In these circumstances lines of other elements, which represent levels higher than the average, should show small separations in the magnetic field of the spot. It seems probable that in this way the lack of perfect agreement between the laboratory and solar results observed in the case of titanium and chromium can be accounted for.

A further important test was afforded by the well-known phenomenon exemplified in Preston's law. According to this law, the distance between the components of the lines split up by a magnetic field varies directly as the square of the wave-length. This we found to be true even in the case of a metal like iron, the lines of which cannot be grouped into series, if the average separations of a sufficient number of lines were considered. We should therefore expect that the widening of lines in spots would rapidly decrease toward the violet, and that the separation of spot doublets should diminish in a similar way. A study of the spot spectrum shows that this actually occurs.

It soon appeared that the normal spot spectrum always contains triplets as well as doublets (Fig. 8). These are less easily recognised, because the presence of the central line crowds the components so closely together that they are not readily separated with the resolving power available. As these triplets are photographed even when the spot is very near the middle of the sun, it is evident that the spot always sends out light which makes a considerable angle with the lines of force. In a normal triplet the central line is of twice the intensity of the side components, when observed at right angles to the lines of force, and disappears altogether when observed parallel to the lines of force. Thus, by determining the relative intensities of the central and side lines of such a triplet, the angle between the lines of force and the line of vision can be obtained. In the case of sun-spots, the data at present available are not sufficient for the accurate determination of this angle, but it seems to lie between 30° and 60° when the spot is near the centre of the sun. On the hypothesis that the magnetic field is produced by the spot vortex, it would then follow that the axis of the vortex, instead of being radial, as we at first assumed, makes an angle of much less than 90° with the surface of the photosphere.

The time at my disposal permits me to describe briefly only a few other phases of this investigation. In the laboratory the central line of triplets is polarised in a plane parallel to the magnetic field. Hence, if the light is passed through a Nicol prism, used without a rhomb, it should be possible to extinguish this line at certain positions of the Nicol, in which case a spot triplet would appear as a doublet. This test has also been applied to the spot triplets, with the expected result. In fact, this method supplies a convenient means of recognising close triplets, the components of which are too closely crowded to be seen separately before the central line is cut out. Indications have also been obtained of what may prove to be unequal rotation of the plane of polarisation of this central line in different parts of spots. The gradual decrease in the strength of the field from the umbra to the outer limit of the penumbra has been studied, and magnetic fields have been detected on the sun's disc, in certain regions outside of sun-spots. It is evident that many new phases of the subject are likely to be developed in the future, especially if larger images of the sun and more powerful spectrographs are employed. In this connection it may be stated that a tower telescope of 150-feet focal length, to be used on Mount Wilson with a spectrograph of 75-feet focal length, is now under construction.

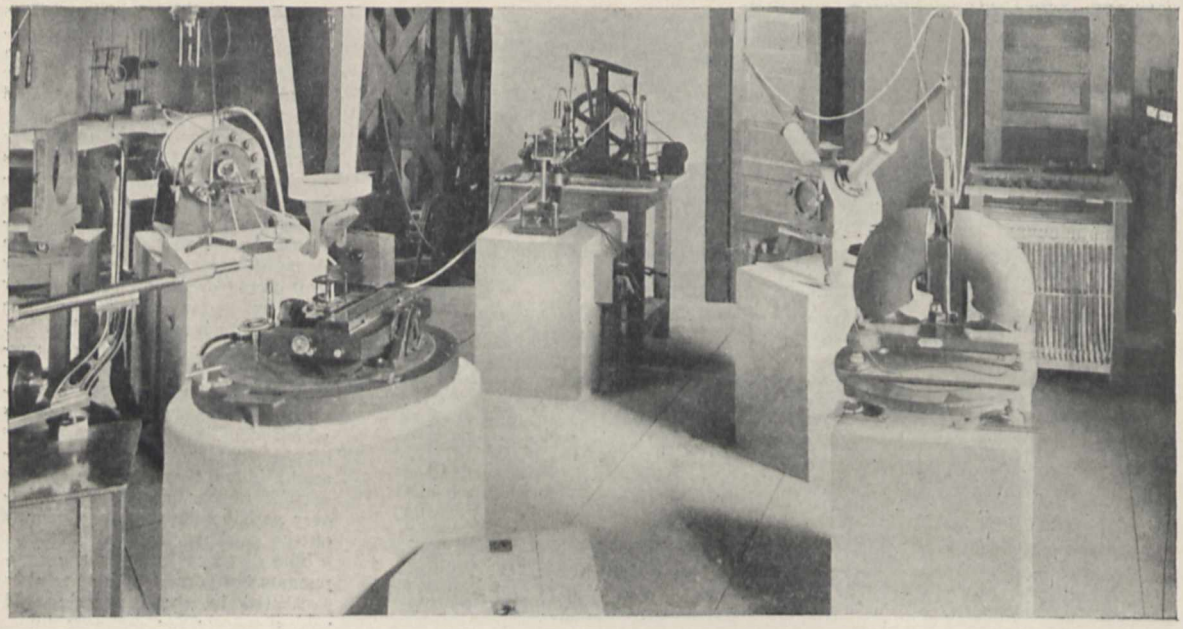

FIG. 7.—Interior of Pasadena Laboratory, showing Slit-end of Vertical Spectrograph and Magnet used in study of Zeeman effect.

This will give a focal image of the sun about 16 inches in diameter, in which small spots, as well as large ones, can be studied.

Although it now seems to be demonstrated that sun-spots are electric vortices, judgment should be reserved as to the various theories which have been advanced to account for their origin. Many of the results I have described appear favourable to Emden's solar theory, but it seems to be opposed by the important investigations of Evershed, who has found that the metallic vapours in sun-spots flow radially outward from the umbra, parallel to the photosphere. The further development of Evershed's work, and the continued study of solar vortices and magnetic fields, should soon permit a trustworthy theory of sun-spots to be formulated.

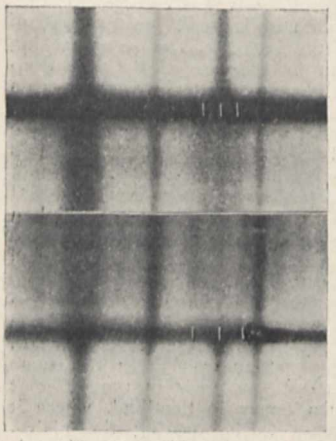

FIG. 8.—Iron Doublet (λ 6301·72) and Triplet (λ 6302·71) in Two Spot Spectra, showing Field Strengths of 2900 and 4500 Gausses respectively.

It is evident that the rapid decrease upward of the strength of the field in spots would prevent this field from having an appreciable influence on the higher solar atmosphere. At the distance of the earth, as Schuster has shown, the combined magnetic effect of several spots, all assumed to be of the same polarity, and having no such rapid decrease in field strength at higher levels as is actually observed, would be altogether incompetent to account for terrestrial magnetic storms.

In concluding, I wish to express my appreciation of the assistance I have received from my colleagues at Mount Wilson. I am particularly indebted to Messrs. Adams, Ellerman, King, Nichols, and St. John for aid in connection with the present investigation.

THE NEW ROOMS OF THE ROYAL SOCIETY OF EDINBURGH.

ON Monday, November 8, the new rooms of the Royal Society of Edinburgh were formally opened by an appropriate inaugural address from the president, Sir William Turner, followed by a brilliant reception. For the purposes of the reception the ordinary meeting-room was transformed into the cloak-room, and the president's address was delivered in the Freemasons' Hall, a few blocks further west in George Street. After the address the audience re-assembled in the society's new abode, and had every opportunity of inspecting the arrangements which had been made for the accommodation of the large and growing library and for other possessions of the society.

The important events which led up to the migration of the society from its historic haunts in the beautiful building in Princes Street were described by the president in his address. The National Galleries of Scotland Bill, introduced into the House of Commons in 1906, provided that the Royal Institution, so long the home of the society, should form a part of the National Gallery of Scotland and be applied to the promotion of the Fine Arts. As the result of representations made by the society, a clause was introduced into the Bill by which the Treasury was empowered to provide funds both for the purchase and equipment of a new habitation for the society, and for an annual grant of 600*l.* to assist in the discharge of the scientific work. The natural feeling of regret at having had to give up one of the finest sites to be found in any city of the world is partly balanced by the knowledge that now the society has, for the first time in forty or fifty years, ample accommodation for its valuable library.

When the building now occupied by the society was vacated two years ago by the Edinburgh Life Assurance Company, operations were at once begun by the Board of Works to fit it for its new function. No structural changes of magnitude were needed to make the rooms effective for their purpose. The late librarian, Mr. Hardy, whose lamented death last spring deprived the society of a singularly efficient and devoted officer, had meanwhile been planning the whole arrangements of the library, and what is now seen is largely the result of his forethought and attention to details.

The building is entered by two doors. The east door is open daily, and through it entrance is at once gained to the front saloon, where there is every convenience for reading and writing. The west door is opened only on meeting days. It leads directly into a staircase, by which immediate ingress is gained to the meeting-room, which is fitted with a lecture table and appliances of various kinds. By the same staircase, also, access is had to the reception room on the first floor and to various library rooms on the second floor.

The guests on the night of the reception passed up the west staircase, at the first turn of which a fine bust of Cuvier greeted them with calm dignity.

Along the walls of the meeting-room (transformed for the occasion into the cloak-room) some other interesting busts are to be seen—Berzelius, John Playfair, Rev. Sir H. Moncrieff Wellwood, and Sir Walter Scott; also an engraving of the statue of Sir Joseph Banks in the British Museum, executed by Chantrey. A photograph of Sir Richard Griffith and an engraving of D. Milne Horne also decorate the walls.

Passing out of the meeting-room and up a few steps we come to the ante-room, with oil portraits of James Watt and William Murdock, one of the pioneers of gas lighting. In the handsome reception-room immediately adjoining are portraits of former well-known presidents and secretaries—Sir T. Makdougall Brisbane, Sir James Hall, Profs. J. D. Forbes and John Robison, the last a Raeburn; also a bust of Sir Roderick Murchison occupies one corner. Passing across the reception-room we emerge at the head of the east staircase, which leads down to the front saloon and to the east door. The portraits which decorate the walls of this fine staircase are (beginning from the top) those of Piazzi Smyth, Patrick Neill, Sir David Brewster, Sir Robert Christison, Sir Walter Scott, and the first president, Henry, Duke of Buccleuch. In addition to these there are several good engravings of portraits of Henry Mackenzie (the "Man of Feeling"), the Right Hon. Jas. Moncrieff, and Dr. William Robertson, the historian (a fine engraving by J. Dixon from the portrait by Sir Joshua Reynolds).

The front saloon has its walls covered with books, and contains a life-like bust of James Gordon, the late librarian. Opening off it at the north-west corner is the librarian's room or office, with a portrait of Sir Humphry Davy over the mantelpiece. Adjoining it is the council-room, with the well-known portrait of Prof. Tait (by Sir George Reid) hanging above the fireplace, and on each side a drawing of the birthplace of Sir Isaac Newton, presented to the society by a son of Prof. Robison. The same donor also gave a small carved door, which formed part of a book-press belonging to Newton. Passing out of the council-room by a door in front of the foot of the east staircase, and turning along a passage to the right, we come to a large oblong room called the back saloon. Round the walls are steel book-cases filled with the Transactions and Proceedings of various scientific societies of foreign countries. The countries are arranged alphabetically, and under each country the towns are similarly arranged, so that a visitor has not the least difficulty in finding the shelves on which the publications of any given society are placed.

Near the council-room door a staircase leads down to the basement, where, in addition to rooms set apart for shelving books, are strong-rooms for storing the society's own Transactions and Proceedings, and the blocks and plates of illustrations. These are all admirably arranged, so that the stock in hand can be estimated almost at a glance.

Taking a general survey of the contents of the many book-cases which line the walls of the various rooms, we soon recognise the guiding principle of the whole. The

front saloon or reading-room contains such journals and periodicals of a general scientific character as are most in demand. The librarian's room contains mathematical journals, the society's own publications, and the various scientific catalogues and dictionaries. In the council-room the reports of scientific expeditions find a place, and the quarto volumes of the American and Indian Geological Surveys, and much of a connected nature. The back saloon has already been described. In the basement we find journals of zoology, botany and medicine, electrical engineering, meteorology, geodesy, geology, &c.

There are no book-cases in the meeting-room or reception-room, but on the second floor there are three fairly large rooms and one small room filled with books. In one we find periodicals and books bearing on geography, biography, philosophy, philology, in another astronomy, and in a third the literary weeklies, monthlies, and quarterlies.

This description is not, of course, exhaustive, for, besides the periodical publications, the Royal Society of Edinburgh possesses many books of historic value and antiquarian interest; also the complete works of famous men of science from Galileo down the centuries. It will serve, however, to show that, as regards the accessibility to their literary treasures, the society has distinctly benefitted by their change of location.

The reception-room on the first floor, where the fellows meet for tea and talk before the afternoon meetings and after the evening meetings, has been beautifully designed, largely under the advice of Sir George Reid.

The least satisfactory of all the arrangements is the meeting-room for the reading of papers, but it is difficult to see how anything better could have been done. The lecture table, with gas fittings, occupies part of one of the long sides. The lantern-screen partly covers the black boards on the wall behind, the lantern being ensconced in a niche in the opposite wall. The hangings and decorative busts have practically killed the echo which was heard when the room was first tried. Yet to the many fellows who remember what used to be, the present arrangement lacks a certain undefinable flavour of old-world dignity. There is too much of the modern lecture-room and too little of the feeling of a scientific and literary society met for the interchange of views.

In other respects, however, the society has gained much by its removal from the limited space at its disposal in the Royal Institution to the spacious accommodation in George Street. Its remarkable collection of portraits and busts can now be seen to advantage, and the ready accessibility to its valuable library of books and periodical literature in all departments of science and in many departments of philosophy and art cannot but confer a great boon to the fellows and others engaged in research work.

The reception on Monday night was a large gathering, representing all phases of national life, such as Parliament, the Church, the Bench and the Bar, other legal bodies, the Scottish universities and leading educational institutions, the Royal Academy, municipalities, parish councils, &c.

THE INTERNATIONAL INVESTIGATIONS IN THE NORTH SEA AND THE SCOTTISH BOARD'S ANNUAL REPORT.[1]

SIX years have now elapsed since the commencement of the international fisheries' work by the seven nations concerned, and with the bulky literature and masses of tables and plates in hand it may be thought that now a stage has been reached which will demonstrate one way or another the position of the sea-fisheries, especially as it was stated that results of importance were early to be forthcoming. Yet in scanning the various publications no very definite general conclusions are apparent, and the question of primary importance to this country remains—excepting the statistics of the bureau—as far from solution as ever. To take the publications in the order above-mentioned, the first is Dr. Kyle's important statistics of the North Sea fisheries for 1906. So far as can be observed, the total of the sea-fisheries of each nation shows an increase both in quantity and value on the previous year (1905), with the exception of Ireland. In the case of such fishes as the cod and the haddock, the ever-recurring variability displays itself in an increase of both in Denmark and the Netherlands, a diminution in Germany, an increase of cod and a diminution of haddock in Belgium, an increase of cod in Sweden, and a great increase of the same fish in England and in Scotland. Along with this is a considerable diminution of plaice in Sweden, England, and Belgium, and a considerable increase in Scotland and the Netherlands, a great increase in Denmark, and a nearly stationary condition in Germany. Dr. Kyle points out, however, that this decrease is due to a diminished capture of the smaller sizes of plaice (*e.g.* in England, Holland, Germany, and Belgium). Much has been written about the decrease of the lemon-dab (or so-called "lemon sole") in Scottish waters, yet in 1908 it brought 70,134*l.*, or 1400*l.* more than in the previous year. In the same way, whilst the sole and the turbot vary in the different nations, the dab remains stationary in Scotland, where it was supposed by its increase to be ousting the plaice. These statistics, which cover a much wider area than it is possible to allude to here, are perhaps the most important result of the international scheme, and they show how uncertain and variable sea-fishing is. Moreover, they demonstrate that whilst in one country the capture of a species may temporarily be diminished, in another it is increased. The comparative constancy of the totals and the large amount of fluctuation in individual species are points emphasised by Dr. Kyle. Further, no Continental nation approaches the share taken by Britain in this industry, England having 39 per cent. and Scotland 34 per cent. as their respective shares, the nearest being Holland with 12 per cent., Germany having only 4·7 per cent.

The report of the International Council between July, 1907, and July, 1908, is chiefly occupied with the record of changes in the *personnel* and an epitome of the seventh annual meeting at Copenhagen. It is noteworthy that the council is still in want of information concerning important fishes, such as the plaice, flounder, and other flat fishes, the haddock and other gadoids, and the herring and mackerel of the North Sea. Anything like finality in its labours seems as far distant as ever, yet hydrographical and "plankton" work still hold it. Prof. Garstang, moreover, gives an interesting account of the distribution of the plaice in the North Sea, Skagerak, and Kattegat according to size, age, and frequency, no fewer than 2048 hauls of the trawl and 327,000 examples of plaice having been dealt with; yet the decline in the returns from Sweden and Belgium after 1904, and from Scotland after 1905, must seriously affect the scope of the results. In regard to general distribution, the facts corroborate those elicited in 1884,[1] viz., the occurrence of small plaice in shallow water and of large in the deeper water, with a constant interchange between the two areas. Yet it is impossible to establish a hard-and-fast correlation between the size of the plaice and depth. The very general distribution of this species over the North Sea is a further guarantee for its safety. Mention is made of "dense" accumulations of plaice in the "protected Scottish Firths," but such accumulations were there before protection existed. It is stated that from fifteen to twenty plaice of 35 cm. were caught per hour in the inner part of St. Andrews Bay, information which will cheer the fishermen there, since for thirty years at least the uniform sizes caught for sale have been from 10 inches to 13 inches. The idea that many large plaice leave the Firth of Forth and enter St. Andrews Bay during the autumn, thereafter proceeding to deeper water to spawn, and again swell the ranks in the Forth, is in need of confirmation. Similar remarks apply to the changes noted in the large plaice

[1] Conseil permanent international pour l'Exploration de la Mer. Bulletin statistique des Pêches maritimes des Pays du Nord de l'Europe, vol. iii. pour l'Année 1906. Pp. 83. (Copenhagen: A. F. Host and Fils, 1909.)
Rapports et Procès-verbaux des Réunions, vol. xi., Juillet, 1907–Juillet, 1908. Pp. xxv+176+51. (Same publishers, 1909.)
Rapports, &c., vol. x., Rapport sur les Travaux de la Commission dans la Période 1902–7. (Same publishers, 1909.)
Twenty-seventh Annual Report of the Fishery Board for Scotland for the Year 1908. Part i., General Report. (Edinburgh: Oliver and Boyd.)

[1] Scientific Trawling Report, pp. 21, 25, 43, 76, &c., 1884, and in General Report, 1885, correspondingly.

of the Moray Firth. Minimum captures on the inner areas or outer "deeps" are not necessarily connected with "migrations." The remarkable oscillations described as occurring in the small plaice of the eastern area of the North Sea, viz. that they pass outward and again "work their way backward" inshore, would have been less phenomenal and would not have required the aid of "hibernation" if researches on the same size on the western shores (British) had been systematically carried out, along with an inquiry into the early post-pelagic and subsequent stages below the sizes selected. Migrations, indeed, loom largely in the international work, even to the supposition that the cat-fish (Anarrhichas) is as regularly migratory in the spring as the hake is in autumn. Moreover, large plaice were common in the Moray Firth before its closure, and are still there, the smaller finding ample scope in the shallows and the larger sufficient depth within the area. In regard to seasonal changes in the stock of plaice, it has long been known that captures in mild weather are greater, and that a cold, frosty morning diminishes them, but it does not follow that such captures give trustworthy information as to "maximum and minimum densities." The changes on the various "banks" naturally follow the spreading of the younger plaice seawards, but "hibernation" of small plaice and immigration of large, mature fishes rest largely on conjecture, as does also the notion, marking notwithstanding, that large numbers of mature fishes "migrate from the north for spawning purposes." The supposed scarcity of large plaice in the deeper water in winter may be due to other causes than migration, though congregation for spawning purposes is reasonable. Mr. Hefford's paper on the proportionate distribution of the sexes of plaice in the North Sea does credit to his ability, but his conclusions would need the support of longer experience, especially as a large inner area, viz. from Montrose to Kinnaird Head, has been omitted. The notion that the proportion of sexes of plaice may yet indicate the intensity of trawling in a given region is scarcely warranted.

Vol. x. consists of a bulky report dealing with the whole period (1902–7). It reiterates the problems to be solved and the methods followed by the administrative committee, with a summary of the results, besides a series of special reports by seven responsible authors. Some of these reports have previously been published, and have received attention elsewhere, so that they need not be alluded to. In the summary of the results the administrative body deals first with the depths and hydrography of the oceanic regions investigated. Then the spawning conditions and spawning places of the gadoids (seventeen in number) are considered, and it is to be noted that the investigation of both is now held to be complete, a view some may doubt, considering the scattered cruises of the steamers, and when on the next page it is stated that the spawning places cannot always be given with absolute certainty. The summary is full of interest, but in the case of several species the limitations given by the committee need re-investigation, and, for instance, no differentiation of the areas of the British coast has been attempted as regards the cod. The third head treats of the "natural conditions in the spawning regions," and an effort is made to connect temperature and salinity with the spawning process. The gadoids, however, are not the only fishes in these waters, and there is perhaps little more in the matter than that an Arctic, a temperate, and a tropical fish finds—each in its own waters—the most suitable spawning conditions. Besides, the refinements of temperatures and salinities, however interesting scientifically, count for little in the main question put before the investigators by the British Government. It was well known that wherever the conditions of life were suitable, there the pelagic larvæ and young fishes were found with great regularity, irrespective of currents, temperatures, and salinities. No current is known which will take the larval cod with unfailing regularity in one direction and the haddock in another, which will keep the larval dabs and top-knots often in deeper water whilst the plaice is with unfailing accuracy sent to the margin of the beach. No currents, temperatures, or salinities will explain why in 1908 the herring fishing was very successful in the northern Scotch area and less successful in the southern, and why in 1909 exactly the reverse was the case. In this connection, Schmidt also gives no reason why the ova and fry of *Gadus luscus* are not carried far from their spawning place. What can those familiar with the subject make of the following:—"According to the spawning time, first the cod eggs, then the haddock eggs, and lastly the whiting eggs are involved in the movement of the currents"? It has not been shown that the currents which distribute the eggs of the pollack and the poor cod in the Atlantic in spring have their equivalents in the summer when the same fishes spawn in the North Sea, though there is little fear as to the safety and distribution of the eggs of these and all other marine fishes. The guarded remarks of the committee are therefore warranted, viz. "the investigations we are discussing here are far from being able to solve so great a problem." Especially does this apply to the notion that all the young green cod which swarm on the Scottish coasts have been spawned on the North Sea bank, and that the cod makes long migrations for the purpose of spawning.

On the important problem of sea-fish hatching the committee make very cautious remarks, basing their views mainly on Knut Dahl's paper. In this it is shown that in small Norwegian fjords where cod spawn the captures by tow-nets were not influenced to any extent by the addition of thirty millions, and that the captures varied much in different years. No difference also was noticed in the quantitative occurrence of young littoral fishes each year. They found no proof of an increase of local stock by artificial hatching, but they do not discourage further experiments. The foregoing is in marked contrast with the results of Fulton in the upper waters of Loch Fyne, where shore-fishing with a push-net found an increase of young plaice during the six years in which 141 millions of young plaice were added, as compared with the following six, in which none were added. Yet in glancing at his figures it would appear that in four of the years in which none were added the average captures per hour compare favourably with those in which millions were put in, and, further, that a fifth year is second highest on the list even of the favoured years. The chances of error in work carried out in the circumstances, and the great variation from eight to 112 per hour when no addition was made, combine with other points to render this experiment in need of confirmation.

Seventy pages are devoted by the administrative body to the distribution, growth, and migrations of the older stages of the important food-fishes, and to some practical fisheries questions in the light of the results obtained. Under the former head the cod, haddock, and whiting alone are dealt with, the ages being determined by measurements by Helland Hansen, who finds little variation in the numbers of large and extra large haddocks during the years of investigation, and by the rings on the scales by Damas, whose prolix paper might well have been abbreviated. The reliance on the catches, for instance, of the haddock, in the deeper water of the North Sea as proving migration is open to question, and the remark by the administrative body that the reporters are not warranted in explaining the "marked" seasonal migrations, some of which are connected with the occurrence of shoals of herring, is safe.

One of the most interesting and important contributions is that of Johs. Schmidt, on the distribution of the pelagic fry of the gadoids and the spawning regions of the gadoids in the North Atlantic from Iceland to Spain. He lays, however, too much stress on his experiences of Icelandic currents in treating the conditions in the North Sea, and shows too evident a tendency to make out a case for the hydrographer.

Of the Scottish Board's report, it need only be said that it proves the prosperous condition of the Scottish fisheries, for though the total does not reach that of the previous year (1907), yet the deficit is due solely to herrings, the "catch" of other fishes being greater in 1908 than in 1907. It is a decade since the ruin of the lemon-dab ("lemon sole" of the Board) was in sight, yet the "catch" of this fish exceeded by almost 1200 cwt. that of 1907, when the record did not vary much from the preceding years. It is sometimes forgotten that the amount of flat fishes rises or falls according to the amount of

energy expended in their capture, not because any noteworthy change has occurred in their numbers.

To sum up the international work, then, it would seem that considerable waste of energy and funds is caused by the re-publication of papers, and by the manner in which several of these overlap. Moreover, it is beyond the scope of science to enter into a disquisition on the fluctuations of the market-price of fishes. It is also noteworthy to find that, after seven years' work, the council now see the magnitude of their task and the absence of finality in their labours. There is no sign of "impoverishment"; on the contrary, their cautious words lean to the opposite view. The committee recommend continuation of their labours, basing this on the fact that various nations share in the North Sea fishing, and that no action could be taken without the consent of the other countries; but as to any important result to be gained by the fisheries there is silence, for it cannot be supposed that hydrography, the collection of fish-food and bottom deposits, can do duty any longer as necessary measures for the welfare of the North Sea fisheries. W. C. M.

THE ASSOCIATION OF TEACHERS IN TECHNICAL INSTITUTIONS.

AT the fifth annual meeting of the Association of Teachers in Technical Institutions, held on Saturday, November 6, Mr. J. Wilson, of the Battersea Polytechnic, president of the association, in moving the adoption of the annual report, reviewed the year's work. In the course of it he laid special stress upon the very important step taken by the association, at its conference at Liverpool, in putting forward a definite series of resolutions relating to educational reforms which appear to them as teachers to be essential to the continued progress of technical education. In these resolutions the association expresses its opinion that it is necessary to raise the school-leaving age to fifteen years; it asks that special attention be given to the teaching, in primary schools, of elementary science, practical arithmetic, and manual training; it calls for complete coordination of the work of the evening continuation schools with that of the evening technical schools; it asks for the provision of technical-secondary schools, including trade schools, with a generous system of scholarships, including allowance for maintenance; and, finally, it endorses the recommendations of the Minority Report of the Poor Law Commissioners respecting compulsory attendance of boys for technical instruction for not less than thirty hours per week. Thus a very definite policy in some important educational problems affecting technical education has been taken up by this association.

Another important, and in this case non-controversial, action is now being broached by this body of teachers. It suggests the desirability of holding a series of "round table" conferences between accredited representatives of primary, secondary, and technical teachers, with the object of discussing the possibility of reforms in the curricula and methods of work in the schools, from the point of view of the needs of the pupils who at a later stage pass on to the technical schools. Most urgent is the necessity for such conferences in the case of the primary and technical teachers, in order that they may arrive at a mutual understanding of the needs of the pupils and the possibility of meeting them, because in the majority of cases where pupils receive any formal teaching after the primary-school work, it is to the technical teachers that they come for it. Such conferences abound with immense possibilities for the benefit of education in all its phases. Broader and more complete knowledge of each other's branch of work and its needs and possibilities must necessarily result, and as a consequence many apparent difficulties in the way of making the educational work in the two or three types of school truly continuous, without unnecessary overlapping, will be removed. The better knowledge of each other's work will remove some prejudices and bring about the necessary unanimity of action in those matters which affect the teachers individually and as a class, such as conditions of service, security of tenure, and superannuation for all classes of teachers; these views being held by the association, it is all but unnecessary to point out to any other class of teachers, who have the duty, responsibility, and honour of teaching the pupils in their earlier years, that criticisms made by this association on the preparation of those pupils for later technical studies is not directed at the teachers, but at the systems imposed upon them, in which ideas, good in themselves, are allowed such sway as to mask the greater essentials of elementary-school work.

In 1888 Parliament passed a Technical Education Act, and for the past twenty-one years progress has been vigorous and rapid. Nevertheless, technical education has touched only a very small fraction of the enormous mass of material represented by the workers of all grades in the industries of the country. We can only regard it as having entered upon its duties, and must look forward to dealing with much larger numbers of students and to a greater range of work. There are two chief factors which may assist in bringing in much larger numbers of the young workers. The first of these is the increasing interest and help of the employers. Efforts in this field have so far produced but scanty results, and the association as a body is not very hopeful of this field. The second factor, to which the association looks with greater hope, is some form of organised effort by the State to achieve the following ends:—

(*a*) Elementary education to be made more real and practical; less "bookish," without diminishing its cultural value.

(*b*) The establishment of some system of compulsory attendance for continued education for all between the ages of fourteen and seventeen years.

(*c*) The linking together of the three main grades of educational effort.

(*d*) The complete coordination of the work of the evening continuation schools with that of the evening technical schools.

It is agreed by many observers, within and without our technical institutions, that technical education is rapidly approaching a crisis in so far as its higher work is concerned in the London polytechnics. The special feature of the moment is the relation of technical institutions to the university colleges. The association holds the opinion that there is room and to spare for the activities of both in those phases of their work which are common, and fully recognises that each has its own special function. It claims that the opportunity for complete study should be within the reach of every capable student, and that, too, in a sympathetic atmosphere. There is visible at the present time, both in London and the provinces, a tendency, under the guise of coordination, to curtail this higher work in both science and technology in these technical institutions, and thus to reduce seriously the students' opportunity. This tendency, if carried into effect, would be disastrous, under present social conditions, to the highest interests of national education, especially as regards the evening students. H. ADE CLARK.

AN ORNITHOLOGIST IN QUEENSLAND.

IN June last the editors of the *Emu* issued a special number (vol. viii., part v.) containing a very interesting account, by Mr. S. W. Jackson, of a trip to northern Queensland in search of the nest and eggs of the tooth-billed bower-bird (*Scenopaestes dentirostris*). The expedition was undertaken on behalf of Mr. H. L. White, and appears, in spite of many difficulties, to have been eminently successful in the attainment of its object. The exploration of the tropical forests of Australia is by no means devoid of danger. Mr. Jackson himself was laid up for a week with "Johnstone River fever," which he regards as the almost inevitable price of his wanderings in the moist, fever-stricken scrubs, and one of his natives was killed by the falling branch of a tree, while the "scrub-itch mites" appear to constitute a plague of no mean order. It was a long time before he succeeded in obtaining the nests and eggs of the tooth-bill, though the playing-grounds were met with in great abundance.

A detailed, though unfortunately somewhat disconnected, account is given of the habits of these truly remarkable birds. They were first observed shortly before the commencement of the breeding season, each one occupying his

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own particular playing-ground without a mate. The play-grounds are cleared from dead leaves and other débris, and decorated with large fresh leaves placed face downwards. The leaves used are of various kinds, though sometimes only one kind may be found in a particular play-ground. The work of decoration is carried out afresh every morning, the leaves of the previous day being thrown on one side and new ones substituted. "Up to 6 a.m. they appeared to be hard at work clearing their bower floors of the old leaves and re-carpeting them with fresh ones, and until this early house-work was done they appeared to be in little mood for song or mimicry. I came across them hard at their re-furnishing, and carrying the long, heavy leaves in their bills *by the stems*, and just as they had severed them from the trees." The birds feed upon a kind of red berry, not yet identified, and the author is inclined to think that the serration of the beak has nothing to do with the collection of food. It is, however, apparently of use in cutting or sawing off the leaves for the decoration of the playing-ground, as was actually observed.

The tooth-bills are wonderful mimics, and Mr. Jackson gives a graphic account of their vocal performances. They seem able to imitate almost all the characteristic sounds of the forest, from the distinctive notes of other birds to the "pulsating rattle of a captured cicada."

After many disappointments the nests were at length found in very tall trees, very loosely constructed of twigs and containing only two eggs of a uniform brown colour. The character of these eggs leads the author to the conclusion that the tooth-bill is really a cat-bird, and not a true bower-bird at all. We cannot refrain from quoting the description of the finding of a pair of these eggs:—"The nest is placed fully 90 feet from the ground, in a mass of dense vegetation at the top of a bean or scrub chestnut-tree (*Castanospermum australe*). The climb is an awkward one, and our best black, who had examined the nest in the first instance, is again chosen to tackle the task. Strapping the egg-pouch around his waist, I say 'Good luck!' and up he goes. Placing the perpendicular and suspended vines between the first and second toes of each foot, he simply walks up, with marvellous and untiring agility. Making his way through the masses of vines and foliage near the top, he at length gains the rare nest, and suddenly exclaims, 'Two pfeller heg sit down!'"

Although the tooth-bill was the main object of the author's quest, the account of his wanderings contains much interesting information about other birds and some very good photographs, and is well worthy of perusal by all field naturalists.

INTERCHANGE OF UNIVERSITY STUDENTS.

IN July last (vol. lxxxi., p. 55) we directed attention to a scheme, which is in course of development, to provide an interchange of university students between the United Kingdom, Canada, and the United States. It was pointed out on that occasion that the objects in view are to enable as many as possible of the educated youth of the countries named to obtain some real insight into the life and customs of other nations at a time when their own opinions are forming, with a minimum of inconvenience to their academic work and the least possible expense. The scheme will afford technical students facilities to examine into questions of interest to them in manufactures and so on, by observation in other countries, and will allow men of one part of the Empire to realise the needs and potentialities of the others.

Among the immediate needs of the executive committee in charge of the scheme, it may be mentioned that, to cover the estimated expenses of twenty-eight annual travelling scholarships, and of two students' travelling and information bureaux (one in Great Britain and one in America) for a provisional period of three years, in which the value of the scheme can be successfully demonstrated, a total sum of 13,000*l.* is needed. This is to be raised in three amounts, proportionate to the expenses incurred:—from the United States, 4500*l.*; from Canada, 1800*l.*; and from the United Kingdom, 7500*l.* There is not likely to be any difficulty in raising the money required in Canada and the United States. British students will incur more expense than others on account of the distances to be covered on the other side by the scholars, who will travel through Canada to the Pacific coast and return *via* the United States.

The committee hopes to be able to complete the organisation so that exchanges may be effected for 1910. To enable this to be accomplished, the treasurer (Lord Brassey) should receive promises to the amount of 7500*l.* within the next month.

Thanks largely to the practical support of the president of the movement (Lord Strathcona), who combines the Chancellorships of Aberdeen and McGill Universities with his work as High Commissioner of Canada, a central office has been established at Caxton House, Westminster. The travelling students will have the advantage of reduced rates of travel, of the special information which the bureau will be able to afford, and of the privilege of being brought, so far as possible, into contact with the actualities of those countries to which they go, whether persons, places, or institutions. A publication of great utility in connection with the movement will be compiled by the bureau.

The arrangements for the other side of the Atlantic also have made good progress. There is to be a bureau in New York under the direction of an American secretary, while at either Montreal or Toronto there will be a representative of the Central Bureau established in London, which forms the headquarters of the movement and the centre for the British Empire. In this connection, also, it may be mentioned that hopes are entertained of the opening in London of a common room for the convenience of the students concerned. The movement has been taken up by prominent educationists and others in the United States and Canada. Under the direction and guidance of the bureau the scholars, selected in the manner previously described, will travel for ten weeks during the long vacation through the respective countries. In order to elicit close observation, a detailed report of the tour will be required from every scholar. Donation forms, and all further information, can be obtained from the honorary secretary, the International Interchange of Students, Caxton House, Westminster, S.W.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

WE learn from the *Revue scientifique* that the inauguration of the new Swiss university at Neuchatel took place on October 19. The University has grown out of the Neuchatel Academy, which was founded in 1866 and was re-organised in 1894.

MAJOR CRAIGIE, the Gilbey lecturer at Cambridge in the history and economics of agriculture, will give two lectures on "The History of Canadian and Australian Development and its Effect on British Agricultural Conditions" on November 17 and 18, at 5 p.m., in the University Chemical Laboratory.

PROF. PERCIVAL has resigned the directorship of the department of agriculture and horticulture of University College, Reading, and has been appointed to the post of professor of agricultural botany. Mr. Ronald V. O. Hart-Synnot has been appointed director of the department of agriculture and horticulture in succession to Prof. Percival.

THE trustees of Princeton University, we learn from *Science*, have accepted the gift of 100,000*l.* of Mr. W. C. Proctor, of Cincinnati, made on condition that an equal sum be obtained by May 1, 1910. Haverford College has received 20,000*l.* to establish a fund for pensioning its professors. The General Education Board in the United States has made a conditional grant of 25,000*l.* to Ohio Wesleyan University, at Delaware, O. Mrs. Charles E. Perkins, of Burlington, Ia., has given 6000*l.* to Harvard University, to establish scholarships for students from Iowa. Harvard University also has received gifts amounting to 1320*l.*, to be used for the immediate benefit of freshmen in Harvard College.

THE President of the Board of Education received a deputation from the County Councils Association Rural Education Conference on November 3. At a meeting last July the conference passed resolutions in favour of manual

training, such as handicraft and gardening for boys and needlework and cookery for girls. On behalf of the deputation, Mr. Hobhouse explained that the resolutions were intended to express a widespread and growing feeling that elementary education should be brought into closer touch with the practical activities of daily life. The agricultural classes have hitherto been unduly prejudiced against the present system of elementary education as being mere book-learning, tending to unfit children for industrial occupations and calculated to produce only clerks and errand boys. The resolutions state that in the opinion of the conference it is not only desirable, but essential, that some form of manual training shall be given in every elementary school and throughout school life. It is often impossible, in the first place, to find teachers qualified to give the necessary instruction. The second difficulty is that of buildings and equipment. Wherever possible in rural schools a room should be provided and a plot of ground secured for practical instruction. Thirdly, while in concentrated populations the present grants for special subjects may be adequate, they are quite insufficient as regards scattered populations. In his reply, Mr. Runciman said the object of the Rural Education Conference may be summed up shortly—that it is sought to make the education of the children in the public elementary schools more practical and less bookish, to make it, in fact, deal more with things than with ideas, and to adapt it more to the special requirements of particular localities. With these objects he said he is in general sympathy, and the Board of Education has shown its approval of them by the changes it has made in the curriculum. The Board has attempted, so far as possible, to encourage the experiments enumerated by the conference; the real pity is that the experiments are so few. This is the fault of the teachers and the local authorities. Even in cases where the equipment is so small that it is impossible to carry on the work, the Board has done what it can to encourage the work of the peripatetic teachers. The gardening classes in elementary schools, as shown in the statistics of his department, have largely increased in number of recent years, and only within the last few weeks an important new departure has been made in arranging for the coordination of the work of the Board of Education with that now done by the Board of Agriculture.

LORD ROSEBERY, as Chancellor of Glasgow University, presided on November 5 at a dinner of the Glasgow University Club, London. In proposing "The University and the Club," Lord Rosebery remarked that there is nothing more interesting at this moment in the non-political aspect of England than the sprouting up of new universities all over the country. This shows an uprising of an intellectual interest which is full of promise at a time when all in the future of this country does not seem equally happy in expectance. These universities are the result of a real desire on the part of the people to partake of the higher, and perhaps even more of the technical, education that the universities afford. The universities are an outward and visible sign of a grace which is not likely to remain inward, but is likely to show itself in the influence of our national destinies. Lord Rosebery later remarked that he cannot help watching with an intense and almost a timid interest the outcome of the teaching of the universities. The destinies of this country are likely to be moulded indefinitely for good or for evil, in the course of the next few years, by the men of ability, and still more the men of character, who rise in each generation to mould their fellows. He hopes that the University of Glasgow will have many such missionaries of Empire, many men who are prepared with strong backs to wrestle and to stand for the truth, to oppose error in whatever place they may find it, and to remember that though they may be working in their own professions, for their own aims most of their time, yet there is part of their time which they owe to the traditions of their own university and to the welfare and future of the Empire itself. Lord Rosebery believes that Oxford and Cambridge have a great task still before them in the advancement of studies which must always appeal to a large, a leisured, and a learned section of the nation; but he is doubtful if grafting on to the ancient institutions newer technical schools is likely to answer to them or to the schools which they are attempting to found. Every university has, or should have, a character of its own, and the characters of Oxford and Cambridge are so strongly marked out, and they have so venerable a tradition to support them, that they need no special modern adjuncts, and Lord Rosebery doubts that they are likely to profit by them much, for, in truth, on the new grounds they cannot compete with the newer universities. The newer universities were founded with the object of promoting those practical and technical branches of knowledge for which the increasing demands of the age have gradually called.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 4.—Sir Archibald Geikie, K.C.B., president, in the chair.—Colonel Sir David **Bruce**, Captains A. E. **Hamerton** and H. R. **Bateman**, and Captain F. P. **Mackie**: (1) The development of *Trypanosoma gambiense* in *Glossina palpalis*; (2) a note on the occurrence of a trypanosome in the African elephant.—The Lord **Rayleigh**: The perception of the direction of sound.—Prof. H. M. **Macdonald**: The diffraction of electric waves.—R. **Houstoun**: The mechanism of the absorption spectra of solutions.—Hon. R. J. **Strutt**: (1) Note on the spontaneous luminosity of a uranium mineral; (2) the accumulation of helium in geological time, ii. The second paper is a continuation of that published in Proc. Roy. Soc., A, vol. lxxxi., 1908, p. 272, the object being to determine the ratio of helium to radio-active matter in minerals as a means of measuring their age. The data given refer chiefly to the iron ores of sedimentary strata. Even some of the most recent are found to contain quantities of helium, denoting great antiquity. Thus ironstone from the Eocene beds of Co. Antrim contains, per gram, $2{\cdot}64\times10^{-4}$ grs. uranium oxide (U_3O_8), $8{\cdot}27\times10^{-4}$ grs. thorium oxide, and $12{\cdot}1\times10^{-4}$ c.c. helium. This, interpreted according to the best available data, would imply an age of thirty million years. Experiments of a preliminary character have been made to determine directly the rate of growth of helium in thorianite and in pitchblende. The data thus obtained will give the rate of formation of helium by the complete series of uranium and thorium respectively, and thus make it possible to interpret more definitely the results of experiments on other minerals for which a direct determination is not feasible; 400 grams of thorianite was found to yield in seven weeks a quantity of helium certainly less than 2×10^{-6} c.c. The annual rate of production per gram of thorianite is, therefore, certainly less than $3{\cdot}7\times10^{-8}$ c.c. The 9 c.c. initially present cannot, therefore, have accumulated in a less time than 240 million years. An experiment on pitchblende of a similar character was consistent with Rutherford's estimate of the rate of production by the uranium series, but was not on a sufficient scale to afford complete confirmation. Experiments on a larger scale are in progress.—J. C. **Chapman** and H. L. **Porter**: The physical properties of gold leaf at high temperatures.—Dr. H. C. **Pocklington**: The dimensions and function of the Martian canals. The nature of the bed of the canals is guessed from Lowell's value of the velocity of flow along them, and then the depth is calculated from the technical formulæ, assuming that the canals are horizontal and carry water from pole to pole. The depth is 500 feet if the canals are as narrow as possible, or 370 feet if they are 4500 feet wide. The amount of water required to fill the canals is determined. To find the function of the canals, it is assumed that their arrangement is the most economical, and it is deduced that they are essentially lines of communication, though, of course, they may also serve to carry water for irrigation.

Physical Society, October 22.—Dr. C. Chree, F.R.S., president, in the chair.—F. E. **Smith**: Cadmium amalgams and the Weston normal cell. Cadmium amalgams may be solid, liquid, or a mixture of solid and liquid phases, the composition of the phases depending on the temperature. When a liquid amalgam is cooled below the lower transition temperature, the centre of the resulting solid is of high cadmium concentration, and the outer skin of low cadmium concentration. Diffusion tends to pro-

duce uniformity, and in consequence the E.M.F. of a cell containing the amalgam is unstable for a considerable length of time. When the amalgam is cooled to a temperature a little below the lower transition temperature, the difference of concentration between the inner and outer parts of the amalgam need be only small to enable the outer skin to be a two-phase system. The diffusion process will be slow, and the E.M.F. may remain constant for a long time. Amalgams which were of uniform cadmium concentration were obtained by chilling liquid amalgams to a temperature of about −50° C.; although not initially stable, rapid diffusion processes resulted in these amalgams becoming approximately uniform throughout after a few days, and their electromotive properties were different from those of slowly cooled amalgams. The experiments indicate that a 12·5 per cent. amalgam may be used safely at all temperatures between 12° C. and 60° C., and a 10 per cent. amalgam at all temperatures between 0° C. and 51° C. Experiments were made on the temperature coefficients of the anode and kathode limbs of the Weston normal cell, and show that if a difference of temperature of 1° C. exists an error of about 3 parts in 10,000 is introduced.—F. **Soddy**: Production of radium from uranium. The measurements on the growth of radium in the three uranium solutions purified between three and four years ago have shown that in all the growth of radium is proceeding at a rate proportional to the square of the time. The ordinary error is not greater than 10^{-12} gram of radium. This result indicates the existence of only one long-lived intermediate product in the series between uranium and radium. The period of average life of this body is 18,500 years in the case of the oldest solution for which data are available; but for the solution prepared last, the period indicated is about half again as long as in the first experiment. Had this solution grown radium at the same rate, with reference to the square of the time, as the older solution has done during the past year, more radium should have been formed than the *total* amount now actually present. This suggests the existence of at least one new intermediate product in the series "uranium A." From a mathematical investigation of the effect of such a body on the rate of growth of radium, it is concluded that it would not, if it existed, appreciably alter the production of radium over the period accurate observations have been made; but its existence would vitiate the calculation of the period of the direct parent of radium according to the simple formula neglecting short-lived products.—F. **Soddy**: The rays and product of uranium X. Experiments have been made with the uranium X preparations separated from 50 kilograms of pure uranyl nitrate. There occurred the growth of a feeble α radiation as the intense β radiation decayed. Such a growth of α rays, concomitant with the decay of β rays, is to be expected if the parent of radium is the direct product of uranium X. From the period of the parent of radium, the uranium X in equilibrium with 1 kilogram of uranium should give by its complete disintegration a product having the α activity of 2 milligrams of uranium if no new intermediate bodies intervened. The preparations of uranium X were examined in a magnetic field sufficient to deviate all rays having a value for $H\rho$ less than 8640, but the still undeviated β radiation produced a leak in the electroscope several times greater than that due to the γ rays. These difficultly deviable β rays are similar in general character and in the value of their absorption coefficient to ordinary β rays. The first measurements were made in an electroscope filled with air. Later, the electroscope was filled with hydrogen, which constituted an enormous advance, and these experiments have shown that the α radiation of the preparation remains constant as the β radiation decays. Anomalies have been encountered with the difficultly deviable β radiation, which appears to vary in intensity according to the conditions; but throughout the "difference leak" between the preparation bare and covered, due to α rays, has remained constant in all the preparations examined. These measurements of the α rays, for different preparations, cover a period from immediately after preparation to nearly a year in the case of the main preparation, and longer periods in the case of weaker preparations. The two most recent preparations each contained the uranium X in equilibrium with about 5 kilograms of uranium, and the growth of α rays if the change of uranium X into the parent of radium were direct should be equal to the α radiation of 10 milligrams of uranium. The parent of radium cannot be the direct product of uranium X. The experiments indicate that it is not a product of uranium X at all, but the subsequent history of the uranium X preparations must be awaited before this can be decided.—F. **Soddy**: The production of helium from uranium and thorium. Helium has been detected in four experiments with uranium, in three with thorium, and in one with pitchblende solutions carried out according to the methods already published. Recent experiments with nearly a year's accumulation of helium from about 2 kilograms of uranium and thorium respectively have ended in failure owing to accidents.

Challenger Society, October 28.—Sir John Murray, K.C.B., F.R.S., in the chair.—Prof. d'A. W. **Thompson**: A new method of estimating the number of fish which escape through the meshes of the trawl. The first step was to envelop the trawl-bag loosely in a net of finer mesh, so that the catch was divided into larger specimens inside the trawl and smaller specimens between the trawl and the outer envelope. When curves of these two classes were plotted on the basis of numerous experiments, they naturally overlapped, the overlap representing fish of a length intermediate between those which could not possibly get through the trawl-mesh and those which were certain to slip through it. From the overlapped area a ratio could be deduced and tested in both directions against the curves, which appeared to give a fair measure of the small fish lost by an ordinary trawl without a finer envelope.

PARIS.

Academy of Sciences, November 2.—M. Bouchard in the chair.—M. **Le Chatelier** and S. **Wologdine**: The phosphides of iron. Of the nine apparent phosphides examined, only four have a certain existence, viz. Fe_3P, Fe_2P, FeP, FeP_3, but the composition of the last two is not so certainly established as that of the first two.—A. **Calmette** and C. **Guérin**: Some properties of tuberculous bacillus of bovine origin, cultivated on glycerinated beef bile. Experiments had shown that when guinea-pigs were inoculated with bacillus cultivated in this manner, a much greater virulence was developed, this, however, becoming steadily diminished by successive cultures. Further experiments on horses and heifers showed that with the former the virulence was not only increased, but remained so, while the latter showed the decreasing virulence evident in the guinea-pig.—M. **de Forcrand**: The bicarbonates of rubidium and cæsium. They form anhydrous crystals, stable on exposure at ordinary temperatures, neither absorbing water nor evolving carbon dioxide. The solubilities are much greater than that of potassium bicarbonate, whilst they are also more stable under heat.—J. **Bosler**: Magnetic perturbations and solar phenomena. Observations were made on the violent magnetic storm of September 25.—A. **Perot**: A means of protecting the silvering of mirrors. This consists in re-covering the mirror with an extremely thin layer of transparent celluloid. If the layer is only sufficiently thin, images remain intense, complete, and do not show diffusion.—P. **Helbronner**: The geodetic complementary triangulations of the high regions of the French Alps. The number of geodetic stations in this district has been raised to 126, of which fifteen are above 3000 metres and forty between 2000 and 3000 metres.—M. **Darmois**: The composition of the essences of terebenthine. The method indicated, based on the measurement of rotatory dispersion, suggests that the essences of terebenthine contain (1) pinene under its two forms; (2) a lævo-carbide in large quantity.—M. **Devaux-Charbonnel**: Note on an attempt to realise an artificial telephonic line.—H. **Baubigny**: Action of heat on the sulphite and double alkaline sulphites of silver. Formation of dithionate. The author believes that during decomposition at 100°, in presence of water, of silver sulphite, and the double alkaline sulphites, the production of di-thionic acid is the principal result.—C. **Gerber**: Localisation of proteolytic ferments in *Vasconcellea quercifolia*. There seems to exist a relation between the enzyme-forming character of certain plants and the coagulability of their latex.—E. **Kayser** and E. **Manceau**: The viscosity ferments of wines.

These are thick bacilli, of length usually less than 2 μ; all are sugar ferments, and anærobic.—B. **Collin**: The hypertrophied forms and degenerated growth among the Acinetians. Intensive culture and constant over-feeding are capable of producing on the organism of these infusoria profound modifications, both morphological and physiological.—Ph. **Dantzenberg**: The marine molluscs found in the scientific expeditions of M. A. Gruvel in West Africa, 1906–9.—W. **Wietrzykowski**: Contributions to the study of the development of Lucernarids.—G. **Eisenmenger**: The glacial excavation of Lake Garda (Italy). If the origin of the Lake of Garda is a tectonic depression dating from Mesozoic, or if, later, different movements took place with a dislocation of Mount Baldo, it is necessary to recognise that the actual configuration of Lake Garda is the work of a very powerful glacial excavation.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 11.

ROYAL SOCIETY, at 4.30.—The Vacuolation of the Blood-platelets—An Experimental Proof of their Cellular Nature: H. C. Ross.—Further Results of the Experimental Treatment of Trypanosomiasis—being a Progress Report to a Committee of the Royal Society: H. G. Plimmer and Captain W. B. Fry.—*Hillhousia mirabilis*, a Giant Sulphur Bacterium: G. S. West and B. M. Griffiths.—The Modes of Division of *Spirochaeta recurrentis* and *S. duttoni* as observed in the Living Organism: H. B. Fantham and Miss A. Porter.—On the Supposed Presence of Carbon Monoxide in Normal Blood and in the Blood of Animals anæsthetised with Chloroform: G. A. Buckmaster and J. A. Gardner.—The Origin and Destiny of Cholesterol in the Animal Organism. Part vi., The Excretion of Cholesterol by the Cat: G. W. Ellis and J. A. Gardner.—The Elasticity of Rubber Balloons and Hollow Viscera (with a Note by W. Sutherland): Prof. W. A. Osborne.

MATHEMATICAL SOCIETY, at 5.30.—Annual General Meeting.—(1) The Ordinal Relations of the Terms of a Convergent Sequence; (2) The Application to Dirichlet's Series of Borel's Exponential Method of Summation; (3) Theorems relating to the Summability and Convergence of Slowly Oscillating Series: G. H. Hardy.—Notes on Synthetic Geometry: Prof. W. Esson.—Kummer's Quartic Surface as a Wave Surface: H. Bateman.—The Green's Function in a Wedge, and Other Problems in the Conduction of Heat: Prof. H. S. Carslaw.—The Envelope of a Line cut Harmonically by two Conics: J. L. S. Hatton.—On a Case of q-Hypergeometric Series: Rev. F. H. Jackson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Presidential Address: Dr. Gisbert Kapp.

FRIDAY, NOVEMBER 12.

PHYSICAL SOCIETY, at 8.—On the Absorption Spectrum of Potassium Vapour: P. V. Bevan.—Some Further Notes on the Physiological Principles underlying the Flicker Photometer: J. S. Dow.—Exhibition of a Colour-perception Spectrometer: Dr. F. W. Edridge-Green.—Tables of Ber and Bei and Ker and Kei Functions, with Furthur Formulæ for their Computation: H. G. Savidge.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Observations of Jupiter, 1907–8: Scriven Bolton.—On the use of an Ordinary Telescope in the Zenith for Determination of Time and Latitude: R. H. M. Bosanquet.—Star Colours and Spectral Types: Stars of Spectrum Type O: W. S. Franks.—Observations of Jupiter's Galilean Satellites, 1909: R. T. A. Innes.—The Effective Temperature of 109 Fixed Stars: J. Wilsing and J. Scheiner.—A New Map of the Moon: W. Goodacre.—An Addition to the Theoretical Secular Acceleration of the Moon's Mean Motion: E. W. Brown.—An Error in the New Lunar Theory: E. W. Brown.—On the Plans for New Tables of the Moon's Motion: E. W. Brown.—The Magnetic Storm of 1909 Sept. 25, and the Associated Solar Disturbance: W. J. S. Lockyer.—A Solar Outburst and a Magnetic Storm: C. Michie Smith.—Spectroscopic Determination of the Systematic Motions of the Stars: S. S. Hough and J. Halm.—Mesures récentes sur la Planète Mars: R. Jonckheere.—Aberration Day Numbers for 1910: H. C. Plummer.—Description of the Society's Harrison Clock: E. T. Cottingham.—The Cyclones of the Indian Ocean, 1856–67, and their Association with the Solar Rotation: E. W. Maunder.—*Probable Papers*: Solar Parallax Papers, No. 8, The Mass of the Moon derived from Photographic Observations of Eros, 1900–1: A. R. Hinks.—The Sun-spots and Associated Magnetic Storm of 1909 September and October: Rev. A. L. Cortie.

MONDAY, NOVEMBER 15.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Mesopotamia: Past, Present, and Future: Sir William Willcocks, K.C.M.G.

TUESDAY, NOVEMBER 16.

MINERALOGICAL SOCIETY, at 8.—Anniversary Meeting.—On an Occurrence of Native Copper with Tin Ore in the Federated Malay States: J. B. Scrivenor.—On a Meteoric Stone from Simondium, Cape Colony: Dr. G. T. Prior.—On Sartorite and other Minerals from the Binnenthal: Prof. W. J. Lewis.—On the Occurrence of Alstonite and Ullmannite, a Species New to Britain in a Barytes-witherite Vein in the New Brancepeth Colliery, near Durham: L. J. Spencer.—A Pocket Sclerometer: C. J. Woodward.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Discussion*: The Single-phase Electrification of the Heysham, Morecambe and Lancaster Branch of the Midland Railway: J. Dalziel and J. Sayers.—The Equipment and Working-results of the Mersey Railway under Steam and under Electric Traction: J. Shaw.—The Effect of Electrical Operation on the Permanent-way Maintenance of Railways, as Illustrated on the Tynemouth Branches of the North-Eastern Railway: Dr. C. A. Harrison.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—The Rothwell Crania: F. G. Parsons.

ROYAL STATISTICAL SOCIETY, at 5.—Inaugural Address: Sir J. A. Baines, President.

WEDNESDAY, NOVEMBER 17.

ROYAL SOCIETY OF ARTS, at 8.—An Imperial Navy: Sir W. H. White, K.C.B., F.R.S.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Methods Employed for Observing Pilot Balloons: C. J. P. Cave.—Registering Balloon Ascents at Gloucester, June 23 and 24, 1909: W. Marriott.—Winter Temperatures on Mountain Heights: W. P. Brown.—The Semi-diurnal Variation of Rainfall: E. Gold.

GEOLOGICAL SOCIETY, at 8.

ENTOMOLOGICAL SOCIETY, at 8.

ROYAL MICROSCOPICAL SOCIETY, at 8.—On the Recent and Fossil Foraminifera of the Shore Sands of Selsey Bill, Sussex; Part iv.: Edwd. Heron-Allen and A. Earland.

THURSDAY, NOVEMBER 18.

ROYAL SOCIETY, at 4.30.—Bakerian Lecture: The Statistical and Thermodynamical Relations of Radiant Energy: Sir J. Larmor, Sec. R.S.

LINNEAN SOCIETY, at 8.—A New Tipulid Subfamily: W. Wesché.—Freshwater Rhizopods from the English Lake District: J. W. Brown.

INSTITUTION OF MINING AND METALLURGY, at 8.

FRIDAY, NOVEMBER 19.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—An Internal-combustion Pump and other Applications of a New Principle: Herbert A. Humphrey.

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